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1 Preface

Thank you for choosing this Doosan Robotics product. Before installing the product, please read this manual completely and follow the instructions for each installation process provided herein. The contents of this manual are accurate as of the date that they are written, and product-related information may be modified without prior notice to the user.

1.1 Copyright

The copyright of this manual and all intellectual property rights contained herein are held by Doosan Robotics. Therefore, using, copying, or distributing any part of this manual without receiving written permission from Doosan Robotics is strictly prohibited. In the event of abuse to or modification for use of any patent, the user will be fully responsible for the consequences.

While the information in this manual is reliable, Doosan Robotics will not be held responsible for any loss or damage that occurs due to errors or typos. The contents of this manual may be modified according to product improvements without prior notification.

Details on updates to the manual can be found on the Robot LAB website (https://robotlab.doosanrobotics.com/).

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1.2 Open Source Software License Information (OSS)

The software installed in this product was developed based on free/open source software.

Details on licensing of free/open source software license can be found on the OSS use page on the Doosan Robotics website (www.doosanrobotics.com/kr/oss/license[1]).

For related inquires, contact the Marketing Department of Doosan Robotics (marketing.robotics@doosan.com[2]).

1 https://www.doosanrobotics.com/kr/oss/license
2 mailto:marketing.robotics@doosan.com

2 PART 1. Safety Manual

The Safety provides safety information the user must be aware of before installing or operating the robot. All robots have risks of high voltage, electricity, and collision. Therefore, in order to minimize the risk of injuries and mechanical damage, one must observe the basic safety cautions while operating the robot and using related parts. To protect user safety and prevent property loss, make sure to read and follow the instructions carefully. The contents of the manual and specifications of the product may change for product and performance improvements.

2.1 Manual Indication Conventions

To communicate safety precautions related to the use of the product, the following symbols are indicated in this manual.

Symbol	Name	Description
Danger	**Danger**	Failure to observe instructions with this symbol may result in serious accidents that could result in death or serious injury to the operator.
Warning	**Warning**	Failure to observe instructions with this symbol may result in serious accidents that could result in death or serious injury to the operator.
Caution	**Caution**	Failure to observe instructions with this symbol may result in product damage or cause injury to the operator.
Note	**Note**	This is additional information to help the user.

2.2 Safety Symbols

Among the symbols used in this manual, symbols related to user safety are as follows:

Symbol	Description
Danger 	This symbol means that immediate hazards can occur due to electrical conditions such as high voltage. Failure to observe instructions with this symbol may result in serious accidents that could result in death or serious injury to the operator.

Symbol	Description
Danger	This symbol means that immediate hazards can occur. Failure to observe instructions with this symbol may result in serious accidents that could result in death or serious injury to the operator.
Warning	This symbol means that potentially dangerous situations can occur due to electrical conditions such as high voltage. Failure to observe instructions with this symbol may result in serious accidents that may cause serious injury to the operator.
Warning	This symbol means potentially dangerous situations can occur. Failure to observe instructions with this symbol may result in serious accidents that may cause serious injury to the operator.
Caution	This symbol means dangerous situations can occur due to overheating. Failure to observe instructions with this symbol may result in serious accidents that may cause serious injury to the operator.
Caution	The product may become damaged or the operator may suffer injury.

2.3 General Instructions

This chapter describes general danger and warning items related to operating the robot.

Warning

- If the robot is installed with electrical devices, install the robot referring to the Installation Manual.

Warning

- If a device is installed on the tool during robot installation, make sure to use appropriate bolts.
- Suitable safety measures, such as safety fences, must be implemented to protect the staff and robot during installation.
- Never operate a damaged robot.
- Make sure to connect safety protection equipment with a safety interface. If such equipment is connected to a general interface, the integrity of safety functions may not be guaranteed.
- If the robot collides with an external object, a significant impact may be generated. The impact the robot receives is proportionate to the kinetic energy, so higher speeds and high payload can generate large impacts. Make sure to maintain a safe speed and payload during operation in collaborative spaces.
- If the robot axis must be rotated when the robot is not operated, it can be rotated at a torque greater than 400 Nm.
- Modifying the robot without prior approval may cause critical breakdowns and accidents.

Caution

- Operating the robot and controller for an extended period of time generates heat. Do not touch the robot with bare hands after operating for an extended period of time. Before performing work that requires touching the robot, such as tool installation, leave the robot for more than 1 hour after turning off the power of the control unit to cool down the robot.

Caution

- Do not expose the robot to powerful magnetic fields. It may cause damage to the robot.
- If the power plug is disconnected or the power is shut off during robot and controller operation, robot and controller failure can occur.
- Do not use the controller being laid. To avoid getting a hand caught in the door by accident, make sure to keep it upright while working with the door open.

2.4 Precautions for Use

Danger

- Do not operate the robot if the robot is abnormal. The user may be injured.
- Do not put fingers inside the controller with power supplied. Live cables are connected, which may lead to electrocution or injury.
- Do not modify the robot. Doosan Robots is not responsible for for any issues that occur due to unauthorized modification.
- Do not enter the robot's operation area or touch the robot when it is operating. This may lead to colliding with the robot, resulting in damage to the robot or injury to the individual.

Warning

- Make sure to read and understand the manuals for all equipment installed.
- To prevent accidents by getting caught by the robot, do not wear loose clothing or accessories when operating the robot. Tie long hair to prevent accidents with hair getting caught by the robot.
- Before operating the robot, comprehensive risk assessment must be performed.
- Safety-related parameters must be determined through the comprehensive risk assessment, and safety parameter settings and the operation of safety functions must be verified before operating the robot.
- Before starting robot operation(Jogging, handguiding, running task program, etc.), make sure that the actual payload and installation are correct and that the actual pose of robot is identical to the pose on screen.
- Nudge and Hand-guiding must only be used if risk assessment approves its use.
- If an error occurs on the controller or the teach pendant, activate the emergency stop function, identify the cause of the error, find the error code on the log screen and contact the supplier.
- Make sure to become completely familiar with the robot user manual prior to operating the robot.
- If the teaching pendant warns the user of a critical error, immediately engage the emergency stop switch, identify the cause of the error, resolve the error and then resume robot operation. If the critical error cannot be resolved, contact the sales agent or robot supplier.
- Direct teaching must only be performed in safe environments. Do not operate the robot if there are sharp edges or jamming near the tool and its surroundings.

- Before performing direct teaching, make sure accurate inputs (tool length, weight, center of gravity) are made. If inputs are different from the tool specification, direct teaching error or malfunctioning can occur.
- To ensure user safety, joints may operate at a certain speed or higher, or the maximum speed of the TCP may be limited during direct teaching. If the limit is exceeded, the protective stop function activates.
- Enable/disable the direct teaching function when the robot has completely stopped. If the direct teaching function is enabled/disabled during robot operation, malfunctions may occur.

Caution

- Take caution of the robot’s movement when using the teach pendant. Failure to do so may lead to colliding with the robot, resulting in damage to the robot or injury to the individual.
- Collision with an object generates considerable kinetic energy, leading to dangerous situations. This energy is proportionate to the speed and payload. (Kinetic Energy = 1/2 Mass x Speed^2)
- Combining different machines may increase existing risks or create new risks. When a robot is integrated into a system, perform risk assessment of the entire system.
- If different safety levels and emergency stop performance levels are required, always select the higher level.
- If a machine that can cause damage to the robot is integrated, it is recommended to individually test all functions and robot programs.
- It is recommended to test the robot program by designating temporary waypoints outside another machine’s workspace. Doosan Robotics is not responsible for damages that occur due to programming error or robot malfunctioning, as well as damage to the equipment.
- If the power plug is disconnected or the power is shut off during robot and controller operation, robot and controller failure can occur.
- For information about additional modules, refer to corresponding manuals.

2.5 Product Usage

This is an industrial product designed specifically for purposes of transferring and assembling objects by attaching components to products using tools, and it must be operated in the conditions specified in its specifications.

This product features special safety functions designed for the purpose of collaborating with human operators, and it operates with human operators without specific boundaries. Conduct work with the system only when all applications, including the tool, workpiece, boundary and other equipment, are confirmed to have no harm.

The following uses are considered inappropriate because they exceed the boundaries of the product’s intended purpose. Doosan Robotics will not be held responsible for any damage and malfunctioning of the robot, property losses and injuries to users due to such inappropriate uses.

- Use in an environment with potential explosions
- Use in application related to medicine and human lives
- Use in transporting humans and animals
- Use without risk assessment
- Use in locations where performance and operation environment specifications are not met
- Use in environments with insufficient safety functions
- Use of the robot as a step to stand on
- Use under conditions beyond the IEC International Standard for Electromagnetic Compatibility in Industrial Environments

2.6 Risk Assessment

legally mandatory in most countries. In addition, safety assessment of robot installation changes according to the overall system integration method, so it is impossible to perform risk assessment solely with the robot.

In order to perform risk assessment, the administrator overseeing the overall system establishment must install and operate the robot according to ISO12100 and ISO10218-2. In addition, the administrator can refer to the technical specification, ISO/TS 15066.

Risk assessment must consider the overall work process in terms of the overall life cycle of the robot application. Key objectives of risk assessment are as follows:

- Robot setting and work teaching for robot operation
- Troubleshooting and maintenance
- Proper robot installation

Before supplying power to the robot arm, make sure to perform a risk assessment. Setting appropriate safety settings and identifying the need for additional emergency stop buttons and other protective measures are parts of risk assessment.

Identifying appropriate safety settings is a critical aspect of developing a collaborative robot application. For more information, refer to the corresponding chapter of the manual.

Some safety functions are designed specifically for collaborative robot applications. These functions can be set up through safety function settings, and they are optimized for responding to specific risks identified through the risk assessment performed by the integrator.

The safety functions of the collaborative robot can be set up in the safety setting menu, and they offer the following features:

- Force and power limitation: Limits the stopping force and pressure of the robot in case of collisions between the robot and a worker
- Momentum limitation: Limits the energy and impact load by reducing the speed of the robot when a collision between the robot and a worker occurs
- Joint position and TCP limitation: Limits robot movement to prevent moving towards specific body parts of users such as the neck or head

- TCP and tool pose limitation: Limits certain areas or characteristics of a tool and workpiece to minimize related risks (i.e., limits the movement of sharp edges of workpieces aimed at users)
- Speed limitation: Limits robot movement to stay at low speed in order to secure time for the user to avoid a collision before a collision between the robot and a worker occurs

Applying appropriate safety settings is considered to be the same as fixing the robot to a specific location and connecting it to a safety-related I/O. For example, setting password protection can prevent unauthorized safety setting changes by individuals not approved by the system integrator.

Key items to note when performing risk assessment of the collaborative robot application are as follows:

- Severity of individual potential collisions
- Probability of individual potential collision occurrence
- Probability of individual potential collision avoidance

If the robot is installed on a non-collaborative robot application that cannot sufficiently remove risks using its internal safety functions (e.g., use of dangerous tool), the system integrator must decide to install additional protection devices during risk assessment (e.g., use of protection devices capable of protecting the integrator during installation and programming).

2.7 Robot Mode and State

The operation modes of the robot consist of Manual Mode, where the user controls the robot directly, and Auto mode, where the robot operates without direct user control.

2.7.1 Manual Mode

This is the mode in which the robot operates according to direct user control. The robot only operates when a button related to an action is pressed, and releasing the button results in stopping the corresponding action.

- In Manual Mode, the TCP movement speed is limited to less than 250 mm/s according to the Robot Safety Regulations. However, when handguiding, the limits set in **Robot Parameter > Safety Settings > Robot Limits** are applied.
- If risk assessment results indicate that a 3-position Enable Switch is necessary, the 3-position Enable Switch can be connected in Robot **Parameter> Safety Settings > Safety I/O**. In this case, the Enable Switch must be set in the center position to allow the robot to operate in Manual Mode and to turn on the servo.

In Manual Mode, it is possible to configure robot peripherals in **Robot Parameters** or to program robot tasks in **Task Editor**, and if the robot cannot be operated normally for reasons such as the robot exceeding the safety threshold, the Recovery function can be performed to restore normal operation.

2.7.2 Automatic Mode

This is the mode in which the robot operates without direct user control. The robot will execute the programmed task or predefined sequence with a simple operation command and without additional user input.

Task Editor can verify the programmed task in virtual mode, execute it in actual operation, and perform robot tool weight and automatic weight center measurement functions.

- If risk assessment results indicate that a 3-position Enable Switch is necessary, the 3-position Enable Switch can be connected in the **Robot Parameter > Safety Settings > Robot Limits** setting. In this case, the Enable Switch must be set in the center positionto play or start, or resume Automatic Mode and to turn on the servo..

2.7.3 Other Mode

Unlike normal modes such as manual mode and automatic mode, this is exceptional mode.

This mode includes special states such as controller booting, initializing and states related to Backdrive at which you can push robot by hand without drive power.

2.7.4 Status and Flange LED Color for Each Mode

Manual Mode

Mode	Status		Description	Flange and/or base LED
Manual	Manual Standby		• This is the default status of teaching. • **Robot Parameter** and **Task Editor** can be used to configure the work condition or perform task programming. • It monitors the stop status with Safe Operating Stop (SOS).	Blue
		Manual Jogging	• The jog function is used to operate the robot.	Blue Flashing
		Manual Handguiding	• The manipulator can be operated directly by hand.	Light blue flashing
	Recovery Standby		• Recovery in progress. • All safety functions except for axis and TCP speed monitoring are disabled during recovery. • It monitors the stop status with Safe Operating Stop (SOS).	Yellow Flashing

Mode	Status		Description	Flange and/or base LED
		Recovery Jogging	• The jogs of each axis can be used to correct the exceeded safety threshold.	Yellow Flashing
		Recovery Handguiding	• The manipulator can be moved directly by hand to correct the exceeded safety threshold.	Yellow Flashing
	Interrupted		• Protective Stop is activated by a Protective Stop input or exceeding the safety threshold. • It monitors the stop status with Safe Operating Stop (SOS). • A yellow protective stop pop-up appears. After the cause of the protective stop is removed, pressing the Reset button will switch the robot status to **Manual Standby** and the pop-up will disappear. • If the exceeded safety limit cannot be released without moving the robot, it can be released by pressing the Recovery button to enter safety recovery mode and moving the robot. • If it is not possible to release the protective stop input from the protective device, pressing the Safety I/O button can cancel the protective stop input setting to release it.	Yellow
	Servo Off		• The servo is turned off due to an emergency stop or Protective Stop input, or exceeding the safety threshold. • It is identical to Safe Torque Off (STO). • The servo can only be turned on when the cause of the emergency stop or protective stop has been cleared. • If the exceeded safety limit cannot be released without moving the robot, it can be released by turning on the servo in the safety recovery mode screen and moving the robot. • If it is not possible to release the protective stop input from the protective device, canceling the protective stop input setting in the Safety I/O setting menu releases it.	Red (M/H Series)

Automatic Mode

Mode	Status	Description	Flange and/or base LED
Auto	Auto Standby	• The UI of the Teach Pendant is the actual mode execution screen in the workspace. • Press the Execute button to execute the task program. • White is displayed for a single work area and green is displayed for a collaborative work area.	White / Green
	Auto Running	• The task program is being executed. • White is displayed for a single work area, green is displayed for a collaborative work area, and white and yellow are displayed in turn for a priority work area.	White Flashing / Green Flashing White & yellow Flashing in turn
	HGC (HandGuide Control) Standby	• The Handguiding command is executed during task program execution. • The system waits until the user presses the "Handguiding" button. • It monitors the stop status with Safe Operating Stop (SOS).	Light blue
	HGC Running	• The robot pose can be changed by pressing the Handguiding button. • After the robot stops 3 times, if the HGC End & Resume signal is input via Safety IO, it switches to Auto Running and the task program is subsequently executed.	Light blue flashing
	Auto-measure	• The weight center point of the end effector is measured automatically. Please note that the safety monitoring functions of the robot are disabled.	Yellow Flashing

Mode	Status	Description	Flange and/or base LED
	Interrupted	• Protective Stop is activated by a Protective Stop input or exceeding the safety threshold. • It monitors the stop status with Safe Operating Stop (SOS). • A yellow protective stop pop-up appears. After the cause of the protective stop is removed, pressing the Reset button will switch the robot status to **Manual Standby** and the pop-up will disappear. • If the exceeded safety limit cannot be released without moving the robot, it can be released by pressing the recovery button to enter safety recovery mode and moving the robot. • If it is not possible to release the protective stop input from the protective device, pressing the Safety I/O button can cancel the protective stop input setting to release it.	Yellow
	Servo Off	• The servo is turned off due to an emergency stop or Protective Stop input, or exceeding the safety threshold. • It is identical to Safe Torque Off (STO). • The servo can only be turned on when the cause of the emergency stop or protective stop has been cleared. • If the exceeded safety limit cannot be released without moving the robot, it can be released by turning on the servo in the safety recovery mode screen and moving the robot. • If it is not possible to release the protective stop input from the protective device, canceling the protective stop input setting in the Safety I/O setting menu releases it.	Red (M/H Series)

Other status

Mode	Status	Description	Flange and/or base LED
-	Backdrive Hold	• The brakes on all 6 axes are engaged, locking out unpowered operation.	Yellow Flashing
	Backdrive Release	• Brake Release has been selected, causing 1 or more joints to be released. • Note that if the robot is released without the brake being re-engaged, the axis will not be fixed and will fall.	Yellow Flashing

Mode	Status	Description	Flange and/or base LED
	Backdrive Servo Off	• Servo turned off due to an emergency stop or joint speed limit exceeded. • It is identical to Safe Torque Off (STO).	Red (M/H Series)
	Initializing	• This is the process of booting up the controller and initializing the robot.	Red flashing

2.8 Product Warranty and Responsibility

Doosan Robotics (hereinafter referred to as “Doosan” or “Manufacturer”) offers a restricted warranty as stipulated in this warranty certificate for all robot systems (collectively “robot”) and parts of the system (excluding parts that are exceptions or restricted according to the terms and conditions below) sold through Doosan or official sales agents. The warranty stipulated by this warranty certificate is a restricted warranty, and it is the only warranty provided by the Manufacturer. All warranty items shall be handled according to the conditions listed below.

2.8.1 Scope of Warranty

The material and manufacturing defects of each robot and its parts (collectively, “Doosan Products”) are subject to the warranty provided by the Manufacturer. This warranty is only offered to the end user (hereinafter referred to as “Customer”). The warranty period is 1 year starting from the date when the robot was installed.

The scope of this warranty limits the Manufacturer's only responsibility for all Doosan products and the Customer's only remedy to the repair or replacement of defective Doosan products.

Doosan does not compensate any or all financial, operation or productions losses, any or all indirect losses such as damage to other equipment, and any or all deliberate, special or consequential losses that occur due to defects of Doosan Products.

2.8.2 Restrictions and Exceptions of Warranty

To maintain the warranty, thorough maintenance procedures stipulated by the Manufacturer must be observed and recorded. This warranty is voided if the Manufacturer determines that the user failed to observe the following stipulated procedures.

- If a Doosan Product is inappropriately handled or used by the user
- If parts or S/W not provided by Doosan are installed
- If a Doosan Product is incorrectly repaired or maintained by an unofficial repair technician or unauthorized individuals
- If the user modified a Doosan Product without prior approval from the Manufacturer
- If a Doosan Product was used for non-industrial or personal purposes
- If the life cycle of consumables has ended

- If the warranty claim is made after the warranty period
- If the breakdown is caused by natural disasters (fire, flood, abnormal power, etc.)

This warranty does not apply to damages caused by external circumstances the Manufacturer does not have any control over such as theft, intentional destruction, fire, natural disasters, war or act of terrorism.

Notwithstanding the exceptions or restrictions of this warranty, this warranty does not include any warranties where a Doosan Product satisfies the buyer's production standards or miscellaneous requirements, or operates without any errors or without any interruption. The Manufacturer does not assume responsibility for any uses by the buyer, and the Manufacturer does not assume any responsibility for defects other than repair or replacement such as defects in design, production, operation and performance.

2.8.3 Transfer

This warranty is included in the warranty period, and if the Doosan robot is sold to a different individual through a private transaction, the warranty can also be transferred. However, the warranty is only valid if the Manufacturer is notified of this transaction, and the warranty period is still in effect. The assignee of this warranty must observe all conditions stipulated in this warranty.

2.8.4 Contact

marketing.robotics@doosan.com[3]

2.9 Safety Function

Users/system integrators can make use of the various safety functions, including safety-rated stop function, monitoring function and interface function, to protect operators and machines, and can also connect other machines and safety/protection equipment.

Each safety-rated stop function, monitoring function and interface function satisfy Category 3, Performance Level d(PL d) defined by ISO 13849-1 and Hardware Fault Tolerance 1, Safety Integrity Level 2(SIL 2) defined by IEC 62061.

The joint-level operated safety functions of Doosan Robotics uses the safety functions described in IEC 61800-5-2.

Note

- Work cells must be set using the safety functions and interface according to the risk assessment performed on the corresponding robot application by the system integrator, and refer to this manual for information required for this..
- If the safety systems of the robot detect system defects, such as hardware defects including emergency stop circuit shortage, position sensor damage or control communication error, Stop Category 0 is immediately initiated.

3 mailto:marketing.robotics@doosan.com

- Meanwhile, if the safety systems of the robot detect violations during safety monitoring, such as pressing the emergency stop switch, protective stop signal input, detection of external impact, or physical parameters (robot/TCP position, speed, momentum) exceeding set parameters, the system stops the robot using the mode set as the stop mode setting in the safety setting menu. (Selects Stop Category 0, 1 or 2)
- For information on the time and stopping distance until the robot comes to a full stop from the moment the above error or violation occurs, refer to Stop Distance and Stop Time(p. 72). This time must be considered as part of the risk assessment performed by the system integrator.
- In special cases (collision detection, TCP Force Violation), a Safety Stop Mode that stops the robot after accepting the external force for 0.25 seconds after event occurrence can be used to avoid clamping situations where limbs are jammed between the fixated jig/workpiece and the robot. (RS1 Stop Mode)
- The safety setting menu can set various safety functions to limit the movement of joints, robot and TCP. TCP means the location of the output flange center point added by the TCP offset.

2.9.1 Safety-rated Stop Subfunction

Safety-rated stop subfunction is used to stop the robot when Safety-Rated Monitoring Function(p. 26) detects limit violation or when a stop signal is received from the dedicated input terminal of Safety-rated Stop Subfunction(p. 21).

Note

- PFHd (Probability of a dangerous Failure per Hour): The probability of dangerous safety-related system/subsystem failures occurring in an hour
- PL (Performance Level): The performance level of safety-related components (SRP/CS) of control system defined by ISO 13849-1
- SIL (Safety integrity level): The safety integrity level of safety-related electronic control systems (SRECS or SCS) according to IEC 62061
- Stop Category: The category of stop functions defined by IEC 60204-1

	Safety Function	Description	PFHd	PL, SIL
1	STO (Safe Torque Off) & SBC (Safe Brake Control)	It is the safety stop function corresponding to Stop Category 0, and it immediately cuts motor power to all joint modules. WIth motor power down, the axis will continue to rotate due to inertia, so the brakes must be operated simultaneously to stop with frictional force of the brake. • As the motor power is cut off, the robot can be operated after releasing the stop function and setting the Servo On. • For more information about servo on methods, refer to What is Servo On? (p. 238) • The robot brake is used for maintaining the current pose when driving force is lost (i.e., power off, etc.) not for deceleration. Frequently using STO can result in brake wear or decelerator durability loss, so it is recommended to use SS1 unless necessary.	2.87E-8 /h	PL e Cat. 4 SIL 3

	Safety Function	Description	PFHd	PL, SIL
2	SS1 (Safe Stop 1)	This is the safety stop equivalent of Stop Category 1, which decelerates all joints to the maximum possible to stop, then cuts the power to the motor and engages the brake to keep it stationary. • If the predefined deceleration does not occur normally during stopping, it is switched to STO stop. • Power is cut off after deceleration, and like STO, the robot can be operated after releasing the stop function and setting the Servo On. • For more information about servo on methods, refer to What is Servo On?	1.78E-7 /h	PL d Cat. 3 SIL 2
3	SS2 (Safe Stop 2)	This is the safety stop equivalent of Stop Category 2, which decelerates all joints to the maximum possible to stop, then switches it to the stop status monitoring function. • If the predefined deceleration does not occur normally during stopping, it is switched to STO stop. • All joints are stopped with maximum deceleration by a Stop Mode corresponding to Stop Category 2, and SOS (Safe Operating Stop) is engaged.	1.78E-7 /h	PL d Cat. 3 SIL 2

	Safety Function	Description	PFHd	PL, SIL
4	Reflex Stop (RS1)	It is the safety stop function corresponding to Stop Category 2, and it utilizes Floating Reaction (a function to comply with the external force for a moment after the collision is detected) to respond to external force, and Safe Operating Stop (SOS) is engaged. • If excessive location, change in direction or speed is detected during Floating Reaction, or if deceleration is not done appropriately during stopping, STO stop is engaged.	1.93E-7 /h	PL d Cat. 3 SIL 2

2.9.2 Safety-Rated Stop Function

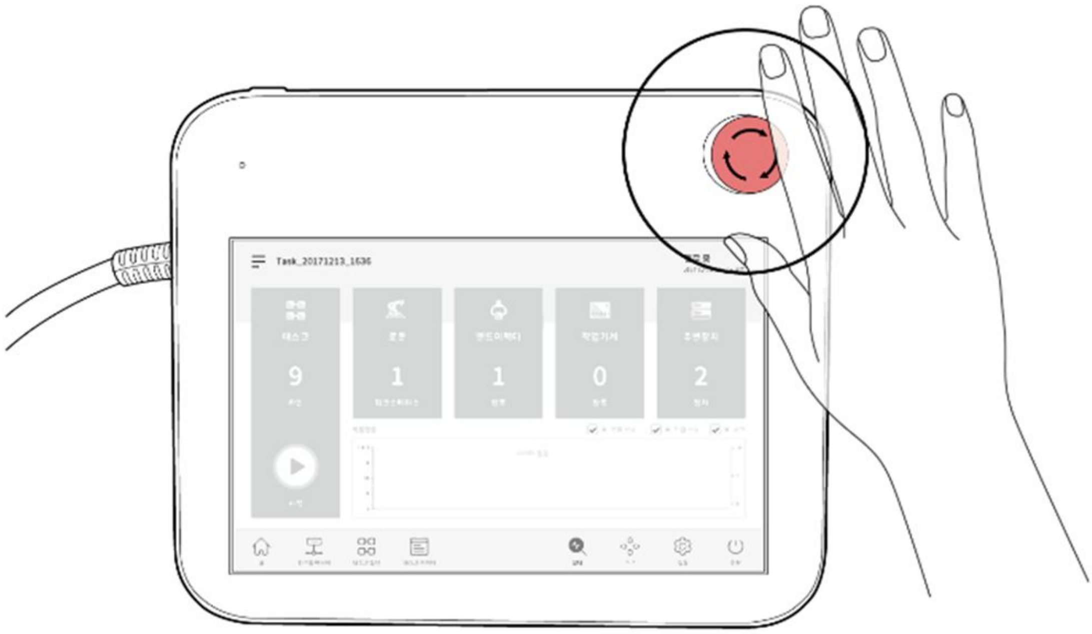
	Safety Function	Safety Function Trigger Condition Triggering Event	Intended Action Intended Result	PFHd	PL, SIL
1	Emergency Stop	If the Emergency Stop switch connected to the TBSFT EM terminal is pressed If the Emergency Stop switch of the teach pendant is pressed	Emergency Stop is engaged according to the configured Safety Stop Mode. • STO or SS1	2.87E-8 /h	PL e Cat. 4 SIL 3
2	Protective Stop	In case the protective equipment connected to the PR terminal of TBSFT is activated,	Emergency Stop is engaged according to the configured Safety Stop Mode. • STO, SS1, or SS2	1.78E-7 /h	PL d Cat. 3 SIL 2

How to resume work after a protective stop

- If the tool center point (TCP) of the robot is within the Collaborative Zone and the Nudge function is enabled, the user can apply force to the robot directly (Nudge) to resume work. For more information, refer to Setting the Collaborative Zone(p. 304) and Nudge.

Emergency Stop

The Emergency Stop button is available to stop the system in case of an emergency. In emergency situations, press the Emergency Stop button in the top right corner of the teach pendant to immediately stop the system.



> **Note**
>
> - Emergency stops should be used as a complementary protective measure, not as a safeguard.
> - The safety stop mode for the emergency stop is set to Safe Stop 1 (SS1) by default.
> - Additional Emergency Stop buttons can be installed if deemed necessary as a result of evaluating the risk to the robot application.
> - The Emergency Stop button must comply with IEC 60947-5-5.
> - If an emergency stop triggered through the port set in Safety I/O, the button capable of accessing the screen for Safety Input setting at the bottom of the emergency stop popup window is enabled.

Protective Stop

The robot also features Protective Stop function which can stop the robot using pressure sensitive protective equipment, such as safety matts, or electro-sensitive protective equipment, such as light curtain laser scanners.

For more information about connecting protective devices, refer to Setting the Terminal Block for Contact Input (TBSFT)(p. 169) and Configuring Configurable Digital I/O (TBCI1 - 4,TBCO1 - 4)(p. 172).

2.9.3 Safety-Rated Monitoring Function

두산로봇은 위험성평가를 통한 위험 저감조치로 사용할 수 있는 안전정격 감시기능을 제공합니다. The threshold detected by each monitoring function can be configured in the Robot Parameter> Safety Settings > Robot Limits.

Note

- Safety limits is the condition where the safety-rated monitoring function triggers the stop function. When stop is completed, the position of the robot and force applied externally may differ from the configured safety limit.
- PFHd (Probability of a dangerous Failure per Hour): The probability of dangerous safety-related system/subsystem failures occurring in an hour
- PL (Performance Level): The performance level of safety-related components (SRP/CS) of control system defined by ISO 13849-1
- SIL (Safety integrity level): The safety integrity level of safety-related electronic control systems (SRECS or SCS) according to IEC 62061

	Safety Function	**Safety Function Trigger Condition** **Triggering Event**	**Intended Action** **Intended Result**	**PFHd**	**PL, SIL**
1	SOS (Safe Operating Stop)	The current position is maintained with power supplied to the motor and the brake disengaged (Servo ON state). If the angle of one axis exceeds a certain angle when stopped	STO	1.78E-7 /h	PL d Cat. 3 SIL 2
2	SLP Joint Angle Limit SLP (Joint Angle Limit)	If any of the axis angles exceed the configured limit	Emergency Stop is engaged according to the configured Safety Stop Mode. • STO, SS1, or SS2	1.78E-7 /h	PL d Cat. 3 SIL 2
3	SLS Joint Speed Limit SLS (Joint Speed Limit)	If any of the axis speeds exceed the configured limit	Emergency Stop is engaged according to the configured Safety Stop Mode. • STO, SS1, or SS2	1.78E-7 /h	PL d Cat. 3 SIL 2

	Safety Function	Safety Function Trigger Condition Triggering Event	Intended Action Intended Result	PFHd	PL, SIL
4	SLT Joint Torque Limit SLT (Joint Torque Limit)	If the torque applied to each axis exceeds the predefined limit	Emergency Stop is engaged according to the configured safety stop mode. • STO	1.93E-7 /h	PL d Cat. 3 SIL 2
5	Collision Detection Collision Detection	If any of the torques applied to each axis exceed the limit for configured collision detection sensitivity	Emergency Stop is engaged according to the configured Safety Stop Mode. • STO, SS1, SS2, or RS1 • Stop Mode for **Collaborative Zone**and **Standalone Zone** can be set individually.	1.93E-7 /h	PL d Cat. 3 SIL 2
6	TCP/Robot Position Limit #TCP/Robot Position Limit#	When the TCP or robot (including Tool Shape) deviates from or encroaches the range set in the space limit,	Emergency Stop is engaged according to the configured Safety Stop Mode. • STO, SS1, or SS2	1.78E-7 /h	PL d Cat. 3 SIL 2
7	TCP Orientation Limit TCP #Orientation Limit#	If the difference between the set direction and the TCP orientation exceeds the configured threshold within the Tool Orientation Limit Zone,	Emergency Stop is engaged according to the configured Safety Stop Mode. • STO, SS1, or SS2	1.78E-7 /h	PL d Cat. 3 SIL 2
8	TCP Speed Limit #TCP Speed Limit#	If the TCP speed exceeds the configured threshold,	Emergency Stop is engaged according to the configured Safety Stop Mode. • STO, SS1, or SS2	1.78E-7 /h	PL d Cat. 3 SIL 2

	Safety Function	Safety Function Trigger Condition Triggering Event	Intended Action Intended Result	PFHd	PL, SIL
9	TCP Force Limit TCP Force Limit	If the external force applied to the TCP exceeds the configured limit	Emergency Stop is engaged according to the configured Safety Stop Mode. • STO, SS1, SS2, or RS1 • Stop Mode for **Collaborative Zone**and **Standalone Zone** can be set individually.	1.93E-7 /h	PL d Ca t. 3 SIL 2
10	Robot Momentum Limit Robot Momentum Limit	If the momentum of the robot exceeds the configured limit	Emergency Stop is engaged according to the configured Safety Stop Mode. • STO, SS1, or SS2	1.78E-7 /h	PL d Ca t. 3 SIL 2
11	Mechanical Power Limit #Robot Power Limit#	If the mechanical power of the robot exceeds the configured threshold,	Emergency Stop is engaged according to the configured Safety Stop Mode. • STO, SS1, or SS2	1.78E-7 /h	PL d Ca t. 3 SIL 2

2.9.4 Safety-Rated I/O

Doosan Robotics provides a safe-rated input interface to which safety protection devices, protection devices, emergency stop switches, control devices, etc., can be connected. In addition, a safety-rated output interface is provided that outputs the robot mode and status information as well as whether the TCP is inside various types of safe areas.

Note

- PFHd (Probability of a dangerous Failure per Hour): The probability of dangerous failures of safety-related system/subsystem per hour
- PL (Performance Level): The performance level of safety-related components (SRP/CS) of control system according to ISO 13849-1
- SIL (Safety integrity level): The safety integrity level of safety-related electronic control systems (SRECS or SCS) according to IEC 62061

	Safety Function	Description	PFHd	PL, SIL
1	Safety IO	A duplexed interface for safety related signal input and output If the input signals do not match or if duplexed output signal feedbacks do not match, it stops the robot and displays an error message.	4.04E-8 /h	PL d Cat. 3 SIL 2

It is the safety-rated input and output, and it offers following functions: For more information, refer to Safety Signal I/O(p. 33).

Safety Input	Safety Output
Emergency Stop (L), Emergency Stop - No Loopback (L), Protective Stop (L), Protective Stop - STO (L), Protective Stop - SS1 (L), Protective Stop - SS2 (L), Protective Stop (L) - Auto Reset & Resume (R), Interlock Reset (R), Reduced Speed Activation(L), 3-Pos Enable Switch (H), Handguiding Enable Switch (H), Remote Control Enable (H), Safety Zone Dynamic Enable (H), Safety Zone Dynamic Enable (L), HGC End & Task Resume (R)	Emergency Stop (L), Emergency Stop - excl. No Loopback Input (L), Safe Torque Off (L), Safe Operating Stop (L), Abnormal (L), Normal Speed (L), Reduced Speed (L), Auto Mode (L), Manaul Mode (L), Remote Control Mode (L), Standalone Zone (L), Collaborative Zone (L) High Priority Zone (L), Tool Orientation Limit Zone (L), Designated Zone (L)

2.10 Safety Function Settings

	Classification	Safety Settings	Description
1	Basic/ Universal Settings	World Coordinates Setting(p. 249)	A coordinate system representing the robot and workpiece can be set.
		Robot Limits Setting(p. 274)	The universal safety limit for joints and robot/TCP safety-rated monitoring functions can be set.
		Safety Signal I/O Setting(p. 278)	Configurable digital I/O ports can be set as safety signal I/Os.

	Classification	Safety Settings	Description
		Safety Stop Modes(p. 281)	The Stop Mode can be set when the Emergency Stop or Protective Stop is activated, or when the safety-rated monitoring function detects limit violation.
		Nudge(p. 308)	Parameters related to the nudge function, which is capable of resetting Protective Stop or resuming auto operation of the robot can be set when specific conditional are met.
2	Tool and Robot Pose	Tool Weight Setting(p. 266)	The workpiece payload, which acts as the basis for control and safety functions, can be set.
		Tool Shape Setting(p. 269)	Robot tool shapes, which are used in space limit and self-collision prevention functions, can be set.
		Mount (Robot Installation Pose) Setting(p. 247)	The robot installation pose can be set.
3	Space Limit	Space Limit Setting(p. 302)	The **robot/TCP position limit function** can be activated.
4	Zone	Setting the Collaborative Zone(p. 304)	It is the zone which can be set for collaborative work between robot and operator. • Nudge or hand guiding control (HGC) functions can only be performed in the **Collaborative Zone**. • The task speed and joint speed can be decelerated automatically by setting deceleration rate, and the collision detection sensitivity, TCP force limit, TCP speed limit and Safety Stop Mode are overridden within the Zone. • Zones that are not set as the **Collaborative Zone** are treated as **Standalone Zone** of the robot.
		Setting the Crushing Prevention Zone(p. 305)	The robot work position and space around obstacles can be set to reduce the risk of limbs jamming between robots and obstacles. • The robot TCP speed, collision sensitivity and safety stop mode are fixed at 200 mm/s or less, 100% and RS1 respectively, and the TCP force limit is overridden within the Zone. • It is treated as the **Collaborative Zone**.

	Classification	Safety Settings	Description
		Setting the Collision Sensitivity Reduction Zone(p. 306)	Just like the case where force must be applied via contact with the workpiece, collision detection and TCP force limit safety functions can be disabled (Muting) or can be used to ease off the limit. • Unlike other zones, the collision detection sensitivity and TCP force limit can be set lower and higher than the universal limit respectively in the Collision Sensitivity Reduction Zone. • It is treated as a **High Priority Zone**.
		Setting the Tool Orientation Limit Zone(p. 307)	This can be used to reduce risks related to the direction of the workpiece or tool of the robot. • If the **tool center point (TCP)** is positioned within the Zone, the **TCP Orientation Limit** safety function is activated.
		Setting the custom zone(p. 303)	Safety limits can be used differently by zones depending on the necessity of robot application. • The selected safety limits is overridden within the Zone. • Properties of **Collaborative Zone** or **High Priority Zone** can be granted.

2.10.1 Robot Limits

In Robot Limits, universal safety limits of various safety functions related with robots can be set as Normal Mode and Reduced Mode.

If each robot parameter exceeds the configured safety limit, the robot activates Protective Stop. Robot limits can be set in **Robot Parameter> Safety Settings > Robot Limits**.

Note

- Robot can be operated after removing the cause of Protective Stop and after deactivating Protective Stop by resetting.
- If the cause of the Protective Stop by safety functions cannot be removed, Safety Recovery Mode helps for restoration to Normal Operation because there is no Protective Stop by safety functions.

Caution

- The safety limit is the condition in which the safety-rated monitoring function determines whether to activate robot stop or not. When stop is completed, the position of the robot and force applied externally may differ from the configured safety limit.

TCP/Robot

It limits various physical parameters related to the TCP/robot. This safety function can be used in power and force limit operation modes.

- TCP Force: It sets the force limit applied from the TCP of the robot end. It can be used for purposes of detecting unintended external forces.
- Mechanical Power: It sets the limit of the robot's mechanical power. Mechanical power is proportionate to the robot torque and speed.
- TCP Speed: It sets the speed limit of the TCP of the robot end. It can be used for speed and gap monitoring operation mode.
- Momentum: It sets the robot momentum limit. Momentum is proportionate to speed and weight, and the impact is the same as the physical amount.
- Collision Sensitivity: It sets the sensitivity of the collision detection function which determines whether to continue work or activate Protective Stop with the torque detected in each robot axis. If the sensitivity is 100%, it detects collisions by external forces very sensitively, and it seldom detects collision if the sensitivity is 1%.

Note

If the robot has stopped due to collision detection, the cause is one of the followings:

1. TCP force limit violation
2. Collision detection violation

Joint angle speed

It sets the maximum rotation speed of each axis. The limit can be set for each axis.

Note

- The joint angle speed is set to the maximum value as a default.
- In general, certain axis speed is not set differently among each other.

Joint angle

It sets the maximum operating angle of each axis. The limit can be set for each axis.

- All axes are capable of +/- 360 degree rotation, but the joint angle value is set to a limit in Normal Mode as a default.
- If the robot is installed on the ground, it is recommended to set the operation range of the axis No.2 to +/- 95 degrees to prevent the collision.
- If the robot is installed on a cylindrical pillar or if you deal with a workpiece close to the robot base, the joint angle limit can be modified to allow a wider operating range.

Note

Adding Workcell Items in the Zone allows a separate safety limit to be set for designated zones. Safety limits which are capable of overriding are designated depending on the zone type. For more information, refer to the following link.

- Setting the Collaborative Zone(p. 304)
- Setting the Crushing Prevention Zone(p. 305)
- Setting the Collision Sensitivity Reduction Zone(p. 306)
- Setting the Tool Orientation Limit Zone(p. 307)
- Setting the custom zone(p. 303)

2.10.2 Safety Signal I/O

This function inputs/outputs safety-related signals through a redundant terminal. If any one of the safety input/output signals is detected that the redundant signal is different, the system determines whether it is a short circuit or hardware defect and stops the robot with STO Stop Mode. Safety Signal I/O can be set in **Robot Parameter > Safety Settings > Safety I/O**.

- Safety Input Setting

Signal Name	Description
Emergency Stop (L)	This is used for the purpose of receiving an Emergency Stop signal from the robot device or connecting an Emergency Stop Switch additionally installed around the robot. • **High**: Normal operation • **Low**: This will cause the robot to stop according to the Safety Stop Mode of **Emergency Stop** set **in the Safety** Stop Mode.
Emergency Stop – No Loopback (L)	This is used for the purpose of receiving an Emergency Stop signal from the robot device or connecting an Emergency Stop Switch additionally installed around the robot. This signal does not enable the **"Emergency Stop – excl. No Loopback Input" safety** output. • **High**: Normal operation • **Low**: This will cause the robot to stop according to the stable stop mode of **Emergency Stop** set in the **Safe Stop** mode.
Protective Stop (L)	It can be used in conjunction with Safeguarding Devices such as safety mats, light curtains, laser scanners, etc. • **High**: Normal operation • **Low**: This will cause the robot to stop according to the stable stop mode of **Protective Stop** set in the **Safe Stop mode**.

Signal Name	Description
Protective Stop - STO (L)	• **High**: Normal operation • **Low**: It immediately cuts off the power to the motor and activates the brakes to force the robot to stop.
Protective Stop - SS1 (L)	• **High**: Normal operation • **Low**: After a control stop, it cuts off the power to the motor and activates the brakes.
Protective Stop - SS2 (L)	• **High**: Normal operation • **Low**: After a control stop, **Safe Operating Stop**
Protective Stop (L) - Auto Reset & Resume (R)	**Unlike Protective Stop** this signal can reset the **Interrupted** state and automatically resume operation. This enables automatic restart after Safety-rated Monitored Stop as described in ISO TS 15066. • **Low:** It follows **Protective Stop - SS2**. • **Rising (Low to High):** Operation is automatically resumed without manual reset or resume. **Warning** • Automatically resuming operation without direct intervention may be dangerous. • A comprehensive risk assessment must be performed to ensure that it is safe to use this signal.
Interlock Reset (R)	This is used to reset a state changed to **Interrupted** by **Protective Stop**. • **Rising (Low to High):** This allows the interlock to be reset and returned to normal standby.
Reduced Speed Activation (L)	• **High**: Operates the robot at the normal speed set in the task • **Low**: It operates the robot at a speed proportionately reduced from the speed set in the task. The reduction ratio can be adjusted using the Speed Reduction Ratio slide bar. When a signal is detected within the **Collaborative Zone** the robot operates (more slowly) according to the smaller Speed Reduction Ratio between the main Speed Reduction Ratio and the collaborative zone Speed Reduction Ratio.
3 Pos Enable Switch (H)	A work permission signal used when connecting the operation permission device to the 3-position switch. • **High:** Jog / servo ON available in Manual Mode **Play/Resume/servo on** available in Automatic Mode • **Low: Jog/servo on** unavailable in Manual Mode. **Play/Resume/servo on** unavailable in Automatic Mode.

Signal Name	Description
Handguiding Enable Switch (H)	A work permission signal used when connecting the operation permission device to the handguiding enable switch. • **High**: Hand-guiding available • **Low**: Hand-guiding unavailable
HGC End & Resume (R)	When the handguiding command is executed in automatic mode, the task program stops. A signal used to resume the execution of the task program after the user has executed the handguiding control. • **Rising (Low to High)**: The execution of the task program resumes after the HandGuiding Control is performed.
Safety Zone Dynamic Enable (H)	This can be used to dynamically enable or disable a safe **space limit** or **zone**. This signal is only available if Dynamic Zone Enable is set when setting up space limit and zone. • **High**: This enables space limits/zones **that** have been temporarily enabled or disabled by this signal. • **Low**: This disables space limits, zones that have been temporarily enabled or disabled by this signal.
Safety Zone Dynamic Enable (L)	This can be used to dynamically enable or disable a safe **space limit** or **zone**. This signal is only available if Dynamic Zone Enable is set when setting up space limit and zone. • **High**: This **disables** any space limit/zone that were temporarily enabled or disabled by this signal. • **Low**: This **enables** any space limit and zone that were temporarily enabled or disabled by this signal..
Remote Control Enable (L)	This is used to enable **Remote Control Mode**. • **High**: **Enables the Remote Control Mode** • **Low**: **Disables the Remote Control Mode**

Note

- Low active safety input signals allocated at SI1 & SI2 or SI3 & SI4 on TBSI are test-pulse tolerant.
  One test pulse with a maximum duration of 1 ms is allowed every 20 ms.

- **Safety Output Setting**

Signal Name	Description
Emergency Stop **(L)**	Used to notify robot peripherals that an Emergency Stop is required in the following situations. - When the Emergency Stop button on a robot accessory is pressed (teach pendant, smart pendant or emergency stop button box) - When an E-stop signal is input to a dedicated safety input terminal - When an Emergency Stop (L) signal is input from a configurable input terminal to the Safety Input - When an Emergency Stop – No Loopback(L) signal is input from a configurable input terminal to the Safety Input • **High**: Normal operation • **Low**: Emergency stop required
Emergency Stop - excl. No Loopback Input (L)	Used to notify robot peripherals that an Emergency Stop is required in the following situations. - When the Emergency Stop button on a robot accessory is pressed (teach pendant, smart pendant or emergency stop button box) - When an Emergency Stop (L) signal is input from a configurable input terminal to the Safety Input - When an Emergency Stop – No Loopback(L) signal is input from a configurable input terminal to the Safety Input Except when the signal is **Emergency Stop – No Loopback (L)** on a configurable Safety Input. With this signal, deadlock can be avoided because the Emergency Stop signal is not sent back to the peripheral that sent the Emergency Stop signal. • **High**: Normal operation • **Low**: Emergency stop required
#Safe Torque Off (L)#	• **High:** The robot is not servo off, and not in emergency stop state. • **Low:** The robot is servo off and in emergency stop state.
Safe Operating Stop (L)	• **High**: The robot is not in the Standby State. • **Low**: The robot is in the Standby State and Standstill monitoring is enabled.
Abnormal (L)	• **High**: The robot is not in an Interrupted, Recovery, or Auto Measure state. • **Low**: The robot is in either Interrupted, Recovery, or Auto Measure state.
Normal Speed (L)	• **High**: The robot is operating at a reduced speed due to an external **Reduced Speed Activation** safety input signal. • **Low**: Robot operating at normal speed

Signal Name	Description
Reduced Speed (L)	• **High**: Robot operating at normal speed • **Low**: The robot is operating at a reduced speed due to an external **Reduced Speed Activation** safety input signal.
Auto Mode (L)	• **High**: The robot is not currently in **Auto Mode**. • **Low**: The robot is currently in Auto Mode
Manual Mode (L)	• **High**: The robot is not currently in **Manual Mode**. • **Low**: The robot is currently in **Manual Mode**.
Remote Control Mode (L)	• **High**: The robot is not currently in **Remote Control Mode**. • **Low**: The robot is not currently in **Remote Control Mode**.
Standalone Zone (L)	• **High**: The robot's TCP is located in one of the **Collaborative Zones**. • **Low**: The robot's TCP is not in any **Collaborative Zone**.
Collaborative Zone (L)	• **High**: The robot's TCP is not in any **Collaborative Zone**. • **Low**: The robot's TCP is located in one of the **Collaborative Zones**.
High Priority Zone (L)	• **High**: The robot's TCP is not located in any **Collision Sensitivity Reduction Zone** and the **High Priority Zone** option is not checked on the **Custom Zone**. • **Low**: The robot's TCP is located in one of the **Collision Sensitivity Reduction Zones** or the **High Priority Zone** option is checked on the **Custom Zone**.
Tool Orientation Monitoring Zone (L)	• **High**: The robot's TCP is not located in any **Tool Orientation Limit Zone**. • **Low**: The robot's TCP is located in one of the Tool Orientation Limit Zones.
Designated Zone (L)	This is used to check whether the **Tool Center Point (TCP)** is located within the user-defined zone. The **Designated Zone** signal defined in the Safety Output settings screen can be selected on the Zone settings screen. • **High**: TCP is not within any zone associated with a **Designated Zone** Safety Output. • **Low**: TCP is in the zone associated with a **Designated Zone** Safety Output.

2.10.3 Safety Stop Modes

The safety-rated monitoring function can detect limit violations and set the Stop mode used when stopping the robot.

- For more information about Stop Mode, refer to Safety-rated Stop Subfunction(p. 21).

Safety Stop Modes can be set in **Robot Parameter > Safety Settings > Safety Stop Modes**. For more information about each item, refer to Safety-Rated Monitoring Function(p. 26).

	Safety Stop Mode	Description
1	**Emergency Stop**	It sets the Stop Mode when the Emergency Stop button of the teach pendent or the additionally installed external device is activated. (Only STO or SS1 can be selected.)
2	**Protective Stop**	It sets the Stop Mode when the externally connected protective equipment is activated.
3	**Joint Angle Limit Violation**	It sets the Stop Mode when the angle of each joint exceeds the set limit range.
4	**Joint Speed Limit Violation**	It sets the Stop Mode when the angle joint speed of each joint exceeds the set limit range.
5	**Collision Detection**	It sets the Stop Mode when the external force applied to the axis exceeds the set limit range. Stop modes for **Collaborative Zone** and **Standalone Zone** can be set individually. In addition to **STO**, **SS1** and **SS2** , **RS1** can be set to the stop mode.
6	**TCP/Robot Position Limit Violation**	It sets the **Stop Mode** activated when the tool center point (TCP) and robot position violate the **Position Limit** of the **Robot** set in the **Workcell Manager**. It also determines whether the TCP is within the Safety Zone (**Collaborative Zone, Crushing Prevention Zone, Collision Sensitivity Reduction Zone, Tool Orientation Limit Zone, or Custom Zone**).
7	**TCP Orientation LimitViolation**	It sets the **Stop Mode** when the tool center point **(TCP)** orientation within the TCP **Orientation Limit Zone** exceeds the angle limit range set by the **Robot** through the **Workcell Manager**.
8	**TCP Speed Limit Violation**	It sets the Stop Mode when the speed of the tool center point (TCP) exceeds the set limit range.
9	**TCP Force Limit Violation**	It sets the Stop Mode when the external force applied to the tool center point (TCP) exceeds the set limit range. Stop modes for **Collaborative Zone** and **Standalone Zone** can be set individually. In addition to STO, SS1 and SS2 , RS1 can be set as the Stop Mode.
10	**Momentum Limit Violation**	It sets the **Stop Mode** when the robot momentum exceeds the set limit.
11	**Mechanical Power Limit Violation**	It sets the **Stop Mode** when the mechanical power of the robot exceeds the set limit.

2.10.4 Nudge Setting

If the robot is stopped by Safety Stop Mode SS2 or RS1 within a Collaborative Zone, the Interrupted state can be reset and task can be resumed with Nudge input. Nudge option can be enabled on user defined sections.

To set Nudge, select the **Nudge** item from the **Robot** Workcell. With nudge input, the force to be recognized (nudge force) and the standby time from nudge recognition and until the resuming the work (delay time) can be entered additionally.

The range of force to be detected by nudge input is **10.00 to 50.00 N** for the **M series** and **15.00 to 50.00 N** for the **H series (P series)**.

Warning

- Nudge must only be used only if approved through comprehensive risk assessment.

2.10.5 Space Limit

In addition to the robot's joint angle limits in Robot Limits, it is possible to limit the robot’s operating space to within the direct teaching coordinates. If the robot or TCP violates the Space Limit during auto operation or manual mode, it will stop according to the **Safety Stop Mode** settings.

When the robot or TCP reaches the boundary of the **Space Limit** during direct teaching using hand guiding, a repelling force can be felt.

By selecting the **Inspection Point**, it is possible to select whether the **Space Limit** will target the entire robot body or only the TCP.

By selecting the **Valid Space**, it is possible to select whether the Inspection Point will not violate or not exceed a designated space.

It is possible to easily designate an expanded volume from designated coordinates using **Zone Margin**.

Selecting **Dynamic Zone Enable** will enable/disable the zone according to the input signal from the I/O port. If the input is not enabled, the corresponding **Space Limit** will become disabled, and the robot operates as if the corresponding **Space Limit** is not present

2.10.6 Zone

Depending on the application, certain spaces may require different safety limits to be applied than the global safety limits specified in the Robot Limits Setting(p. 274). It is possible to set a separate safety limit only in the designated section using the section setting function. Overridable safety limits are designated depending on the section type.

- Setting the Collaborative Zone(p. 304)
- Setting the Crushing Prevention Zone(p. 305)
- Setting the Collision Sensitivity Reduction Zone(p. 306)
- Setting the Tool Orientation Limit Zone(p. 307)
- Setting the custom zone(p. 303)

The Valid Space setting makes it possible to specify whether the overridden safety limit applies inside or outside the section.

The Zone Margin setting makes it possible to easily specify how the volume is scaled relative to the specified coordinates.

Safety Limits overridden in a **zone** include the following priorities:

- If a **Zone** is set and some **Safety Limits** are overridden, those **Safety Limits** override over the **global Safety Limits**.
- **Safety Limits** overridden in a **High Priority Zone** override over **Safety Limits** overridden in a non-prioritized zone.
- If there are multiple Safety Limits for a type of safety function at a particular TCP location, the most restrictive Safety Limit in the nested zone takes precedence.
- Because **High Priority Zones** are nested, if there are multiple safety limits for a type of safety function at a particular TCP location, the least restrictive Safety Limit overrides.

Warning

High Priority Zones override other zones and global robot limit settings. If multiple **High Priority Zones** are nested, the safety function overrides the least restrictive safety limit. For safety reasons, **High Priority Zones** should be the minimum possible size.

Selecting **Dynamic Zone Enable** will enable/disable the zone according to the input signal from the I/O port. If the input is not enabled, the corresponding **Space Limit** will become disabled, and the robot operates as if the corresponding **Space Limit** is not present

2.11 Other Safety Measures

For user safety and robot safety recovery, we provide a Safety Recovery mode and an Unpowered Operation mode.

- **Safety Recovery Mode**: In the event of an error with a persistent safety violation or packaging of a robot, the robot can be set to a user-specified position and angle in the Safety Recovery Mode. For more information about Safety Recovery mode, refer to Using the Recovery Module(p. 240).
- **Unpowered Operation**: This function controls the joints of the robot by external force by releasing only the brake with the power to the motor cut off. This function is used when Safety Recovery Mode or Handguiding is not able to return the robot to a normal status. With the Unpowered Operation mode, the brake of each joint can be engaged or disengaged by the user. For more information on unpowered operation, see Using the Backdrive Module(p. 238).

2.12 Validity and Responsibility

This manual does not provide information about the design, installation and operation methods of robot applications integrated with other system. In addition, this manual does not provide information that may influence the safety of the integrated system.

The system administrator must install the robot in a way that observes various safety requirements according to the related national standards and regulations. In addition, the staff in charge of integrating and managing the robot in a system must ensure that all related national safety legislation and regulations are observed. The entity or user of the final system in which the robot is integrated has the following responsibilities, and such responsibilities are not limited to the items listed below.

- Risk assessment of the system with the robot integrated
- Installation and removal of safety devices according to the outcome of the risk assessment performed
- Confirmation of whether the system is properly designed, set up and installed
- Establishment of system operation and instructions
- Management of suitable safety settings in the software
- Prevention of users modifying safety devices
- Validity check of design and installation of integrated system
- Indication of contact information or important notifications related to use and safety
- Provision of technical documents including various manuals
- Provision of information on standards and legislation applied: http://www.doosanrobotics.com/

Compliance with the safety requirements in this manual does not mean all risks can be prevented.

2.13 Disclaimer

Doosan Robotics continues to upgrade product reliability and performance, and Doosan Robotics has the right to upgrade the product without notification. Doosan Robotics endeavors to ensure that all contents in this manual are accurate. However, it does not assume responsibility for errors or missing information.

2.14 Declaration and Certification

2.14.1 Europe Declaration of Incorporation (Original)

DECLARATION OF INCORPORATION

according to EC Machinery Directive 2006/42/EC Annex II Part 1 Section B

We,

Doosan Robotics Inc.

79, Saneop-ro 156beon-gil, Gwonseon-gu, Suwon-si,
Gyeonggi-do, 16648, Republic of Korea

declare under our sole responsibility that the following product:

Product :	**Industrial Robot (Manipulator & Controller)**
Model :	**Manipulator : M0609, M1509, M1013, M0617** **Controller : CS-01**

is in conformity with the following standard(s) or other normative document(s)

Standard	***Description***
EN ISO 12100:20100	**Safety of machinery** **General principles for design** **Risk assessment and risk reduction**
EN ISO 10218-1	**Robots and robotic devices** **- Safety requirements for industrial robots** **Part 1: Robots**
EN 60204-1:2006/A1:2009	**Safety of machinery** **Electrical equipment of machines** **Part 1: General requirements**

The product as the partly completed machinery must not be put into service until the final machinery into which it is to be incorporated has been declared in conformity with the provisions of the Directive 2006/42/EC, as amended by Directive 2009/127/EC, and with the regulations transposing it into national law.

Relevant technical documentations are compiled in accordance with Annex VII, part B of the Directive, and available in electronic form to national authorities upon legitimate request.

Additionally the product declares in conformity with the following directives, according to which the product is CE marked:

2014/35/EU	**Low Voltage Directive (LVD)**
2014/30/EU	**Electromagnetic Compatibility Directive (EMC)**

Suwon, 15th October, 2018
R&D Center

Junhyun Jang
Chief Technical Officer

2.14.2 Europe Machinery Directive Attestation of Conformity

ATTESTATION ◆ BESCHEINIGUNG ◆ ATESTACIÓN ◆ ATTESTATO ◆ ATTESTATION

TÜV SÜD
Product Service

Attestation

No. M7 004249 0063 Rev. 00

Holder of Attestation: **Doosan Robotics Inc**
79, Saneop-ro 156beon-gil, Gwonseon-gu
Suwon-si, Gyeonggi-do 16648
REPUBLIC OF KOREA

Product: **Industrial Robot**
(Manipulator & Controller)

This Attestation of Conformity is issued on a voluntary basis according to Council Directive 2006/42/EC relating to machinery. It confirms that the listed equipment (partly completed machine) complies with the requirements set in article 13 of the directive and is based on the technical specifications applicable at the time of issuance. It refers only to the particular sample submitted for conformity assessment. For details see: www.tuvsud.com/ps-cert

Test report no.: MAEB01121223

Date, 2024-01-15

(Ro-Hyun Park)

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This Attestation does not replace the regulatory EU Declaration of Conformity (DoC) and does not allow for CE marking. Partly completed machines are designated to be assembled in a machine, which complies with the requirements set in the Machinery Directive 2006/42/EC and for which a Declaration of Conformity according to Annex II A of the Machinery Directive 2006/42/EC needs to be drawn up.

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ATTESTATION ◆ ATTESTATO ◆ ATESTACIÓN ◆ BESCHEINIGUNG ◆ ATTESTATION

Product Service

Attestation

No. M7 004249 0063 Rev. 00

Model(s): **Manipulator : M0609, M0617, M1013, M1509, H2017, H2515**
Controller : CS-11, CS-11P

Parameters:

Manipulator :	M0609	M0617	M1013
Rated payload :	6 kg	6 kg	10 kg
Degree of freedom :	6 axis	6 axis	6 axis
Weight :	27 kg	34 kg	33 kg
	M1509	H2017	H2515
	15 kg	20 kg	25 kg
	6 axis	6 axis	6 axis
	32 kg	74 kg	72 kg

Controller :	CS-11	CS-11P
Rated input voltage :	100 - 240 Va.c., 1 Phase	100 - 240 Va.c., 1 Phase
Rated frequency :	50/60 Hz	50/60 Hz
Rated input current :	10 A	10 A
Weight :	9.8 kg	21.7 kg

Tested according to: EN ISO 10218-1:2011
EN ISO 12100:2010
EN 60204-1:2018

Page 2 of 2

This Attestation does not replace the regulatory EU Declaration of Conformity (DoC) and does not allow for CE marking. Partly completed machines are designated to be assembled in a machine, which complies with the requirements set in the Machinery Directive 2006/42/EC and for which a Declaration of Conformity according to Annex II A of the Machinery Directive 2006/42/EC needs to be drawn up.

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ATTESTATION ◆ BESCHEINIGUNG ◆ ATESTACIÓN ◆ ATTESTATO ◆ ATTESTATION

Product Service

Attestation

No. M7 004249 0078 Rev. 00

Holder of Attestation:	**Doosan Robotics Inc** 79, Saneop-ro 156beon-gil, Gwonseon-gu Suwon-si, Gyeonggi-do 16648 REPUBLIC OF KOREA
Product:	**Industrial Robot (Manipulator & Controller)**

This Attestation of Conformity is issued on a voluntary basis according to Council Directive 2006/42/EC relating to machinery. It confirms that the listed equipment (partly completed machine) complies with the requirements set in article 13 of the directive and is based on the technical specifications applicable at the time of issuance. It refers only to the particular sample submitted for conformity assessment. For details see: www.tuvsud.com/ps-cert

Test report no.: MAEB01363023

Date, 2024-01-15

(Ro-Hyun Park)

Page 1 of 2

This Attestation does not replace the regulatory EU Declaration of Conformity (DoC) and does not allow for CE marking. Partly completed machines are designated to be assembled in a machine, which complies with the requirements set in the Machinery Directive 2006/42/EC and for which a Declaration of Conformity according to Annex II A of the Machinery Directive 2006/42/EC needs to be drawn up.

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ATTESTATION ◆ ATTESTATO ◆ ATESTACIÓN ◆ BESCHEINIGUNG ◆ ATTESTATION

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Product Service

Attestation

No. M7 004249 0078 Rev. 00

Model(s): **Manipulator : M1013, M0609, M0617, M1509, H2017, H2515**
Controller : CS-12P, CS-12

Parameters:

Manipulator:	M1013	M0609	M0617
Payload:	10kg	6kg	6kg
Degrees of freedom:	6Axis	6Axis	6Axis
Weight:	33kg	27kg	34kg
	M1509	H2017	H2515
	15kg	20kg	25kg
	6Axis	6Axis	6Axis
	32kg	74kg	72kg

Controller:	CS-12P	CS-12
Rated input voltage:	22~60 VDC	22~60 VDC
Rated input current:	30A	30A
Weight:	21.5kg	9.6kg

Tested according to: EN ISO 10218-1:2011
EN ISO 12100:2010
EN 60204-1:2018

Page 2 of 2

This Attestation does not replace the regulatory EU Declaration of Conformity (DoC) and does not allow for CE marking. Partly completed machines are designated to be assembled in a machine, which complies with the requirements set in the Machinery Directive 2006/42/EC and for which a Declaration of Conformity according to Annex II A of the Machinery Directive 2006/42/EC needs to be drawn up.

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2.14.3 Europe EMC Directive Attestation of Conformity

ATTESTATION ◆ ATTESTATO ◆ ATESTACIÓN ◆ BESCHEINIGUNG ◆ ATTESTATION

TÜV SÜD

Product Service

Attestation of Conformity

No. E8A 004249 0043 Rev. 00

Holder of Attestation: **Doosan Robotics Inc**
79, Saneop-ro 156beon-gil, Gwonseon-gu
Suwon-si, Gyeonggi-do 16648
REPUBLIC OF KOREA

Name of Object: **Industrial Robot**
(Manipulator & Controller)

This Attestation of Conformity is issued on a voluntary basis according to the Directive 2014/30/EU relating to electromagnetic compatibility. It confirms that the listed apparatus complies with the principal protection requirements of the directive and is based on the technical specifications applicable at the time of issuance. It refers only to the particular sample submitted for conformity assessment. For details see: www.tuvsud.com/ps-cert

Test report no.: CPSC01468022

Date, 2023-04-19

(Sang-Hoon Ha)

Page 1 of 2

This Attestation does not replace the regulatory EU Declaration of Conformity (DoC) and does not allow for CE marking. After preparation of the necessary documentation and establishing compliance to requirements of all applicable directives, the manufacturer may sign a DoC and apply the CE marking.
The DoC is issued under the sole responsibility of the manufacturer.

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ATTESTATION ◆ ATTESTATO ◆ ATESTACIÓN ◆ BESCHEINIGUNG ◆ ATTESTATION

Product Service

Attestation of Conformity

No. E8A 004249 0043 Rev. 00

Model(s):	**Manipulator: M0609, M0617, M1013, M1509, H2017, H2515 Controller : CS-01, CS-01P, CS-02, CS-11P**	
Description of Object:		CS-01
	Rated input voltage:	100-240 V a.c., 1Phase
	Rated input frequency:	50/60 Hz
		CS-01P
	Rated input voltage:	100-240 V a.c., 1Phase
	Rated input frequency:	50/60 Hz
		CS-02
	Rated input voltage:	22-60 V d.c.
	Rated input frequency:	N/A
		CS-11P
	Rated input voltage:	100-240 V a.c., 1Phase
	Rated input frequency:	50/60 Hz
Tested according to:	EN 61000-6-4:2007/A1:2011 EN 61000-6-2:2005 EN 61000-3-2:2014 EN 61000-3-3:2013	

Page 2 of 2

This Attestation does not replace the regulatory EU Declaration of Conformity (DoC) and does not allow for CE marking. After preparation of the necessary documentation and establishing compliance to requirements of all applicable directives, the manufacturer may sign a DoC and apply the CE marking. The DoC is issued under the sole responsibility of the manufacturer.

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ATTESTATION ◆ ATTESTATO ◆ ATESTACIÓN ◆ BESCHEINIGUNG ◆ ATTESTATION

Product Service

Attestation of Conformity

No. E8A 004249 0059 Rev. 00

Holder of Attestation:	**Doosan Robotics Inc** 79, Saneop-ro 156beon-gil, Gwonseon-gu Suwon-si, Gyeonggi-do 16648 REPUBLIC OF KOREA
Name of Object:	**Industrial Robot** **(Manipulator & Controller)**
Model(s):	**Manipulator : H2017, H2515** **Controller : CS-11**
Description of Object:	Rated input voltage: 100-240 V a.c., 1Phase (for CS-11) Rated input frequency: 50/60 Hz (for CS-11)
Tested according to:	EN 61000-6-4:2007/A1:2011 EN 61000-6-2:2005 EN 61000-3-2:2014 EN 61000-3-3:2013 EN IEC 61000-6-4:2019 EN IEC 61000-6-2:2019 EN IEC 61000-3-2:2019/A1:2021 EN 61000-3-3:2013/A2:2021

This Attestation of Conformity is issued on a voluntary basis according to the Directive 2014/30/EU relating to electromagnetic compatibility. It confirms that the listed apparatus complies with the principal protection requirements of the directive and is based on the technical specifications applicable at the time of issuance. It refers only to the particular sample submitted for conformity assessment. For details see: www.tuvsud.com/ps-cert

Test report no.: CPSC01470822

Date, 2023-06-01

(Laurent Yuan)

Page 1 of 1

This Attestation does not replace the regulatory EU Declaration of Conformity (DoC) and does not allow for CE marking. After preparation of the necessary documentation and establishing compliance to requirements of all applicable directives, the manufacturer may sign a DoC and apply the CE marking. The DoC is issued under the sole responsibility of the manufacturer.

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ATTESTATION ◆ ATTESTATO ◆ ATESTACIÓN ◆ BESCHEINIGUNG ◆ ATTESTATION

TÜV SÜD
Product Service

Attestation of Conformity

No. E8A 004249 0065 Rev. 00

Holder of Attestation: **Doosan Robotics Inc**
79, Saneop-ro 156beon-gil, Gwonseon-gu
Suwon-si, Gyeonggi-do 16648
REPUBLIC OF KOREA

Name of Object: **Industrial Robot (Manipulator & Controller)**

Model(s): **Manipulator : M1013, M0609, M0617, M1509, H2017, H2515**
Controller : CS-12

Description of Object:

Rated input voltage:	22-60 V d.c. (for CS-12)
Rated input current:	30 A (for CS-12)

Tested according to:
EN 61000-6-4:2007/A1:2011
EN 61000-6-2:2005
EN IEC 61000-6-4:2019
EN IEC 61000-6-2:2019

This Attestation of Conformity is issued on a voluntary basis according to the Directive 2014/30/EU relating to electromagnetic compatibility. It confirms that the listed apparatus complies with the principal protection requirements of the directive and is based on the technical specifications applicable at the time of issuance. It refers only to the particular sample submitted for conformity assessment. For details see: www.tuvsud.com/ps-cert

Test report no.: CPSC01472422

Date, 2023-09-19

(Laurent Yuan)

Page 1 of 1

This Attestation does not replace the regulatory EU Declaration of Conformity (DoC) and does not allow for CE marking. After preparation of the necessary documentation and establishing compliance to requirements of all applicable directives, the manufacturer may sign a DoC and apply the CE marking. The DoC is issued under the sole responsibility of the manufacturer.

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Product Service

Attestation of Conformity

No. E8A 004249 0066 Rev. 00

Holder of Attestation:	**Doosan Robotics Inc** 79, Saneop-ro 156beon-gil, Gwonseon-gu Suwon-si, Gyeonggi-do 16648 REPUBLIC OF KOREA
Name of Object:	**Industrial Robot** **(Manipulator & Controller)**
Model(s):	**Manipulator : H2017, H2515, M1013, M0609, M0617, M1509** **Controller : CS-12P**
Description of Object:	Rated input voltage: 22-60 V d.c. (for CS-12P) Rated input current: 30 A (for CS-12P)
Tested according to:	EN 61000-6-4:2007/A1:2011 EN 61000-6-2:2005 EN IEC 61000-6-4:2019 EN IEC 61000-6-2:2019

This Attestation of Conformity is issued on a voluntary basis according to the Directive 2014/30/EU relating to electromagnetic compatibility. It confirms that the listed apparatus complies with the principal protection requirements of the directive and is based on the technical specifications applicable at the time of issuance. It refers only to the particular sample submitted for conformity assessment. For details see: www.tuvsud.com/ps-cert

Test report no.: CPSC01472822

Date, 2023-09-18

(Laurent Yuan)

Page 1 of 1

This Attestation does not replace the regulatory EU Declaration of Conformity (DoC) and does not allow for CE marking. After preparation of the necessary documentation and establishing compliance to requirements of all applicable directives, the manufacturer may sign a DoC and apply the CE marking. The DoC is issued under the sole responsibility of the manufacturer.

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2.14.4 U.S. NRTL Certification (U.S., CANADA)

ZERTIFIKAT ◆ CERTIFICATE ◆ 認證證書 ◆ СЕРТИФИКАТ ◆ CERTIFICADO ◆ CERTIFICAT

CERTIFICATE

No. U8 004249 0061 Rev. 00

Holder of Certificate: **Doosan Robotics Inc**
79, Saneop-ro 156beon-gil, Gwonseon-gu
Suwon-si, Gyeonggi-do 16648
REPUBLIC OF KOREA

Certification Mark:

Product: **Industrial Robot (Manipulator & Controller)**

This product was voluntarily tested to the relevant safety requirements referenced on this certificate. It can be marked with the certification mark above. The mark must not be altered in any way. This product certification system operated by TÜV SÜD America Inc. most closely resembles system 3 as defined in ISO/IEC 17067. Certification is based on the TÜV SÜD "Testing and Certification Regulations". TÜV SÜD America Inc. is an OSHA recognized NRTL for USA and a Standards Council of Canada ISO/IEC 17065 accredited Certification body for Canada.

Test report no.: MAEA07121823

Date, 2023-07-07

(Ro-Hyun Park)

Page 1 of 2

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ZERTIFIKAT ◆ CERTIFICATE ◆ 認證證書 ◆ СЕРТИФИКАТ ◆ CERTIFICADO ◆ CERTIFICAT

SCC Accredited CB-P/S OCPS Accrédité CCN

OSHA NRTL

TÜV SÜD America

CERTIFICATE

No. U8 004249 0061 Rev. 00

Model(s): **Manipulator : M0609, M0617, M1013, M1509, H2017, H2515**
Controller : CS-11, CS-11P

Tested according to: UL 1740:2018/R:2020-11
CSA Z434:2014

Also evaluated to the following standards: ANSI/NFPA 79:2021

Parameters:

Manipulator :	M0609	M0617	M1013
Rated payload :	6 kg	6 kg	10 kg
Degree of freedom :	6 axis	6 axis	6 axis
Weight :	27 kg	34 kg	33 kg
	M1509	H2017	H2515
	15 kg	20 kg	25 kg
	6 axis	6 axis	6 axis
	32 kg	74 kg	72 kg

Controller :	CS-11	CS-11P
Rated input voltage :	100 - 240 Va.c., 1 Phase	100 - 240 Va.c., 1 Phase
Rated frequency :	50/60 Hz	50/60 Hz
Rated input current :	10 A	10 A
Weight :	9.8 kg	20.1 kg

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ZERTIFIKAT ◆ CERTIFICATE ◆ 認證證書 ◆ СЕРТИФИКАТ ◆ CERTIFICADO ◆ CERTIFICAT

CERTIFICATE

No. U8 004249 0071 Rev. 00

Holder of Certificate: **Doosan Robotics Inc**
79, Saneop-ro 156beon-gil, Gwonseon-gu
Suwon-si, Gyeonggi-do 16648
REPUBLIC OF KOREA

Certification Mark:

Product: **Industrial Robot (Manipulator & Controller)**

This product was voluntarily tested to the relevant safety requirements referenced on this certificate. It can be marked with the certification mark above. The mark must not be altered in any way. This product certification system operated by TÜV SÜD America Inc. most closely resembles system 3 as defined in ISO/IEC 17067. Certification is based on the TÜV SÜD "Testing and Certification Regulations". TÜV SÜD America Inc. is an OSHA recognized NRTL for USA and a Standards Council of Canada ISO/IEC 17065 accredited Certification body for Canada.

Test report no.: MAEA07363623

Date, 2024-01-15

(Ro-Hyun Park)

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ZERTIFIKAT ◆ CERTIFICATE ◆ 認證證書 ◆ СЕРТИФИКАТ ◆ CERTIFICADO ◆ CERTIFICAT

SCC Accredited CB-P/S OCPS Accrédité CCN

OSHA NRTL

TÜV SÜD America

CERTIFICATE

No. U8 004249 0071 Rev. 00

Model(s):	**Manipulator : M1013, M0609, M0617, M1509, H2017, H2515** **Controller : CS-12P, CS-12**
Tested according to:	UL 1740:2018/R:2020-11 CSA Z434:2014/U1:2017-02
Also evaluated to the following standards:	ANSI/NFPA 79:2021

Parameters:

Manipulator:	M1013	M0609	M0617
Payload:	10kg	6kg	6kg
Degree of freedom:	6Axis	6Axis	6Axis
Weight:	33kg	27kg	34kg
	M1509	H2017	H2515
	15kg	20kg	25kg
	6Axis	6Axis	6Axis
	32kg	74kg	72kg
Controller:	CS-12P	CS-12	
Rated input voltage:	22~60 VDC	22~60 VDC	
Rated input current:	30A	30A	
Weight:	21.5kg	9.6kg	

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2.14.5 Functional Safety Certification

ZERTIFIKAT ◆ CERTIFICATE ◆ 認證證書 ◆ СЕРТИФИКАТ ◆ CERTIFICADO ◆ CERTIFICAT

Product Service

CERTIFICATE

No. Z10 004249 0080 Rev. 00

Holder of Certificate: **Doosan Robotics Inc**
79, Saneop-ro 156beon-gil, Gwonseon-gu
Suwon-si, Gyeonggi-do 16648
REPUBLIC OF KOREA

Certification Mark:

Product: **Robot Safety Unit**

The product was tested on a voluntary basis and complies with the essential requirements. The certification mark shown above can be affixed on the product. It is not permitted to alter the certification mark in any way. In addition the certification holder must not transfer the certificate to third parties. This certificate is valid until the listed date, unless it is cancelled earlier. All applicable requirements of the Testing, Certification, Validation and Verification Regulations of TÜV SÜD Group have to be complied. For details see: www.tuvsud.com/ps-cert

Test report no.: DG102165T

Valid until: 2029-03-03

Date, 2024-03-15

(Gert Effenberger)

Page 1 of 2
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ZERTIFIKAT ◆ CERTIFICATE ◆ 認證證書 ◆ СЕРТИФИКАТ ◆ CERTIFICADO ◆ CERTIFICAT

TÜV SÜD Product Service

CERTIFICATE

No. Z10 004249 0080 Rev. 00

Parameters:

Suitable for: ISO TS 15066:2016, ISO 10218-1:2011

Safety functions:
STO, SBC, Emergency Stop: **SIL3, PL e, CAT4**

SS1, SS2, SOS, SLP, SLS, SLT, Protective Stop,
TCP/Robot Position Limit, TCP Orientation Limit, TCP Speed Limit,
TCP Force Limit, Robot Momentum Limit, Robot Power Limit,
Collision Detection, Safety I/O, Reflex Stop: **SIL2, PL d, CAT3**

Safety I/O input	Safety I/O output
Emergency Stop, Emergency Stop – No Loopback, Protective Stop, Protective Stop – STO, Protective Stop – SS1, Protective Stop – SS2, Protective Stop – Auto Reset & Resume, Interlock Reset, Reduced Speed Activation, 3-Pos Enable Switch, Handguiding Enable Switch, Remote Control Enable, Safety Zone Dynamic Enable, HGC End & Task Resume	Emergency Stop, Emergency Stop - excl. No Loopback Input, Safe Torque Off, Safe Operating Stop, Abnormal, Normal Speed, Reduced Speed, Auto Mode, Manual Mode, Remote Control Mode, Standalone Zone, Collaborative Zone, High Priority Zone, Tool Orientation Limit Zone, Designated Zone

Tested according to:

IEC 61508-1:2010
IEC 61508-2:2010
IEC 61508-3:2010
IEC 61800-5-2:2016
ISO 13849-1:2023
IEC 62061:2021
IEC 61000-6-7:2014

Model(s): **Safety Controller for Single & Multi-powered Robot**

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2.14.6 Voluntary Safety Confirmation Declaration (KCs)

자율안전확인 신고증명서

신청인	사업장명	두산로보틱스(주)	사업장관리번호	257-88-001280
	사업자등록번호	257-88-00128	대표자 성명	류정훈
	소재지	(16648) 경기도 수원시 권선구 산업로156번길 79(고색동)		

자율안전인증대상 기계 · 기구명	산업용로봇		
형식(규격)	M0609	용량(등급)	6 axis
자율안전확인번호	17-AB1EQ-01516		
제조자	두산로보틱스(주)		
소재지	(16648) 경기도 수원시 권선구 산업로156번길 79(고색동)		

「산업안전보건법」 제89조제1항 및 같은 법 시행규칙 제120조제3항에 따라
자율안전확인 신고증명서를 발급합니다.

2023년 10월 19일

한국산업안전보건공단 이사장

자율안전확인 신고증명서

신청인	사업장명	두산로보틱스(주)	사업장관리번호	257-88-001280
	사업자등록번호	257-88-00128	대표자 성명	류정훈
	소재지	(16648) 경기도 수원시 권선구 산업로156번길 79(고색동)		

자율안전인증대상 기계 · 기구명	산업용로봇		
형식(규격)	M0617	용량(등급)	6 axis
자율안전확인번호	17-AB1EQ-01515		
제조자	두산로보틱스(주)		
소재지	(16648) 경기도 수원시 권선구 산업로156번길 79(고색동)		

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자율안전확인 신고증명서를 발급합니다.

2023년 10월 19일

한국산업안전보건공단 이사장

자율안전확인 신고증명서

신청인	사업장명	두산로보틱스(주)	사업장관리번호	257-88-001280
	사업자등록번호	257-88-00128	대표자 성명	류정훈
	소재지	(16648) 경기도 수원시 권선구 산업로156번길 79(고색동)		

자율안전인증대상 기계 · 기구명	산업용로봇		
형식(규격)	M1013	용량(등급)	6 axis
자율안전확인번호	17-AB1EQ-01514		
제조자	두산로보틱스(주)		
소재지	(16648) 경기도 수원시 권선구 산업로156번길 79(고색동)		

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자율안전확인 신고증명서를 발급합니다.

2023년 10월 19일

한국산업안전보건공단 이사장

자율안전확인 신고증명서

신청인	사업장명	두산로보틱스(주)	사업장관리번호	257-88-001280
	사업자등록번호	257-88-00128	대표자 성명	류정훈
	소재지	(16648) 경기도 수원시 권선구 산업로156번길 79(고색동)		

자율안전인증대상 기계 · 기구명	산업용로봇		
형식(규격)	M1509	용량(등급)	6 axis
자율안전확인번호	18-AB1EQ-00589		
제조자	두산로보틱스(주)		
소재지	(16648) 경기도 수원시 권선구 산업로156번길 79(고색동)		

「산업안전보건법」 제89조제1항 및 같은 법 시행규칙 제120조제3항에 따라
자율안전확인 신고증명서를 발급합니다.

2023년 10월 19일

한국산업안전보건공단 이사장

자율안전확인 신고증명서

신청인	**사업장명**	두산로보틱스(주)	**사업장관리번호**	257-88-001280
	사업자등록번호	257-88-00128	**대표자 성명**	류정훈
	소재지	(16648) 경기도 수원시 권선구 산업로156번길 79(고색동)		

자율안전인증대상 기계 · 기구명	산업용로봇		
형식(규격)	H2017	용량(등급)	6 axis
자율안전확인번호	20-AE1EQ-02737		
제조자	두산로보틱스(주)		
소재지	(16648) 경기도 수원시 권선구 산업로156번길 79(고색동)		

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자율안전확인 신고증명서

신청인	사업장명	두산로보틱스(주)	사업장관리번호	257-88-001280
	사업자등록번호	257-88-00128	대표자 성명	류정훈
	소재지	(16648) 경기도 수원시 권선구 산업로156번길 79(고색동)		

자율안전인증대상 기계 · 기구명	산업용로봇		
형식(규격)	H2515	용량(등급)	6 axis
자율안전확인번호	20-AE1EQ-02738		
제조자	두산로보틱스(주)		
소재지	(16648) 경기도 수원시 권선구 산업로156번길 79(고색동)		

「산업안전보건법」 제89조제1항 및 같은 법 시행규칙 제120조제3항에 따라
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2023년 10월 19일

한국산업안전보건공단 이사장

2.15 Stop Distance and Stop Time

2.15.1 Measurement Methods and Conditions

- Stop distance is the angle traveled from the moment a stop signal is generated to the moment all manipulator stop operation.
- Stop time is the time from the moment a stop signal is generated to the moment all manipulator stop operation.
- Stop distance and stop time data are provided for Joint 1, Joint 2 and Joint 3, which have large travel distances.
- The movement of an overlapping axis can cause a longer stop distance.
- Stop distance and stop time data are defined according to KS B ISO 10218-1:2011 Declaration and Certification(p. 42).

Stop Category

	Stop Category	**Description**
1	Stop Category 1	The stop distance and stop time of **Joint 1 (Base) and Joint 2 (Shoulder)** are measured at 33%, 66% and 100% of the maximum speed, stretch level and load, respectively. The stop distance and stop time of **Joint 3 (elbow)** is measured at 33%, 66% and 100% of maximum speed and load. The stretch level during Joint 3 measurement is locked at maximum because of the lower arm length and completely flat wrist.
2	Stop Category 0	The stop distance and stop time of **Joint 1 (Base), Joint 2 (Shoulder)** and **Joint 3 (Elbow)** are measured at maximum speed, stretch level and load. The axes of Joint 2 and Joint 3 are parallel to each other, so an impact caused by forced stop on one part may cause a slip on the other side. The angle deviation is also measured.

Measurement Poses and Conditions

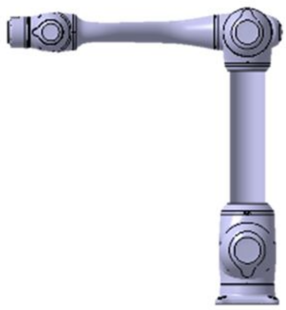
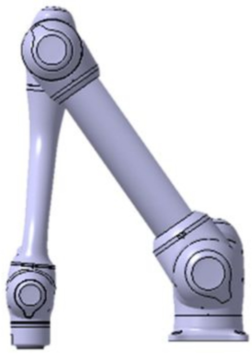
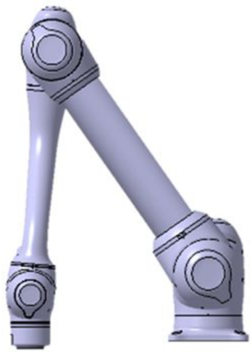
Joint 1 measurement is performed with the rotating axis perpendicular to the ground and during horizontal movement.

Joint 2 and Joint 3 measurements are performed with the rotating axis parallel to the ground and when the robot is stopped in a downward movement vertical to the ground.

Note

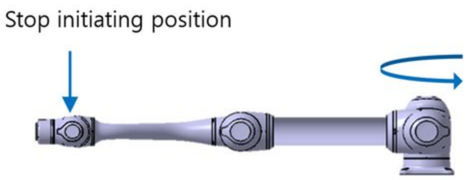
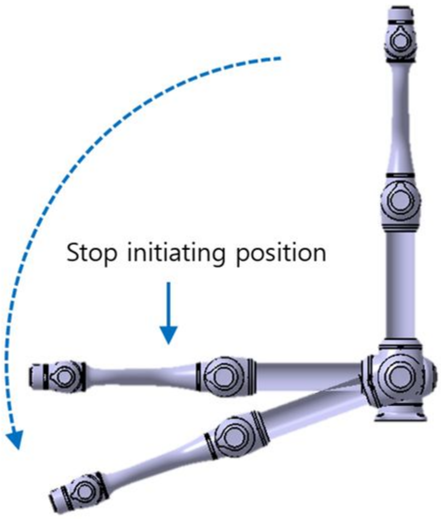
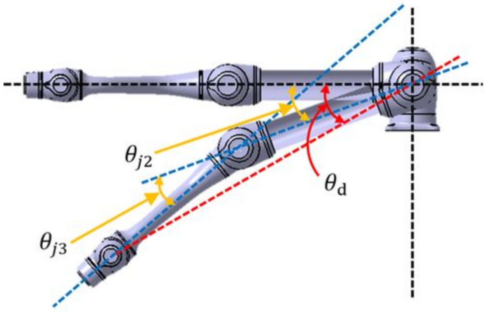
The measurements are the result of the worst case. Measurement may vary according to circumstances

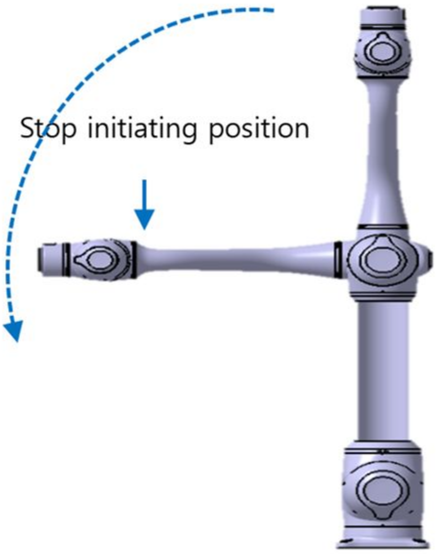
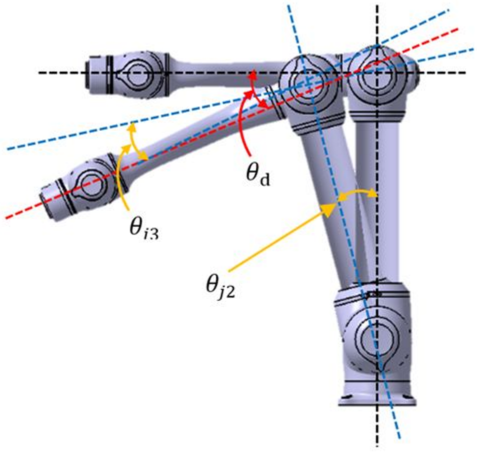
The pose for 33%, 66%, and 100% of extension

	Joint 1	**Joint 2**	**Joint 3**
100% extension **Stop category 0**			
33% extension **Stop category 1**			-
66% extension **Stop category 1**			-

	Joint 1	Joint 2	Joint 3
100% extension **Stop category 1**			

The pose when the stop is initiated and the measured angle (θ_d)

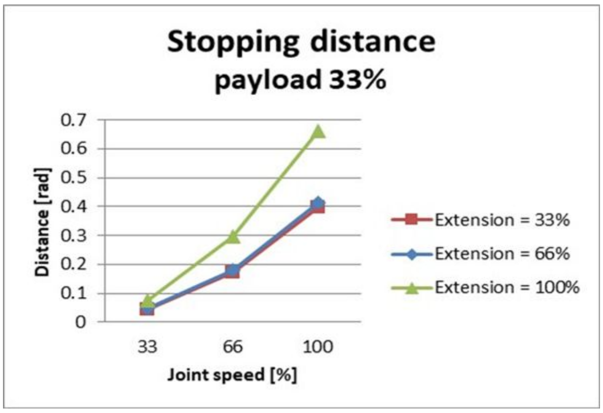
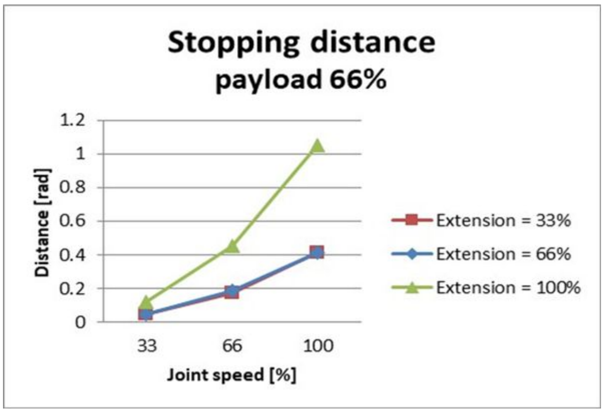
	Joint 1	Joint 2
Joint1		**No slip,** $\theta_d = \theta_{j1}$
Joint2		

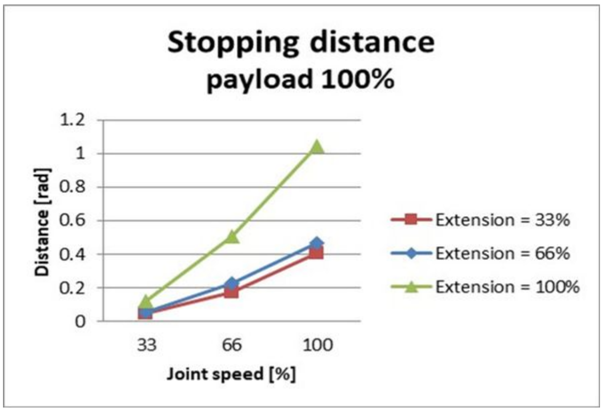
<table>
<tr><th></th><th>Joint 1</th><th>Joint 2</th></tr>
<tr><td>Joint3</td><td>
</td><td>
</td></tr>
</table>

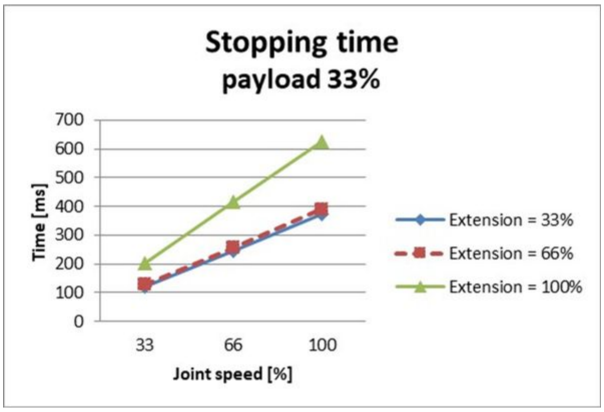
2.15.2 M1013 Stop Category

M1013 Stop Category 1

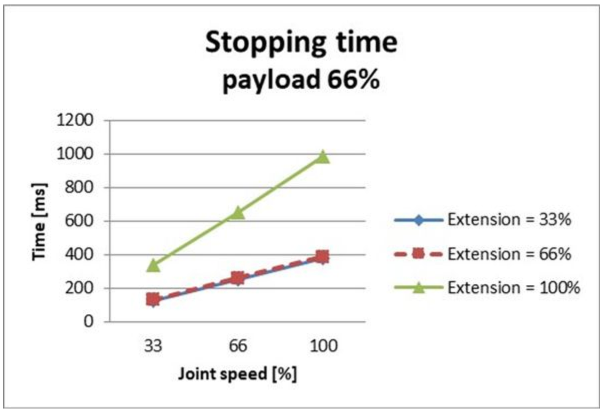
Stop Distance and Stop Time of Joint 1 (Base)

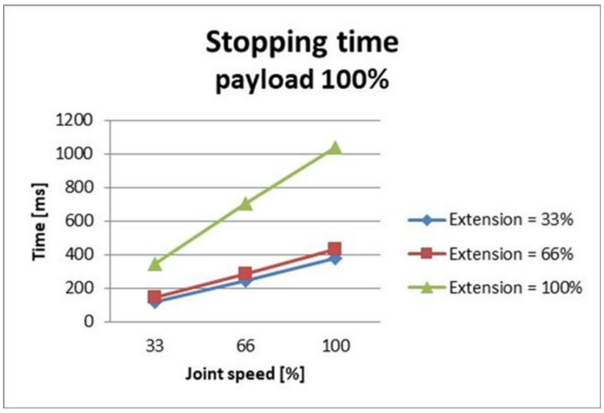
<table>
<tr><th>Stop Distance at 33% of Max. Load (rad)</th><th>Stop Distance at 66% of Max. Load (rad)</th></tr>
<tr><td>
</td><td>
</td></tr>
<tr><td>Stop Distance at Max. Load (rad)</td><td>Stop Time at 33% of Max. Load (ms)</td></tr>
</table>





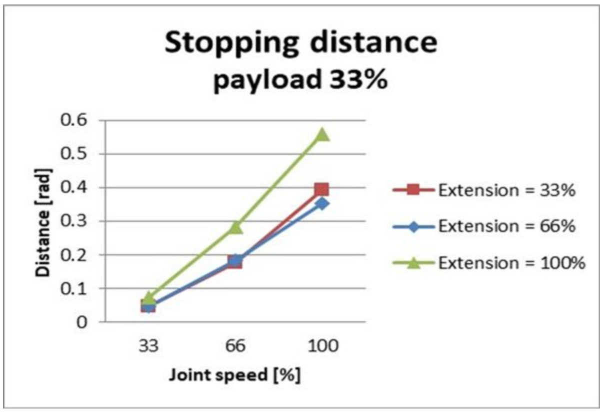
Stop Time at 66% of Max. Load (ms)	**Stop Time at Max. Load (ms)**

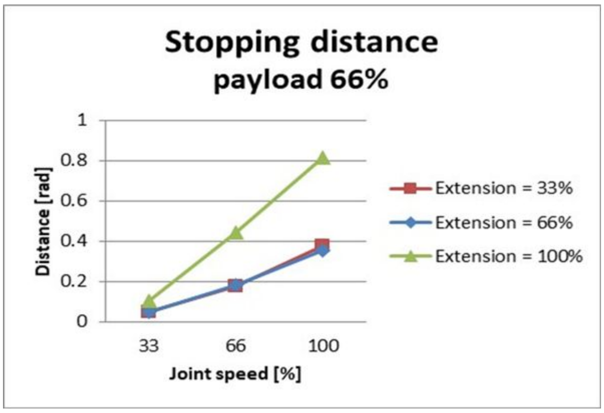




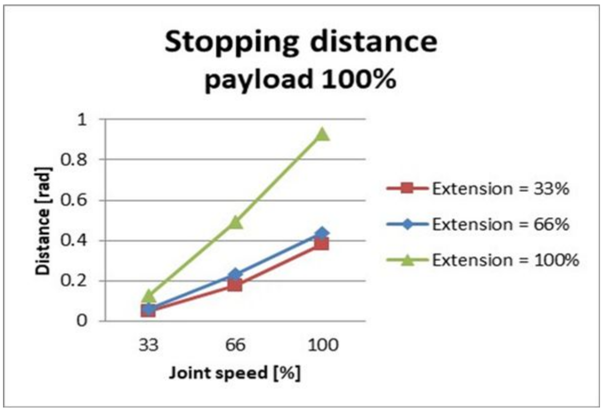
Stop Distance and Stop Time of Joint 2 (Shoulder)

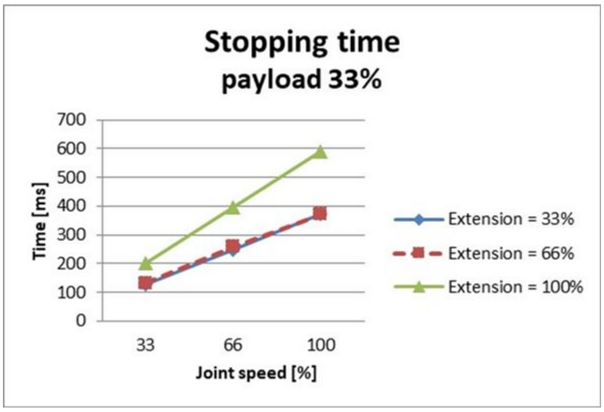
Stop Distance at 33% of Max. Load (rad)	**Stop Distance at 66% of Max. Load (rad)**



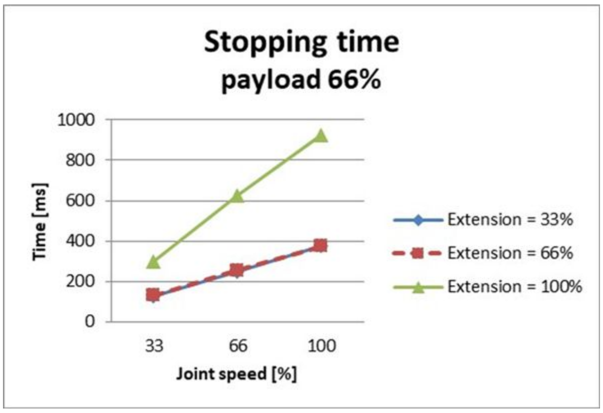


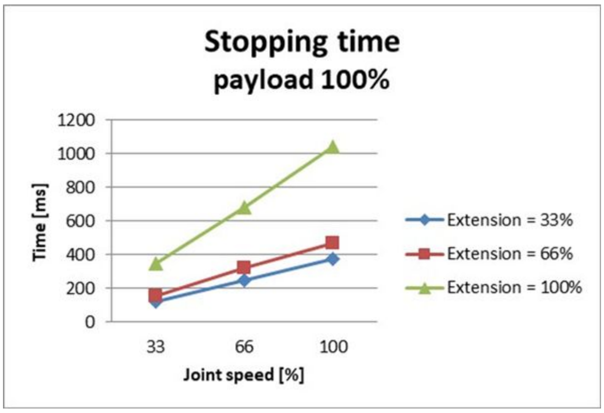
Stop Distance at Max. Load (rad)	**Stop Time at 33% of Max. Load (ms)**





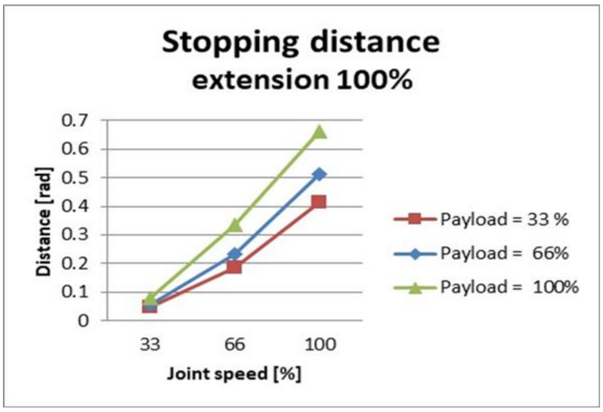
Stop Time at 66% of Max. Load (ms)	Stop Time at Max. Load (ms)

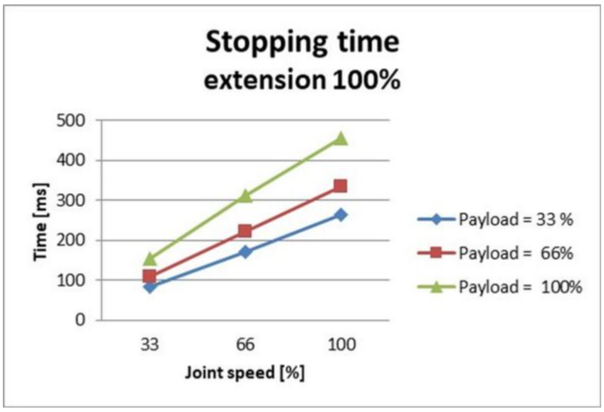




Stop Distance and Stop Time of Joint 3 (Elbow)

Stop Distance at Max. Stretch Level (rad)	Stop Time at Max. Stretch Level (ms)





M1013 Stop Category 0

Joint 1

Extension=100%, Speed=100%, Payload=100%

	Stopping distance (rad)	Stopping time (ms)
Joint 1	0.144	136

Joint 2

Extension=100%, Speed=100%, Payload=100%

	Stopping distance (rad)	Stopping time (ms)
Joint 2 (θ_{j2})	0.15	315
Joint 3 (θ_{j3})	0.346	
Distance (θ_d)	0.314	

Joint 3

Extension=100%, Speed=100%, Payload=100%

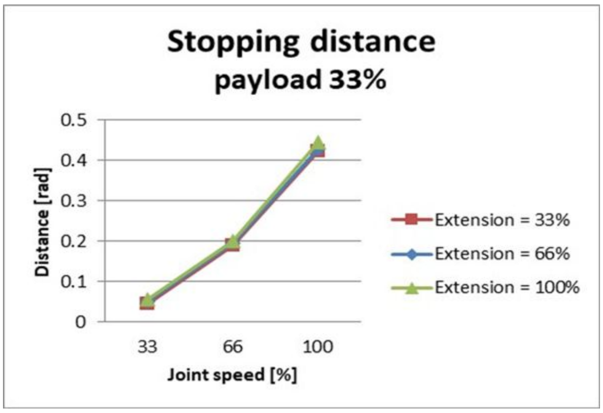
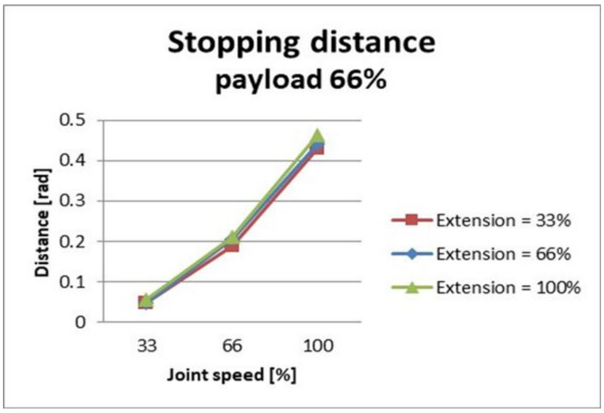
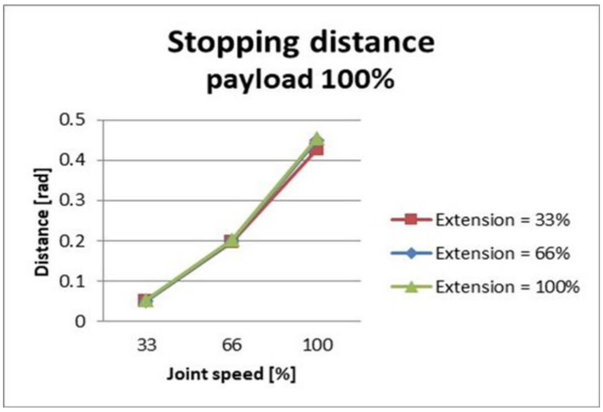
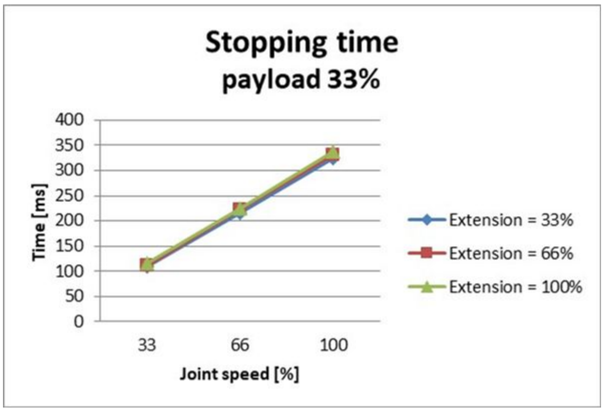
	Stopping distance (rad)	Stopping time (ms)
Joint 2 (θ_{j2})	0.161	225
Joint 3 (θ_{j3})	0.153	
Distance (θ_d)	0.279	

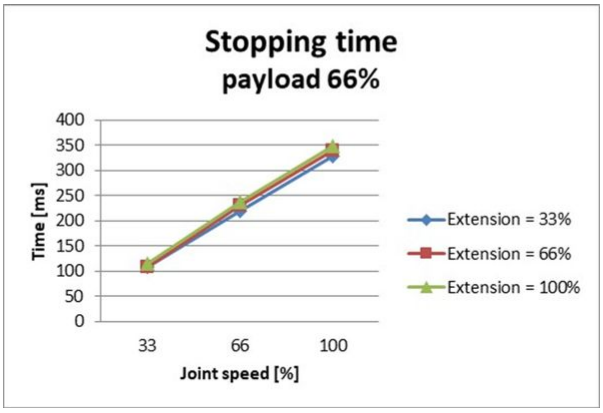
- The joint 2 and joint 3 angles are refer to θ_{j2}, θ_{j3}, θ_d in Measurement Poses and Conditions(p. 72).

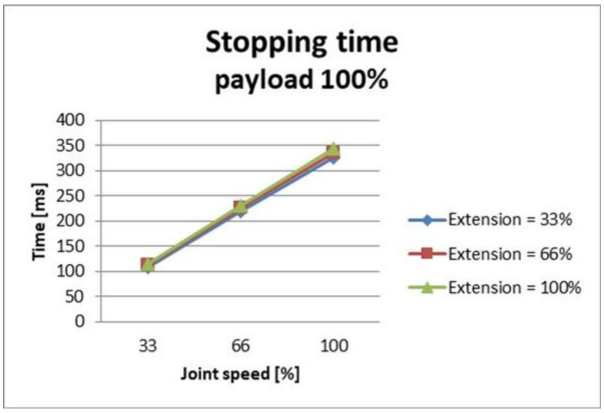
2.15.3 M0609 Stop Category

M0609 Stop Category 1

Stop Distance and Stop Time of Joint 1 (Base)

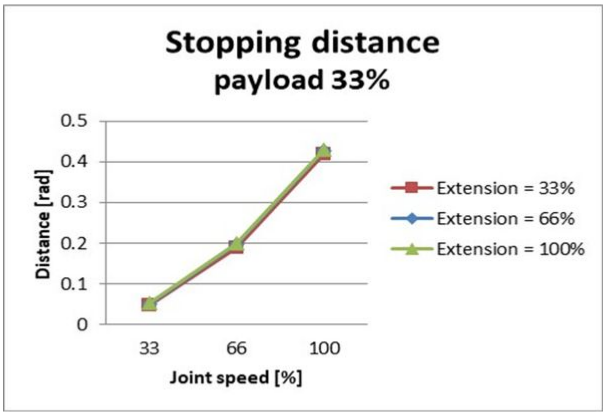
<table>
<tr><th>Stop Distance at 33% of Max. Load (rad)</th><th>Stop Distance at 66% of Max. Load (rad)</th></tr>
<tr><td>
</td><td>
</td></tr>
<tr><th>Stop Distance at Max. Load (rad)</th><th>Stop Time at 33% of Max. Load (ms)</th></tr>
<tr><td>
</td><td>
</td></tr>
<tr><th>Stop Time at 66% of Max. Load (ms)</th><th>Stop Time at Max. Load (ms)</th></tr>
</table>



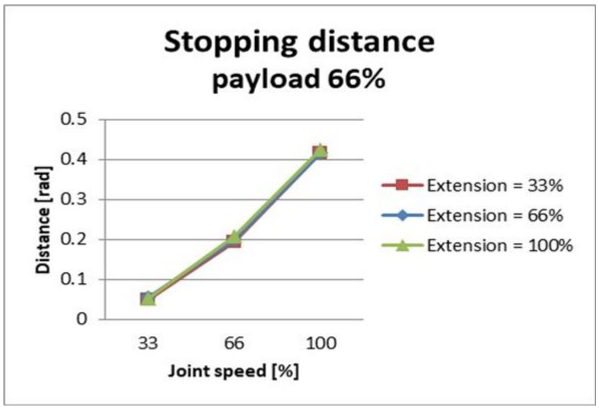


Stop Distance and Stop Time of Joint 2 (Shoulder)

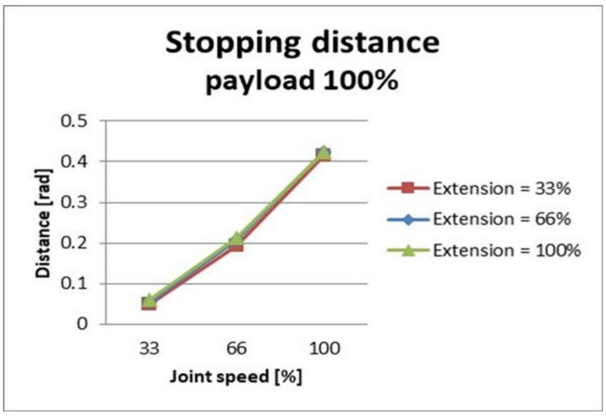
Stop Distance at 33% of Max. Load (rad)



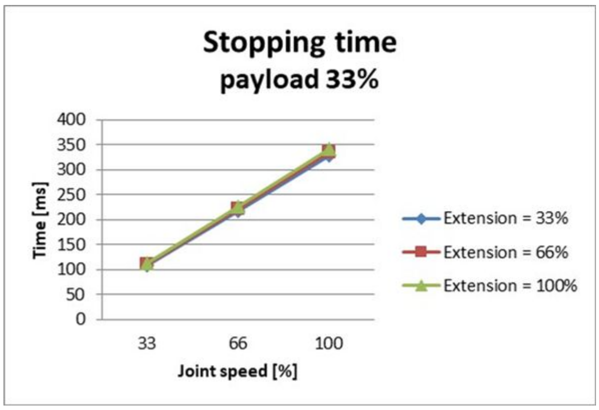
Stop Distance at 66% of Max. Load (rad)



Stop Distance at Max. Load (rad)

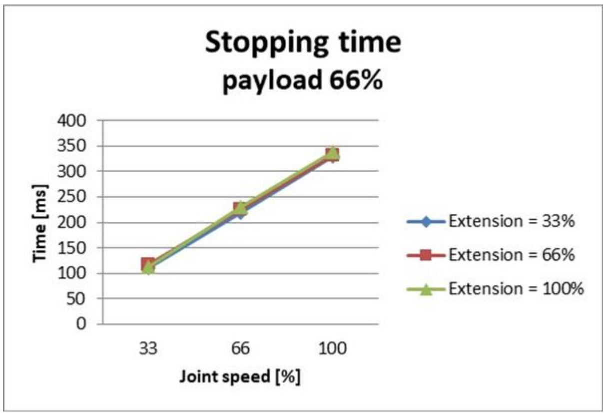
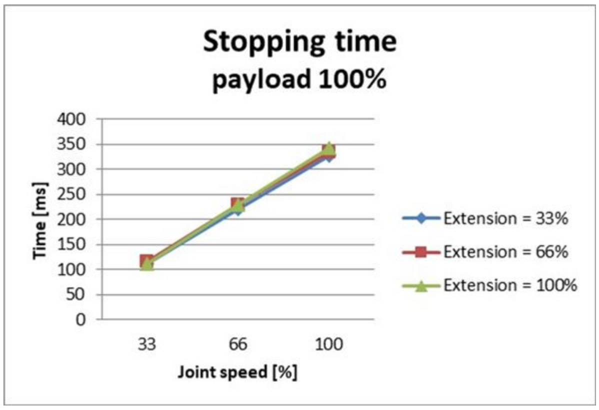


Stop Time at 33% of Max. Load (ms)

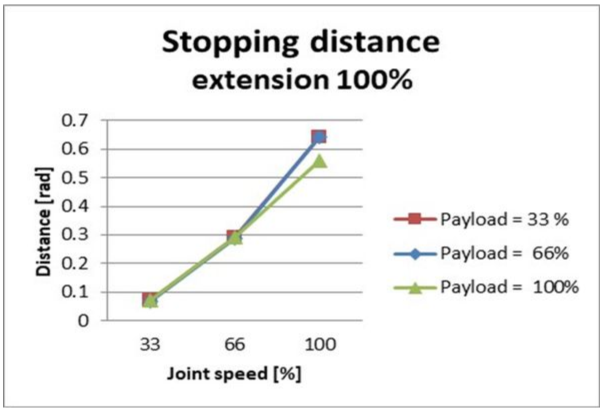
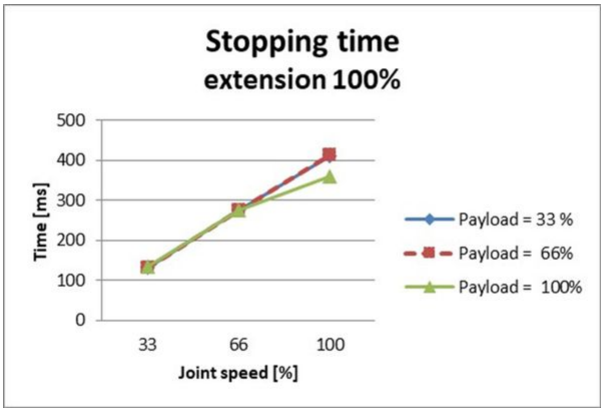


Stop Time at 66% of Max. Load (ms)

Stop Time at Max. Load (ms)

Stop Distance and Stop Time of Joint 3 (Elbow)

Stop Distance at Max. Stretch Level (rad)	Stop Time at Max. Stretch Level (ms)
	

M0609 Stop Category 0

Joint 1

Extension=100%, Speed=100%, Payload=100%

	Stopping distance(rad)	Stopping time(ms)
Joint 1	0.133	92

Joint 2

Extension=100%, Speed=100%, Payload=100%

	Stopping distance(rad)	Stopping time(ms)
Joint 2 (θ_{j2})	0.171	305
Joint 3 (θ_{j3})	0.05	
Distance (θ_d)	0.195	

Joint 3

Extension=100%, Speed=100%, Payload=100%

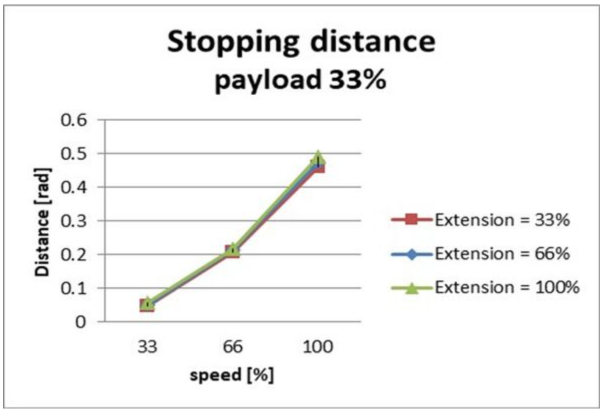
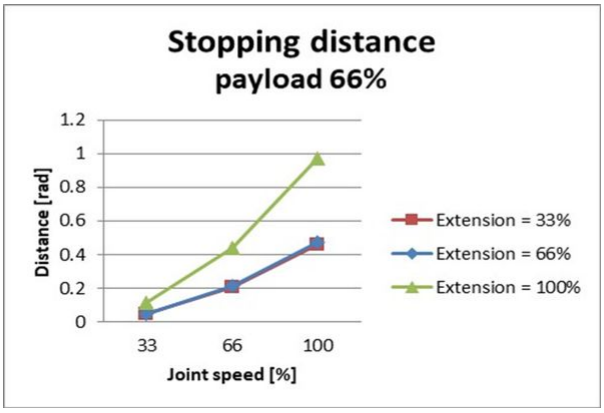
	Stopping distance(rad)	Stopping time(ms)
Joint 2 (θ_{j2})	0.034	113
Joint 3 (θ_{j3})	0.122	
Distance (θ_d)	0.151	

- The joint 2 and joint 3 angles are refer to θ_{j2}, θ_{j3}, θ_d in Measurement Poses and Conditions(p. 72).

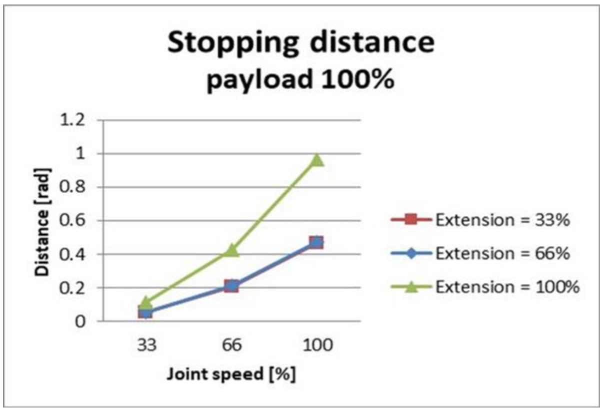
2.15.4 M0617 Stop Category

M0617 Stop Category 1

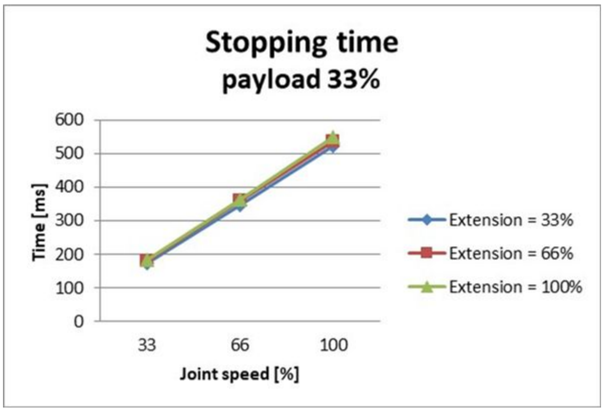
Stop Distance and Stop Time of Joint 1 (Base)

Stop Distance at 33% of Max. Load (rad)	Stop Distance at 66% of Max. Load (rad)
	

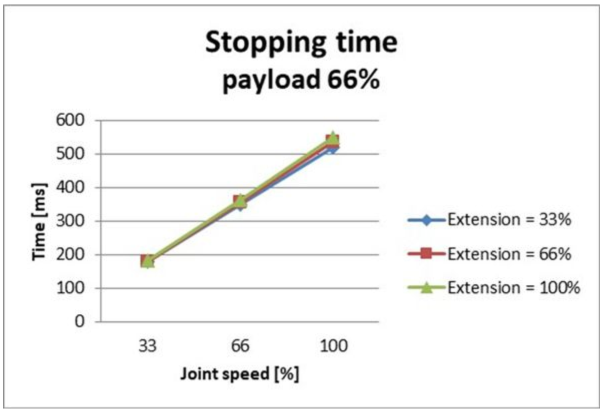
Stop Distance at Max. Load (rad)



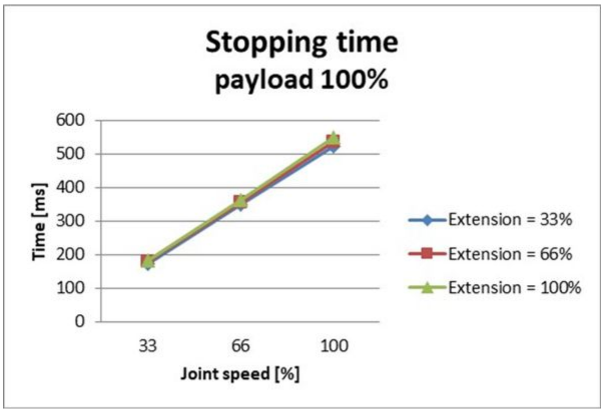
Stop Time at 33% of Max. Load (ms)



Stop Time at 66% of Max. Load (ms)

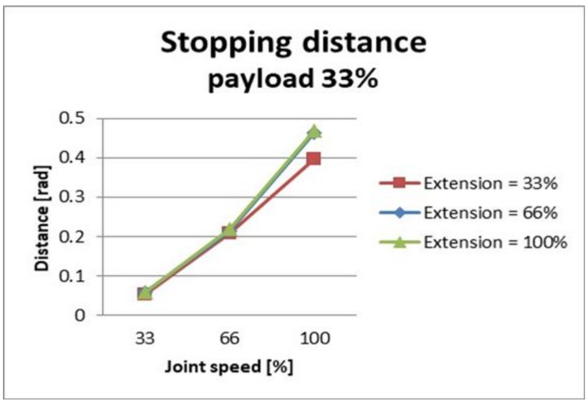


Stop Time at Max. Load (ms)

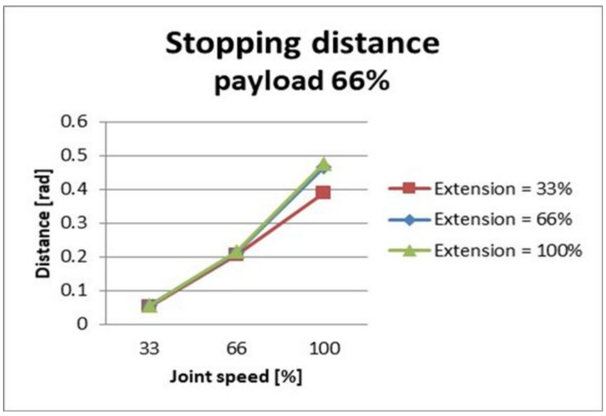


Stop Distance and Stop Time of Joint 2 (Shoulder)

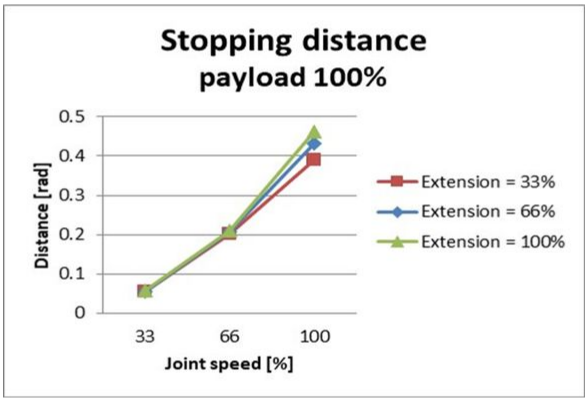
Stop Distance at 33% of Max. Load (rad)



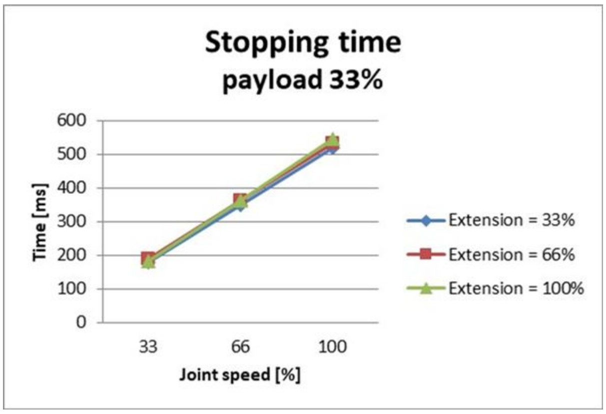
Stop Distance at 66% of Max. Load (rad)



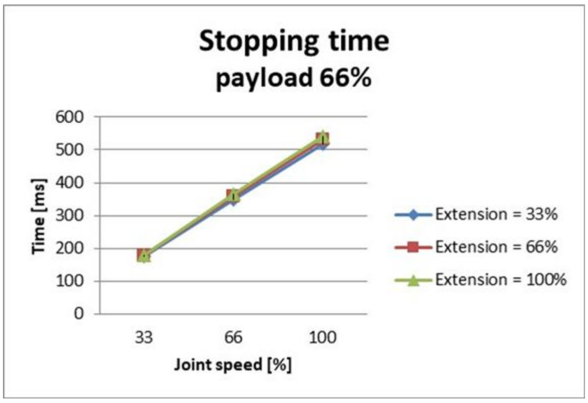
Stop Distance at Max. Load (rad)



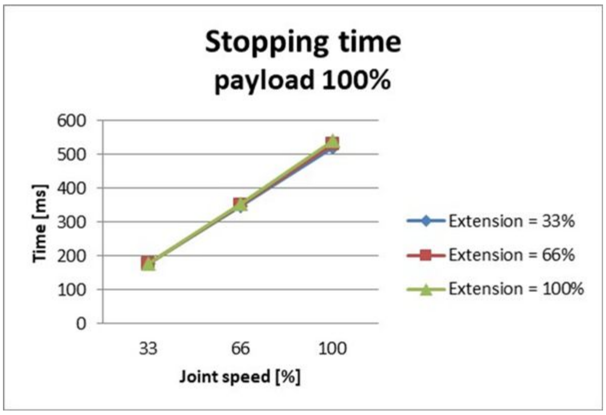
Stop Time at 33% of Max. Load (ms)



Stop Time at 66% of Max. Load (ms)

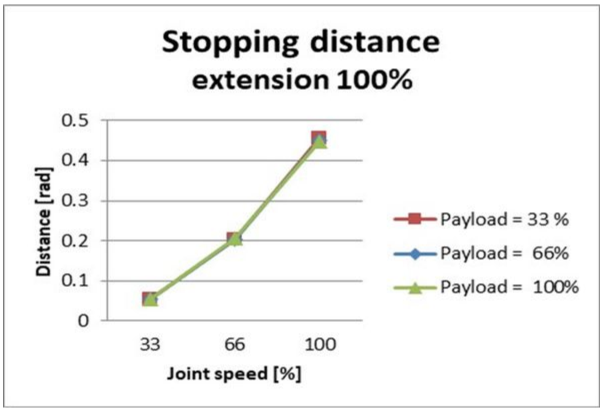


Stop Time at Max. Load (ms)

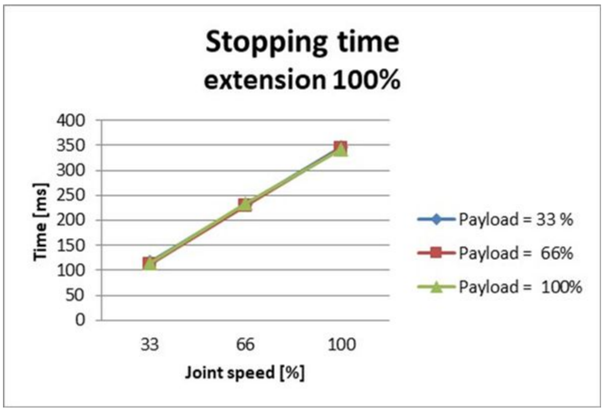


Stop Distance and Stop Time of Joint 3 (Elbow)

Stop Distance at Max. Stretch Level (rad)



Stop Time at Max. Stretch Level (ms)



M0617 Stop Category 0

Joint 1

Extension=100%, Speed=100%, Payload=100%

	Stopping distance(rad)	**Stopping time(ms)**
Joint 1	0.095	89

Joint 2

Extension=100%, Speed=100%, Payload=100%

	Stopping distance(rad)	**Stopping time(ms)**
Joint 2 (θ_{j2})	0.104	326
Joint 3 (θ_{j3})	0.336	
Distance (θ_d)	0.26	

Joint 3

Extension=100%, Speed=100%, Payload=100%

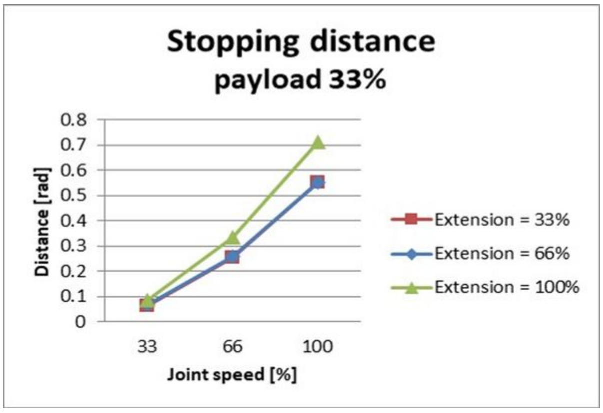
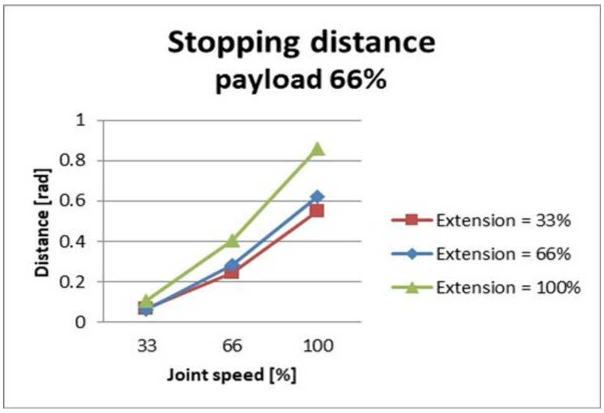
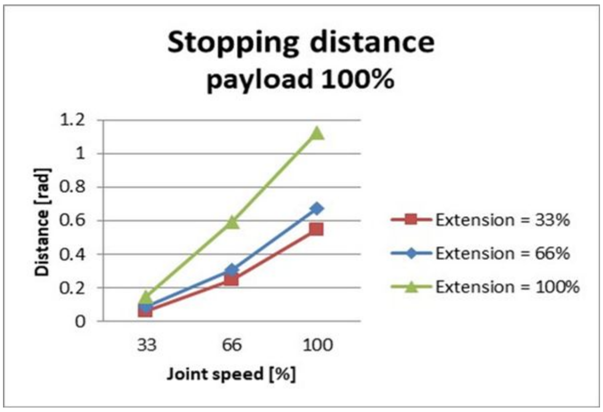
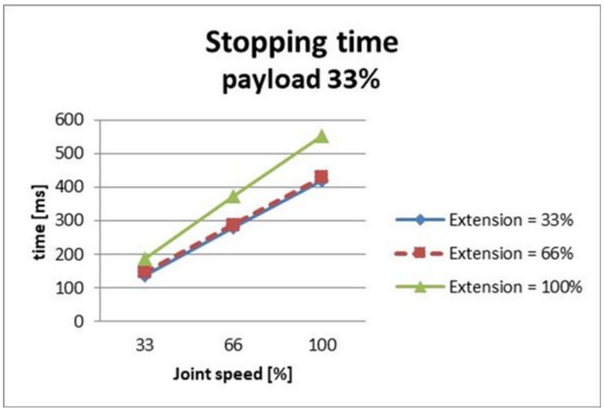
	Stopping distance(rad)	**Stopping time(ms)**
Joint 2 (θ_{j2})	0.079	173
Joint 3 (θ_{j3})	0.119	
Distance (θ_d)	0.185	

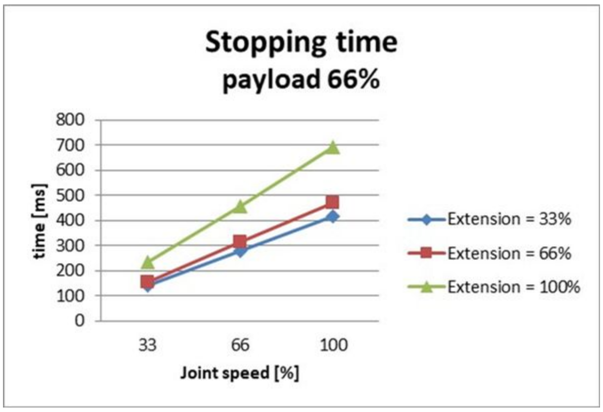
- The joint 2 and joint 3 angles are refer to θ_{j2}, θ_{j3}, θ_d in Measurement Poses and Conditions(p. 72).

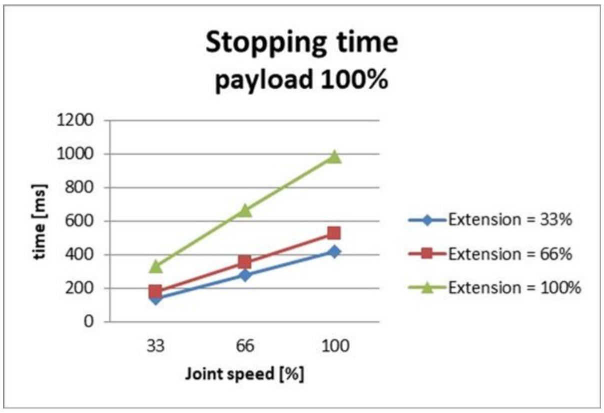
2.15.5 M1509 Stop Category

M1509 Stop Category 1

Stop Distance and Stop Time of Joint 1 (Base)

<table>
<tr><th>Stop Distance at 33% of Max. Load (rad)</th><th>Stop Distance at 66% of Max. Load (rad)</th></tr>
<tr><td>
</td><td>
</td></tr>
<tr><th>Stop Distance at Max. Load (rad)</th><th>Stop Time at 33% of Max. Load (ms)</th></tr>
<tr><td>
</td><td>
</td></tr>
<tr><th>Stop Time at 66% of Max. Load (ms)</th><th>Stop Time at Max. Load (ms)</th></tr>
</table>

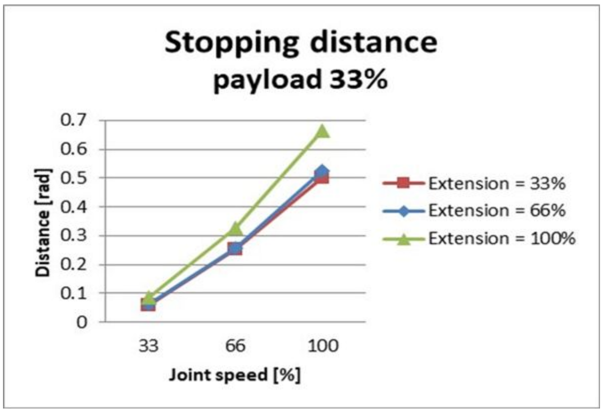


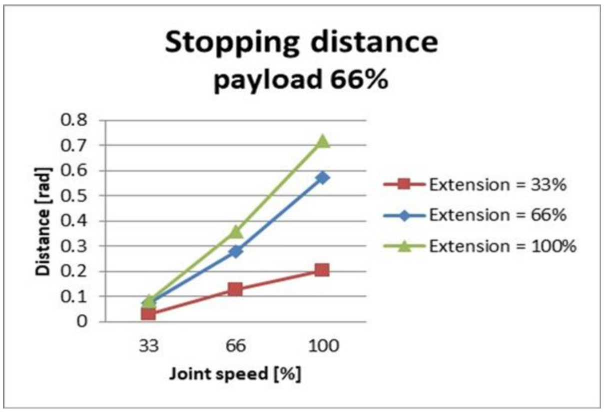


Stop Distance and Stop Time of Joint 2 (Shoulder)

Stop Distance at 33% of Max. Load (rad)

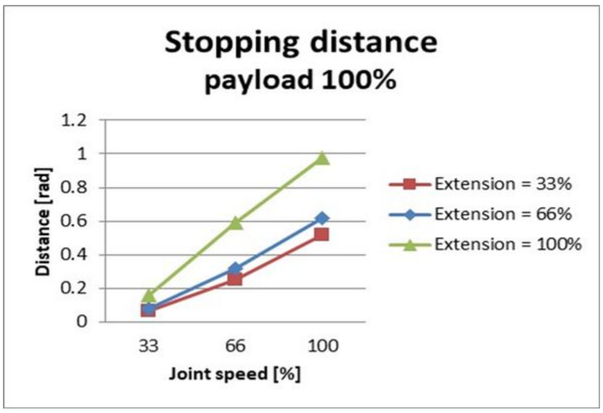
Stop Distance at 66% of Max. Load (rad)

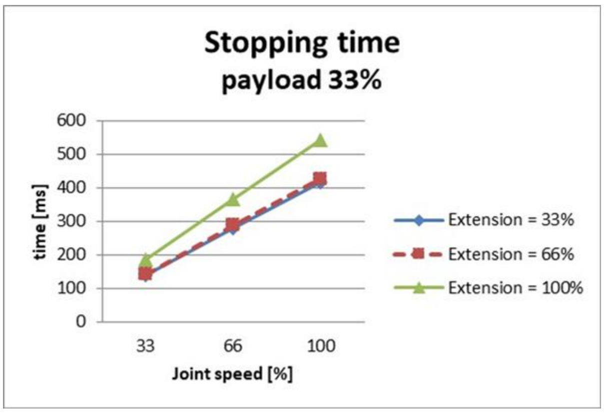




Stop Distance at Max. Load (rad)

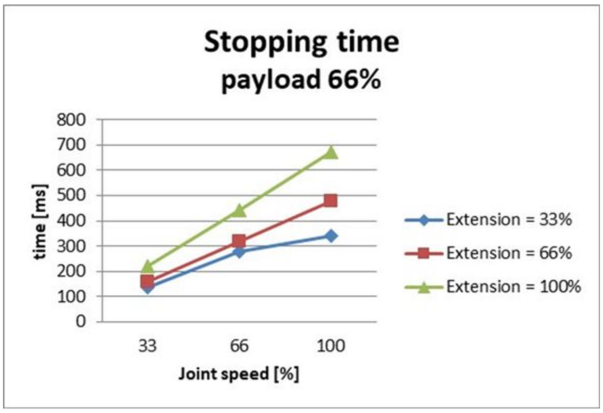
Stop Time at 33% of Max. Load (ms)

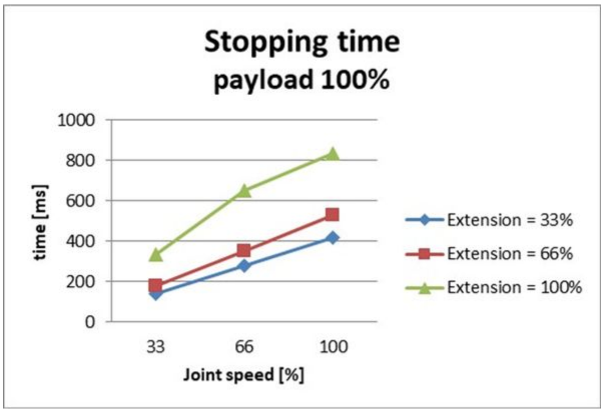




Stop Time at 66% of Max. Load (ms)

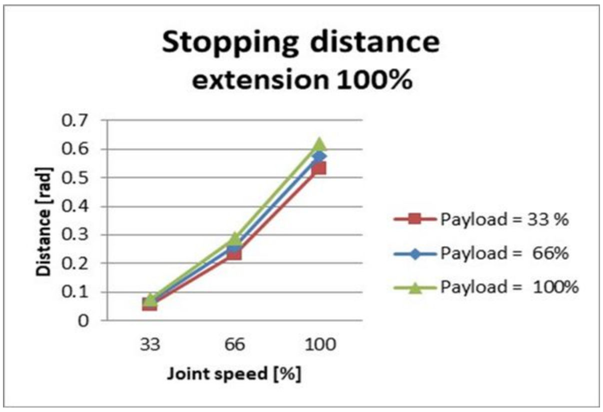
Stop Time at Max. Load (ms)

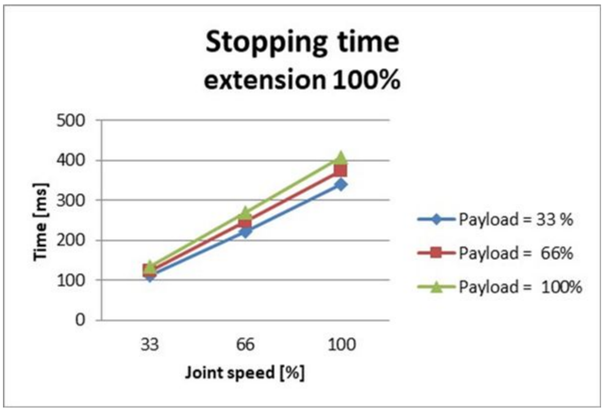




Stop Distance and Stop Time of Joint 3 (Elbow)

Stop Distance at Max. Stretch Level (rad)	Stop Time at Max. Stretch Level (ms)





M1509 Stop Category 0

Joint 1

Extension=100%, Speed=100%, Payload=100%

	Stopping distance(rad)	Stopping time(ms)
Joint 1	0.138	109

Joint 2

Extension=100%, Speed=100%, Payload=100%

	Stopping distance(rad)	Stopping time(ms)
Joint 2 (θ_{j2})	0.105	327
Joint 3 (θ_{j3})	0.492	
Distance (θ_d)	0.338	

Joint 3

Extension=100%, Speed=100%, Payload=100%

	Stopping distance(rad)	Stopping time(ms)
Joint 2 (θ_{j2})	0.155	197
Joint 3 (θ_{j3})	0.134	
Distance (θ_d)	0.258	

- The joint 2 and joint 3 angles are refer to θ_{j2}, θ_{j3}, θ_d in Measurement Poses and Conditions(p. 72).

2.15.6 H2017 Stop Category

H2017 Stop Category 0

Joint 1

Extension=100%, Speed=100%, Payload=100%

	Stopping distance (rad)	Stopping time (ms)
Axis 1	0.12483	98.867

Joint 2

Extension=100%, Speed=100%, Payload=100%

	Stopping distance (rad)	Stopping time (ms)
Axis 2	0.09471	296.568

	Stopping distance (rad)	Stopping time (ms)
Axis 3	0.44703	

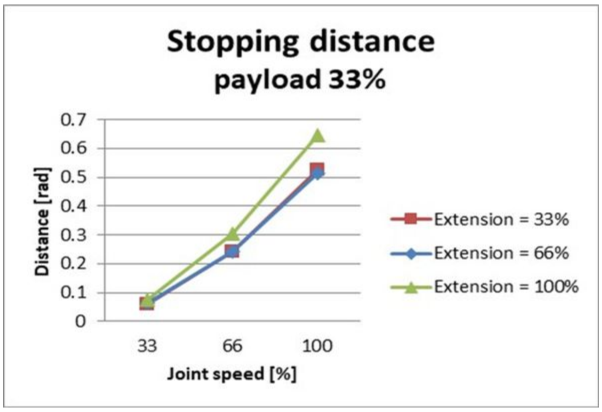
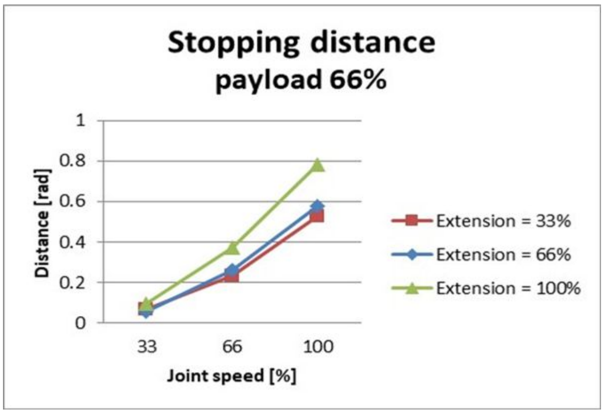
Joint 3

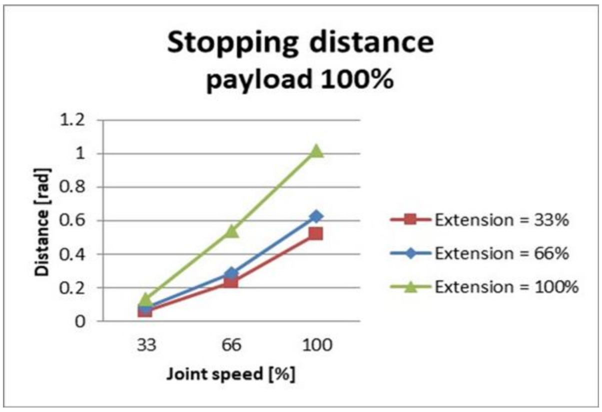
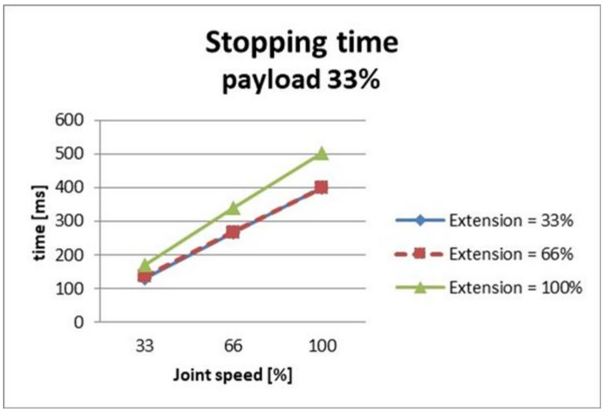
Extension=100%, Speed=100%, Payload=100%

	Stopping distance (rad)	Stopping time (ms)
Axis 2	0.14045	178.785
Axis 3	0.12168	

H2017 Stop Category 1

Stop Distance and Stop Time of Joint 1 (Base)

Stop Distance at 33% of Max. Load (rad)	Stop Distance at 66% of Max. Load (rad)
	
Stop Distance at Max. Load (rad)	**Stop Time at 33% of Max. Load (ms)**

<table>
<tr><td>
</td><td>
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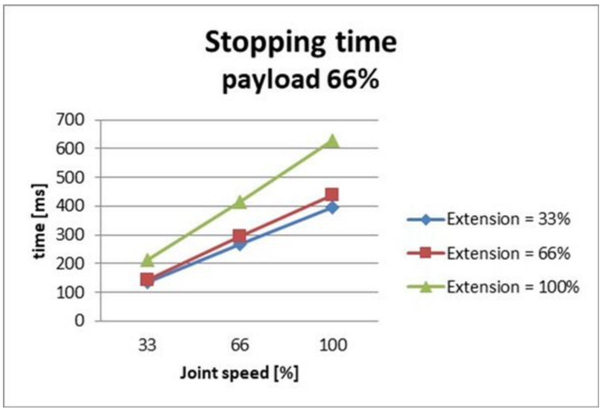
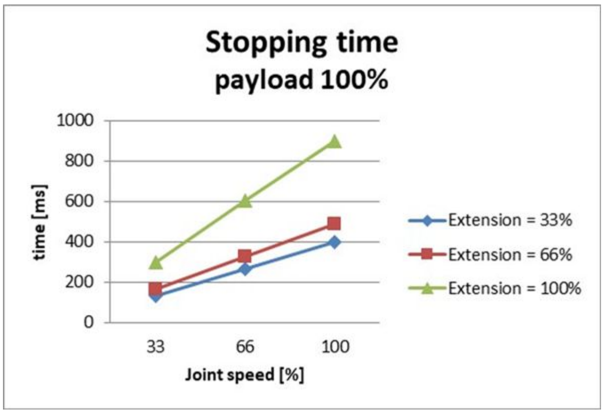
<tr><td>Stop Time at 66% of Max. Load (ms)</td><td>Stop Time at Max. Load (ms)</td></tr>
<tr><td>
</td><td>
</td></tr>
</table>

Stop Distance and Stop Time of Joint 2 (Shoulder)

<table>
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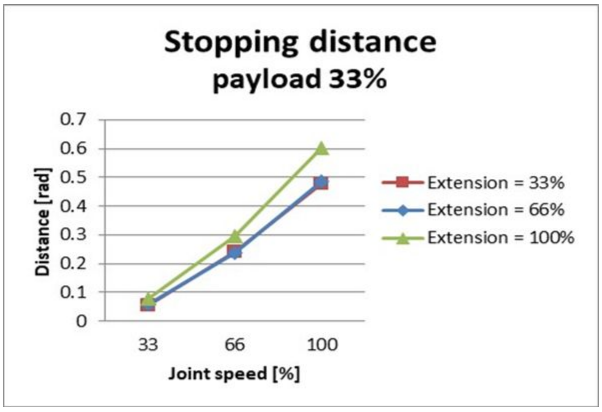
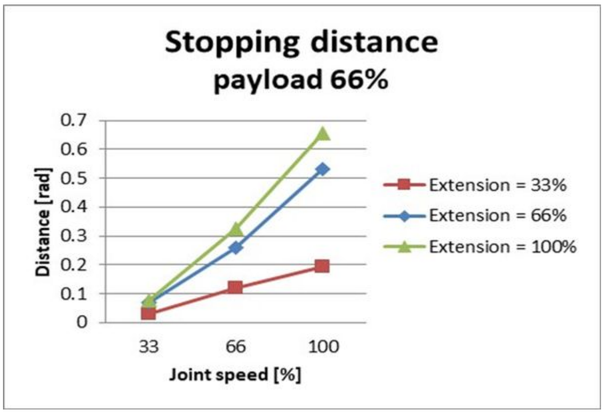
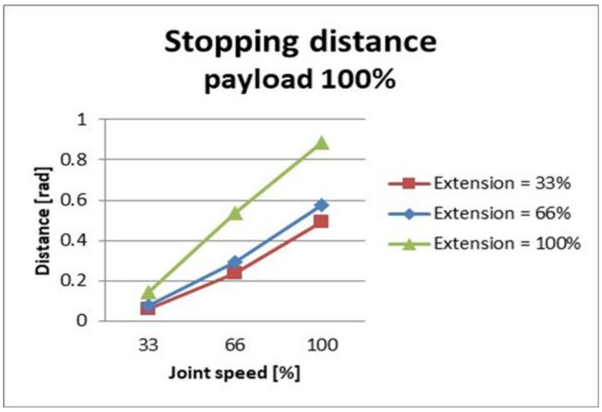
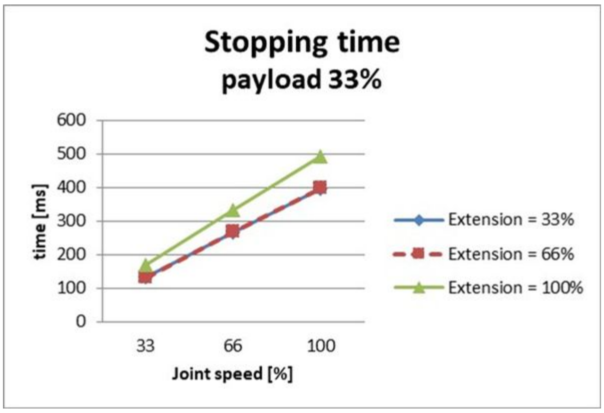
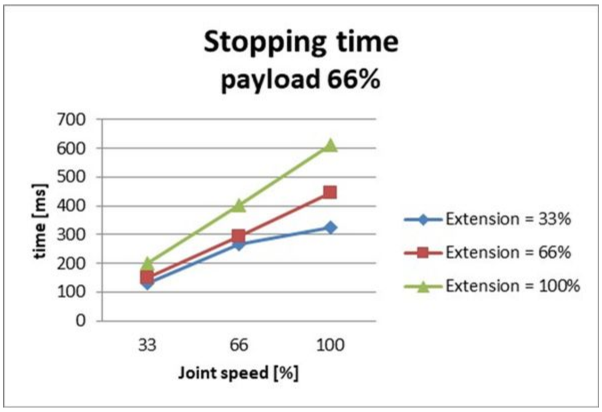
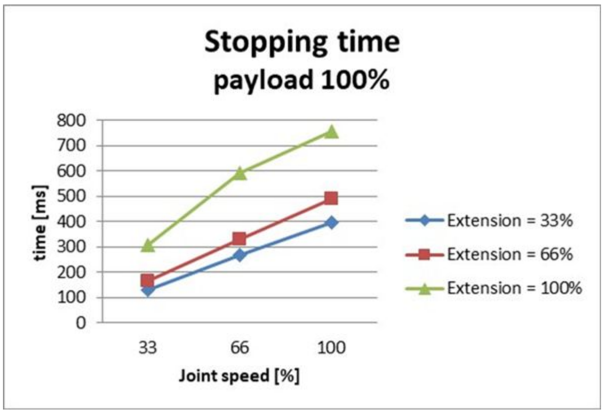
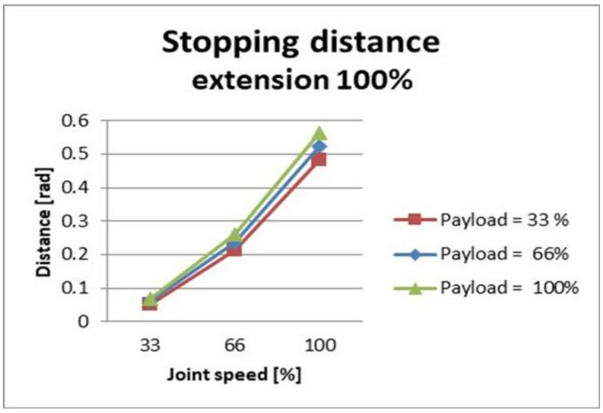
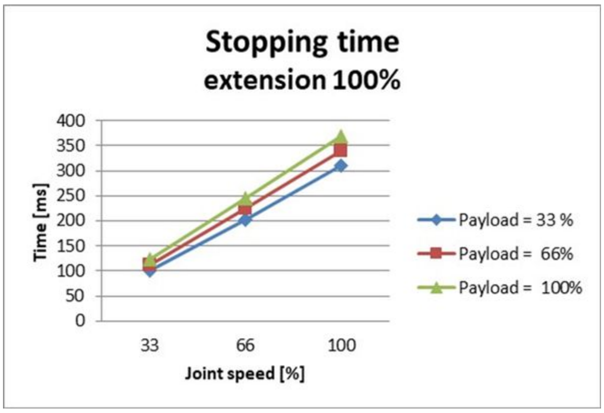
<tr><td>
</td><td>
</td></tr>
<tr><td>Stop Distance at Max. Load (rad)</td><td>Stop Time at 33% of Max. Load (ms)</td></tr>
</table>





Stop Time at 66% of Max. Load (ms)	Stop Time at Max. Load (ms)
	

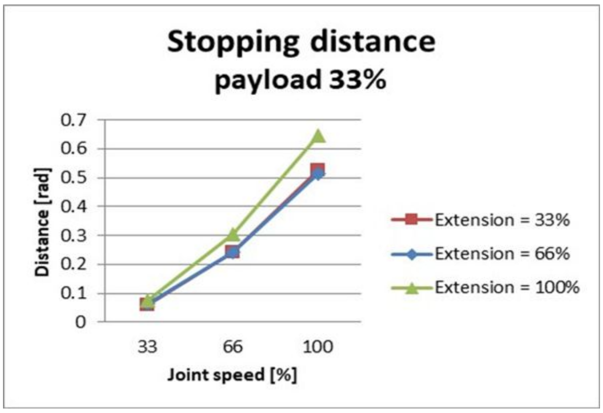
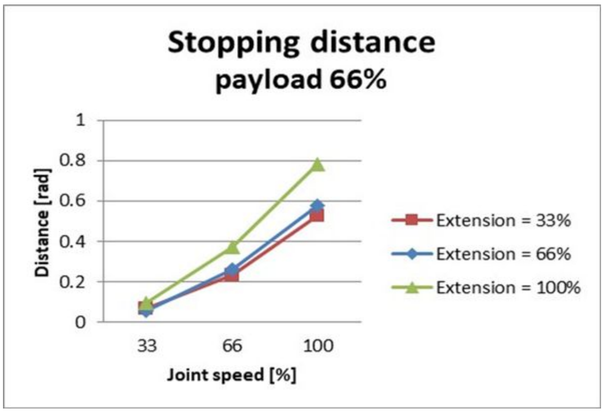
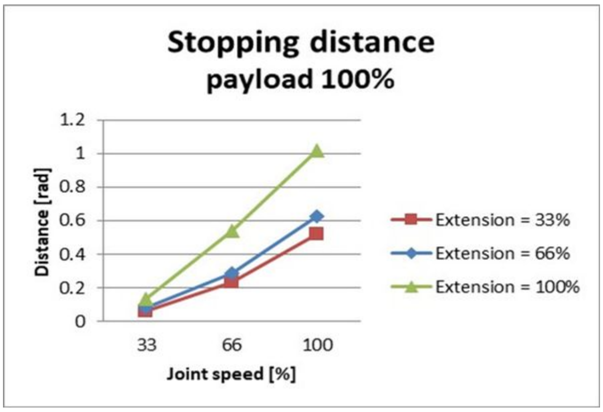
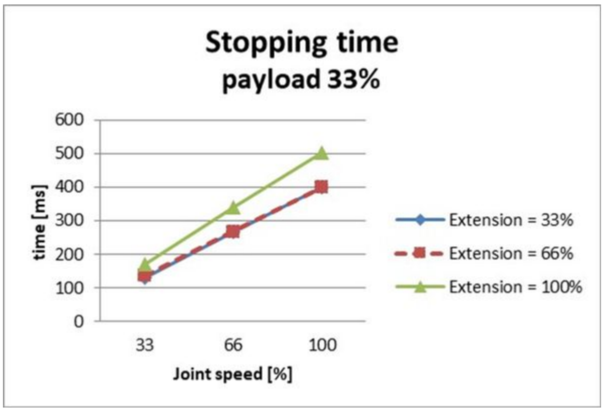
Stop Distance and Stop Time of Joint 3 (Elbow)

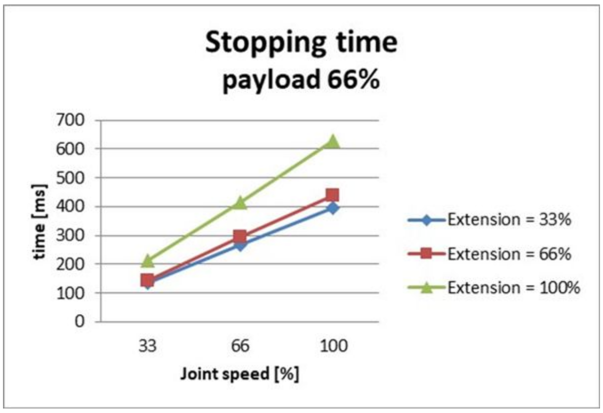
Stop Distance at Max. Stretch Level (rad)	Stop Time at Max. Stretch Level (ms)
	

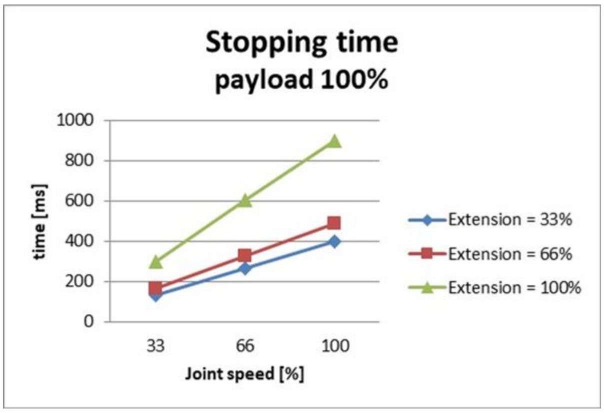
2.15.7 H2515 Stop Category

H2515 Stop Category 1

Stop Distance and Stop Time of Joint 1 (Base)

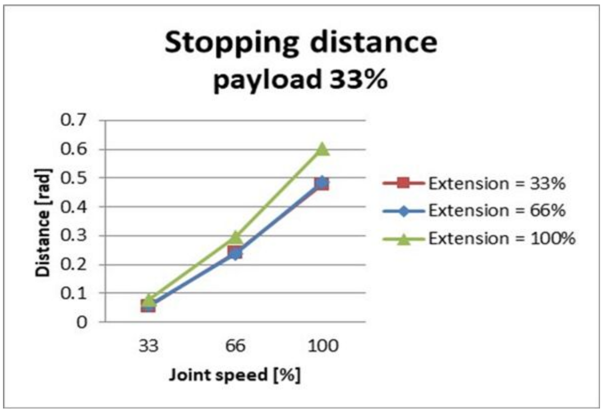
<table>
<tr><th>Stop Distance at 33% of Max. Load (rad)</th><th>Stop Distance at 66% of Max. Load (rad)</th></tr>
<tr><td>
</td><td>
</td></tr>
<tr><th>Stop Distance at Max. Load (rad)</th><th>Stop Time at 33% of Max. Load (ms)</th></tr>
<tr><td>
</td><td>
</td></tr>
<tr><th>Stop Time at 66% of Max. Load (ms)</th><th>Stop Time at Max. Load (ms)</th></tr>
</table>



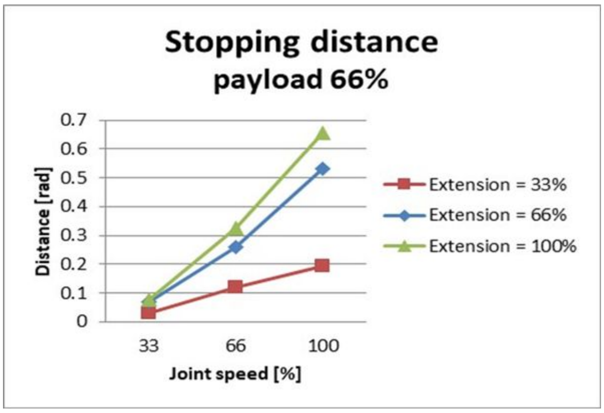


Stop Distance and Stop Time of Joint 2 (Shoulder)

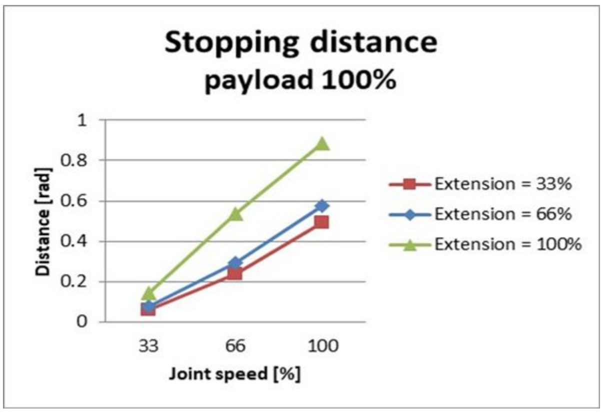
Stop Distance at 33% of Max. Load (rad)



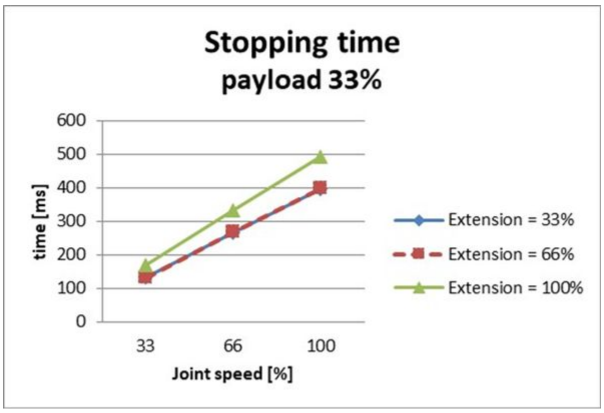
Stop Distance at 66% of Max. Load (rad)



Stop Distance at Max. Load (rad)

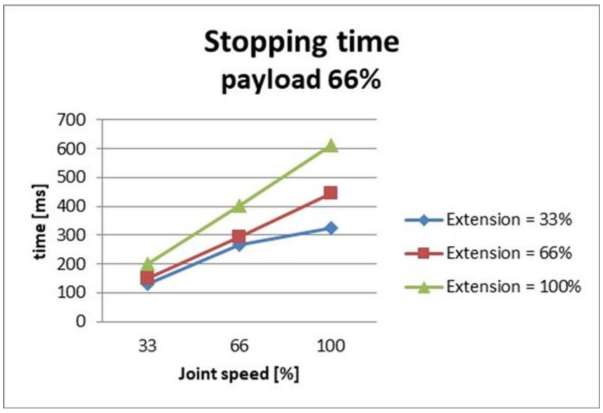
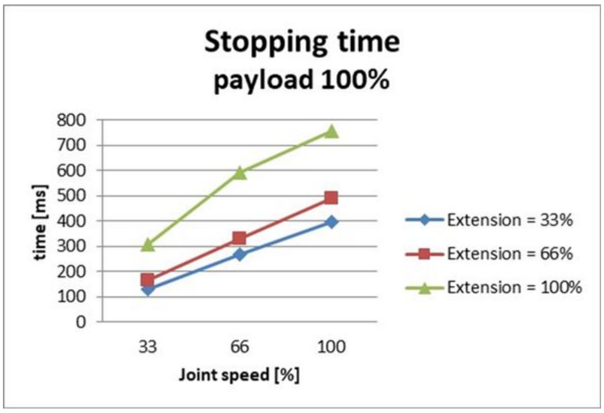


Stop Time at 33% of Max. Load (ms)

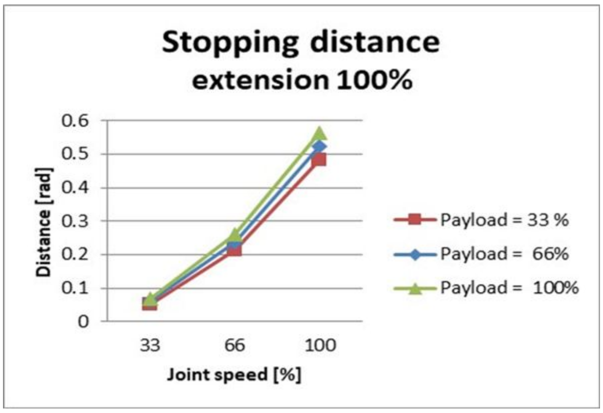
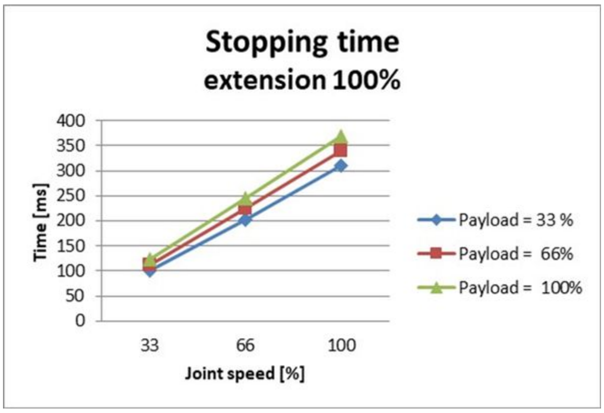


Stop Time at 66% of Max. Load (ms)

Stop Time at Max. Load (ms)

Stop Distance and Stop Time of Joint 3 (Elbow)

Stop Distance at Max. Stretch Level (rad)	Stop Time at Max. Stretch Level (ms)
	

H2515 Stop Category 0

Joint 1

Extension=100%, Speed=100%, Payload=100%

	Stopping distance (rad)	Stopping time (ms)
Axis 1	0.12483	98.867

Joint 2

Extension=100%, Speed=100%, Payload=100%

	Stopping distance (rad)	Stopping time (ms)
Axis 2	0.09471	296.568
Axis 3	0.44703	

Joint 3

Extension=100%, Speed=100%, Payload=100%

	Stopping distance (rad)	Stopping time (ms)
Axis 2	0.14045	178.785
Axis 3	0.12168	

2.16 Upper/Lower Threshold Range and Default Value of Safety Parameters

2.16.1 M1509

Parameters		Normal			Reduced			Tolerance (+/-)
		Min	Max	Default	Min	Max	Default	
Joint Angle Limits	**J1 (degree)**	-360	360	-360~360	-360	360	-360~360	3/-3
	J2 (degree)	-360	360	-95~95	-360	360	-95~95	3/-3
	J3 (degree)	-150	150	-135~135	-150	150	-135~135	3/-3
	J4 (degree)	-360	360	-360~360	-360	360	-360~360	3/-3
	J5 (degree)	-360	360	-135~135	-360	360	-135~135	3/-3
	J6 (degree)	-360	360	-360~360	-360	360	-360~360	3/-3
Joint Speed Limits	**J1 (degree/s)**	0	150	150	0	150	150	10
	J2 (degree/s)	0	150	150	0	150	150	10

	J3 (degree/s)	0	180	180	0	180	180	10
	J4 (degree/s)	0	225	225	0	225	225	10
	J5 (degree/s)	0	225	225	0	225	225	10
	J6 (degree/s)	0	225	225	0	225	225	10
Robot/TCP Limits	**Force (N)**	0	800	162	0	800	81	-
	Power (W)	0	1600	650	0	1600	120	-
	Speed (mm/s)	0	7000	2000	0	7000	1000	-
	Momentum (kgm/s)	0	135	68	0	135	40	-
	Collision Detection Sensitivity (%)	1	100	75	-	-	-	-
Safety I/O	**Speed Reduction Ratio (%)**	-	-	-	1	100	20	-

2.16.2 M1013

Parameters		**Normal**			**Reduced**			**Tolerance (+/-)**
		Min	**Max**	**Default**	**Min**	**Max**	**Default**	
Joint Angle Limits	**J1 (degree)**	-360	360	-360~360	-360	360	-360~360	3/-3
	J2 (degree)	-360	360	-95~95	-360	360	-95~95	3/-3
	J3 (degree)	-160	160	-135~135	-160	160	-135~135	3/-3
	J4 (degree)	-360	360	-360~360	-360	360	-360~360	3/-3
	J5 (degree)	-360	360	-135~135	-360	360	-135~135	3/-3

	J6 (degree)	-360	360	-360~360	-360	360	-360~360	3/-3
Joint Speed Limits	**J1 (degree/s)**	0	120	120	0	120	120	10
	J2 (degree/s)	0	120	120	0	120	120	10
	J3 (degree/s)	0	180	180	0	180	180	10
	J4 (degree/s)	0	225	225	0	225	225	10
	J5 (degree/s)	0	225	225	0	225	225	10
	J6 (degree/s)	0	225	225	0	225	225	10
Robot/TCP Limits	**Force (N)**	0	550	144	0	550	72	-
	Power (W)	0	1600	600	0	1600	100	-
	Speed (mm/s)	0	8000	2000	0	8000	1500	-
	Momentum (kgm/s)	0	165	82	0	165	50	-
	Collision Detection Sensitivity (%)	1	100	75	-	-	-	-
Safety I/O	**Speed Reduction Ratio (%)**	-	-	-	1	100	20	-

2.16.3 M0617

Parameters		**Normal**			**Reduced**			**Tolerance (+/-)**
		Min	**Max**	**Default**	**Min**	**Max**	**Default**	
Joint Angle Limits	**J1 (degree)**	-360	360	-360~360	-360	360	-360~360	3/-3
	J2 (degree)	-360	360	-95~95	-360	360	-95~95	3/-3

	J3 (degree)	-165	165	-145~145	-165	165	-145~145	3/-3
	J4 (degree)	-360	360	-360~360	-360	360	-360~360	3/-3
	J5 (degree)	-360	360	-135~135	-360	360	-135~135	3/-3
	J6 (degree)	-360	360	-360~360	-360	360	-360~360	3/-3
Joint Speed Limits	**J1 (degree/s)**	0	100	100	0	100	100	10
	J2 (degree/s)	0	100	100	0	100	100	10
	J3 (degree/s)	0	150	150	0	150	150	10
	J4 (degree/s)	0	225	225	0	225	225	10
	J5 (degree/s)	0	225	225	0	225	225	10
	J6 (degree/s)	0	225	225	0	225	225	10
Robot/TCP Limits	**Force (N)**	0	500	108	0	500	54	-
	Power (W)	0	1600	600	0	1600	100	-
	Speed (mm/s)	0	8000	2000	0	8000	1500	-
	Momentum (kgm/s)	0	180	90	0	180	55	-
	Collision Detection Sensitivity (%)	1	100	75	-	-	-	-
Safety I/O	**Speed Reduction Ratio (%)**	-	-	-	1	100	20	-

2.16.4 M0609

Parameters		Normal			Reduced			Tolerance (+/-)
		Min	Max	Default	Min	Max	Default	
Joint Angle Limits	J1 (degree)	-360	360	-360~360	-360	360	-360~360	3/-3
	J2 (degree)	-360	360	-95~95	-360	360	-95~95	3/-3
	J3 (degree)	-150	150	-135~135	-150	150	-135~135	3/-3
	J4 (degree)	-360	360	-360~360	-360	360	-360~360	3/-3
	J5 (degree)	-360	360	-135~135	-360	360	-135~135	3/-3
	J6 (degree)	-360	360	-360~360	-360	360	-360~360	3/-3
Joint Speed Limits	J1 (degree/s)	0	150	150	0	150	150	10
	J2 (degree/s)	0	150	150	0	150	150	10
	J3 (degree/s)	0	180	180	0	180	180	10
	J4 (degree/s)	0	225	225	0	225	225	10
	J5 (degree/s)	0	225	225	0	225	225	10
	J6 (degree/s)	0	225	225	0	225	225	10
Robot/TCP Limits	Force (N)	0	400	96	0	400	48	-
	Power (W)	0	1600	300	0	1600	80	-
	Speed (mm/s)	0	7000	2000	0	7000	1000	-
	Momentum (kgm/s)	0	75	38	0	75	23	-

	Collision Detection Sensitivity (%)	1	100	75	-	-	-	-
Safety I/O	**Speed Reduction Ratio (%)**	-	-	-	1	100	20	-

2.16.5 H2515

Parameters		**Normal**			**Reduced**			**Tolerance (+/-)**
		Min	**Max**	**Default**	**Min**	**Max**	**Default**	
Joint Angle Limits	**J1 (degree)**	-360	360	-360~360	-360	360	-360~360	3/-3
	J2 (degree)	-125	125	-95~95	-125	125	-95~95	3/-3
	J3 (degree)	-160	160	-145~145	-160	160	-145~145	3/-3
	J4 (degree)	-360	360	-360~360	-360	360	-360~360	3/-3
	J5 (degree)	-360	360	-135~135	-360	360	-135~135	3/-3
	J6 (degree)	-360	360	-360~360	-360	360	-360~360	3/-3
Joint Speed Limits	**J1 (degree/s)**	0	100	100	0	100	100	10
	J2 (degree/s)	0	80	80	0	80	80	10
	J3 (degree/s)	0	100	100	0	100	100	10
	J4 (degree/s)	0	180	180	0	180	180	10
	J5 (degree/s)	0	180	180	0	180	180	10
	J6 (degree/s)	0	180	180	0	180	180	10
Robot/TCP Limits	**Force (N)**	0	1200	243	0	1200	122	**-**
	Power (W)	0	1600	800	0	1600	650	**-**

	Speed (mm/s)	0	2500	2000	0	2500	1500	-
	Momentum (kgm/s)	0	400	200	0	400	122	-
	Collision Detection Sensitivity (%)	1	100	75	-	-	-	-
Safety I/O	**Speed Reduction Ratio (%)**	-	-	-	1	100	20	-

2.16.6 H2017

Parameters		**Normal**			**Reduced**			**Tolerance (+/-)**
		Min	**Max**	**Default**	**Min**	**Max**	**Default**	
Joint Angle Limits	**J1 (degree)**	-360	360	-360~360	-360	360	-360~360	3/-3
	J2 (degree)	-125	125	-95~95	-125	125	-95~95	3/-3
	J3 (degree)	-160	160	-145~145	-160	160	-145~145	3/-3
	J4 (degree)	-360	360	-360~360	-360	360	-360~360	3/-3
	J5 (degree)	-360	360	-135~135	-360	360	-135~135	3/-3
	J6 (degree)	-360	360	-360~360	-360	360	-360~360	3/-3
Joint Speed Limits	**J1 (degree/s)**	0	80	80	0	80	80	10
	J2 (degree/s)	0	80	80	0	80	80	10
	J3 (degree/s)	0	80	80	0	80	80	10
	J4 (degree/s)	0	180	180	0	180	180	10
	J5 (degree/s)	0	180	180	0	180	180	10
	J6 (degree/s)	0	180	180	0	180	180	10

Robot/TCP Limits	**Force (N)**	0	1200	243	0	1200	122	-
	Power (W)	0	1600	800	0	1600	650	-
	Speed (mm/s)	0	2500	2000	0	2500	1500	-
	Momentum (kgm/s)	0	400	200	0	400	122	-
	Collision Detection Sensitivity (%)	1	100	75	-	-	-	-
Safety I/O	**Speed Reduction Ratio (%)**	-	-	-	1	100	20	-

2.17 Potential Risks

- Jamming fingers between the manipulator base and mount
- Jamming limbs between the Link 1 and Link 2 (between Joint 3 (J3) and Joint 4 (J4))
- Jamming limbs between Joint 1 and Joint 2 (J1 and J2) and Joint 5 and Joint 6 (J5 and J6)
- Penetration of skin by sharp edges or surfaces of the tool
- Penetration of skin by sharp edges or surfaces of objects in the operating space of the robot
- Contusion caused by robot movement
- Bone fracturing due to movement between heavy payload and hard surface
- Accidents that occur due to loosening of bolts securing the robot flange or tool
- Object falls from the tool due to inappropriate grip or sudden power shortage
- Accidents that occur due to mistaking an emergency stop button of different equipment
- Errors that occur due to unauthorized safety parameter modification

3 PART 2. Starting Up the Robot

From Starting Up the Robot, the user can learn the overall process from robot installation to robot operation. Install the robot according to the following 4 steps, and create a task program to execute:

- Step 1. Robot Installation(p. 106) : Install the robot and connect the controller and teach pendant.
- Step 2. Tool Installation and I/O Testing(p. 114) : Install the tool and test the I/O signal.

3.1 Journey Map

The journey map lists the process from the installation of Doosan Robotics robot to actual operation in sequential order. Refer to each guide item to begin using the robot.

3.1.1 Step 1. Robot Installation

	Classification	Work	Mandatory Work	Difficulty	Time (Minutes)
1	Robot Installation	Remove packing	✔	EASY	3
		Connect cable to the controller	✔	EASY	1
		Secure the robot base	✔	EASY	3
		Connect controller to robot	✔	EASY	1
		Connect power to controller	✔	EASY	1
		Position controller	✔	EASY	1
2	Initial start Up	Power-up controller	✔	EASY	3
		Disengage emergency stop button	✔	EASY	1
		Disengage packaging pose	✔	EASY	3
		Servo Off	✔	EASY	1

3.1.2 Step 2. Tool Installation and I/O Testing

	Classification	Work	Mandatory Work	Difficulty	Time (Minutes)
1	Tool Installation	Install tool	✓	EASY	5
2	I/O Testing	Turn system power off	✓	EASY	1
		Connect wires	✓	NORMAL	10
		Turn system power on	✓	EASY	1
		Test controller and flange I/O	✓	NORMAL	10

3.2 Step 1. Robot Installation

In this step, you can learn how to install and initially start up the Doosan Robotics robot.

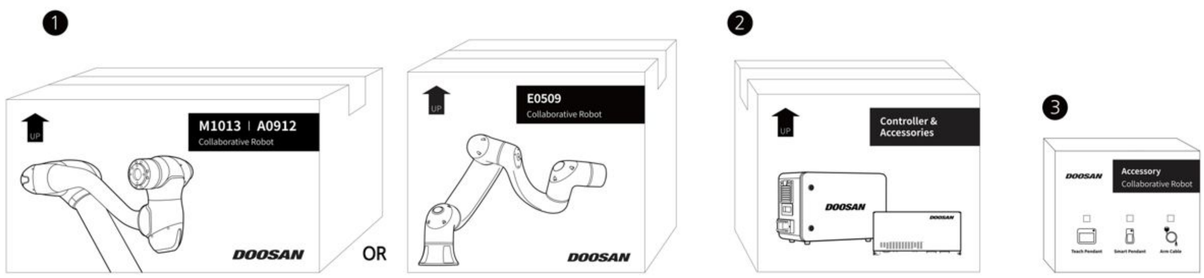
> **Caution**
>
> - Before installing the robot, make sure to read and follow Cautions during Installation(p. 158) and Installation Environment(p. 145).
> - For more information about robot installation, refer to PART 3. Installation Manual(p. 119).

3.2.1 Remove packing

MANDATORY **EASY** **3 MIN**

Upon purchasing the Doosan Robotics robot, two boxes containing the robot and controller will be delivered. Remove the packing and check the contents. For more information about the components, refer to Component Check(p. 119).

1. The manipulator is contained in the larger box.
2. The controller is contained in the smaller box.
3. The teach pendant and robot cables are contained in the accessory box



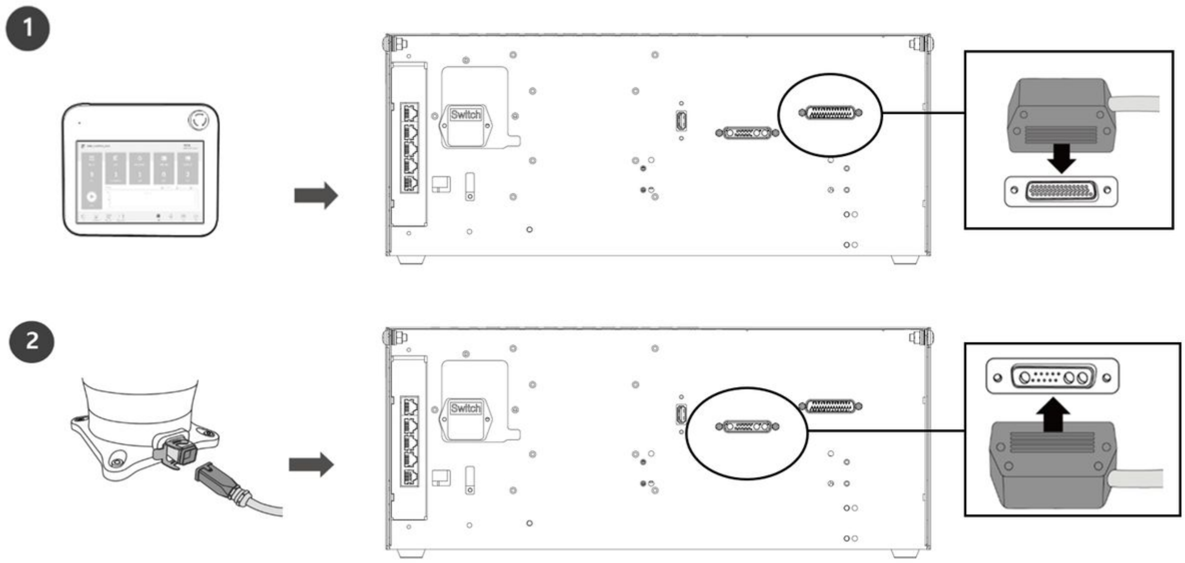
> **Caution**
>
> - To ensure safety during delivery, all products are wrapped and packed using solid protective materials, so take caution when removing them from the box.
> - When removing the product from the box, take caution not to damage to products due to falling.

3.2.2 Connect cable to the controller

MANDATORY **EASY** **1 MIN**

Connect the teach pendant and robot cable to the controller.

1. Push the teach pendant cable into the corresponding controller connector until a click is heard. This will prevent the cable from becoming loose.
2. Push the robot cable's opposite end into the corresponding controller connector until a click is heard to prevent the cable from becoming loose.



> **Caution**
>
> - Make sure to check that the pins in the cable end are not damaged or bent before connecting the cable.
> - If the noise generated by electromagnetic waves causes issues, it is necessary to install a ferrite core to ensure normal operation. For more information about the ferrite core installation location, refer to the followings:
>   - Connecting Manipulator to Controller(p. 153)
>   - Connect Controller to Teach Pendant(p. 149)

3.2.3 Secure the robot base

EASY 3 MIN

When securing the robot base and when installing a tool on the tool flange, the following additional components are required:

- M8 hexagonal wrench bolt: 4
- Φ5 place marker pin 2

Use M8 in the four holes in the robot base to secure the robot. For more information, refer to Securing the Robot(p. 154).

- It is recommended to use a tightening torque of 20 Nm to tighten the bolts. Use washers (spring-flat) to prevent loosening by vibration.
- Use two Φ5 place marker pins to accurately install the robot in a fixed location.

3.2.4 Connect controller to robot

MANDATORY **EASY** **1 MIN**

Connect the robot cable to the corresponding controller connector and place a securing ring on it to prevent the cable from becoming loose.

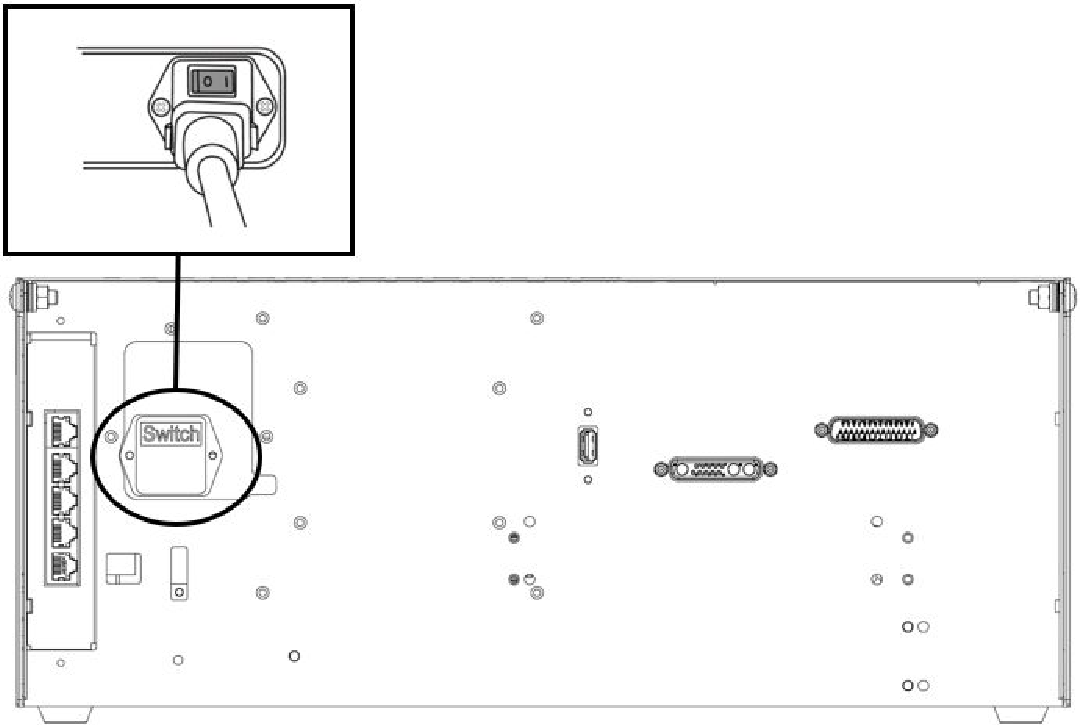
- Push the robot cable's opposite end into the corresponding controller connector until a click is heard to prevent the cable from becoming loose.

3.2.5 Connect power to controller

MANDATORY **EASY** **1 MIN**

To supply power to the controller, connect the power cable of the control box to a standard IEC power outlet.

- After connecting the power cable, make sure that the robot is properly grounded (electrical ground connection).
- Establish a common ground for all equipment in the system with unused bolts related to the ground symbol inside the controller. The ground conductor must satisfy the maximum current rating of the system.
- For more information, refer to Connecting Power to Controller(p. 151).



The power supply must satisfy minimum requirements such as grounding and circuit breakers. The electrical specifications of the included AC controller are as follows:

Parameter	Specifications
Input Voltage	100 – 240 VAC
Input Power Fuse (@100-240V)	15 A
Input Frequency	47 – 63 Hz

Refer to the following appendix for optional controller information.

3.2.6 Position controller

MANDATORY **EASY** **1 MIN**

When installing the controller on the floor, secure at least 50 mm of space on each side of the controller to enable ventilation.

Caution

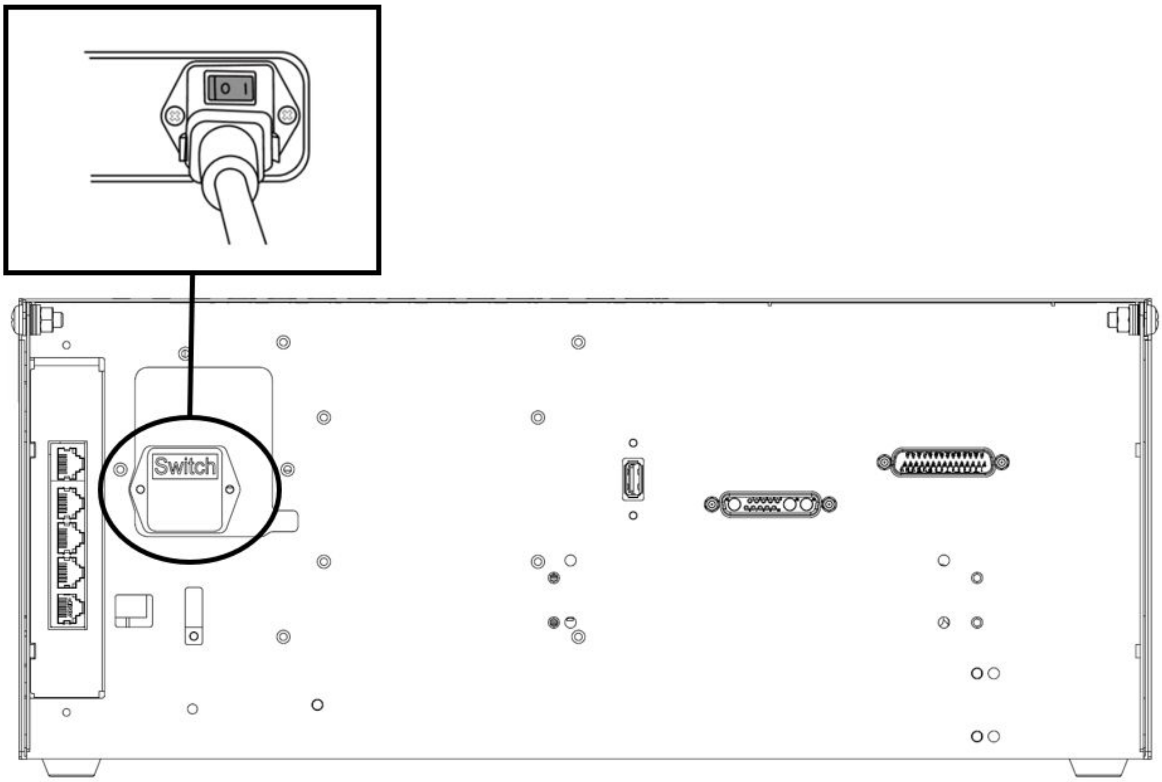
- Ensure that the cables have curvatures greater than the minimum curvature radius. For more information, refer to Routing of Manipulator Cable and Teach Pendant Cable(p. 150).

3.2.7 Power-up controller

MANDATORY **EASY** **3 MIN**

The power switch of the controller is located at the bottom of the controller.

1. Press the Power button on the bottom of the controller. The power for systems such as the robot, controller, teach pendant and smart pendant is turned on.



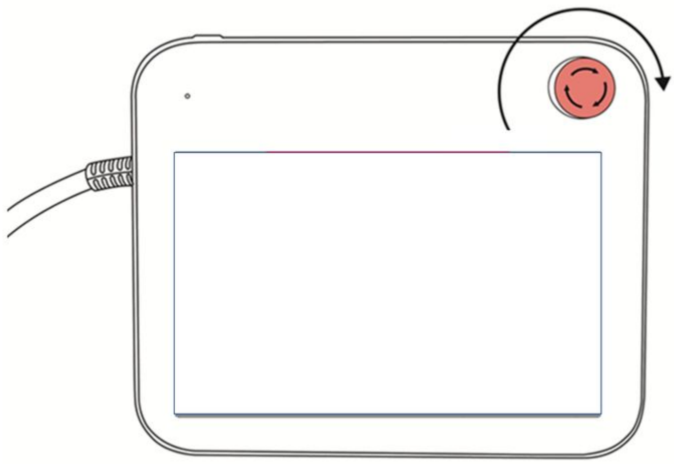
2. Press and hold the power button (Fig. 2) until the teach pendant screen powers up. The teach pendant LED (Fig. 1) and flange LED (Fig. 3) will blink red until the robot controller connects to the network.

- For more information about equipment other than the teach pendant, refer to Power on/off the system(p. 220) .

> **Note**
>
> LED positions of each Doosan Robotics robot series are as follows:
> - A: Flange LED
> - B: Axis 1 LED

3.2.8 Disengage emergency stop button

MANDATORY EASY 1 MIN



After robot installation and after the initial system boot up, a warning popup is displayed as the emergency stop button of the teach pendant is pressed. The emergency stop button must be disengaged in order to operate the robot.

- Twist the emergency stop button clockwise to disengage the emergency stop state.

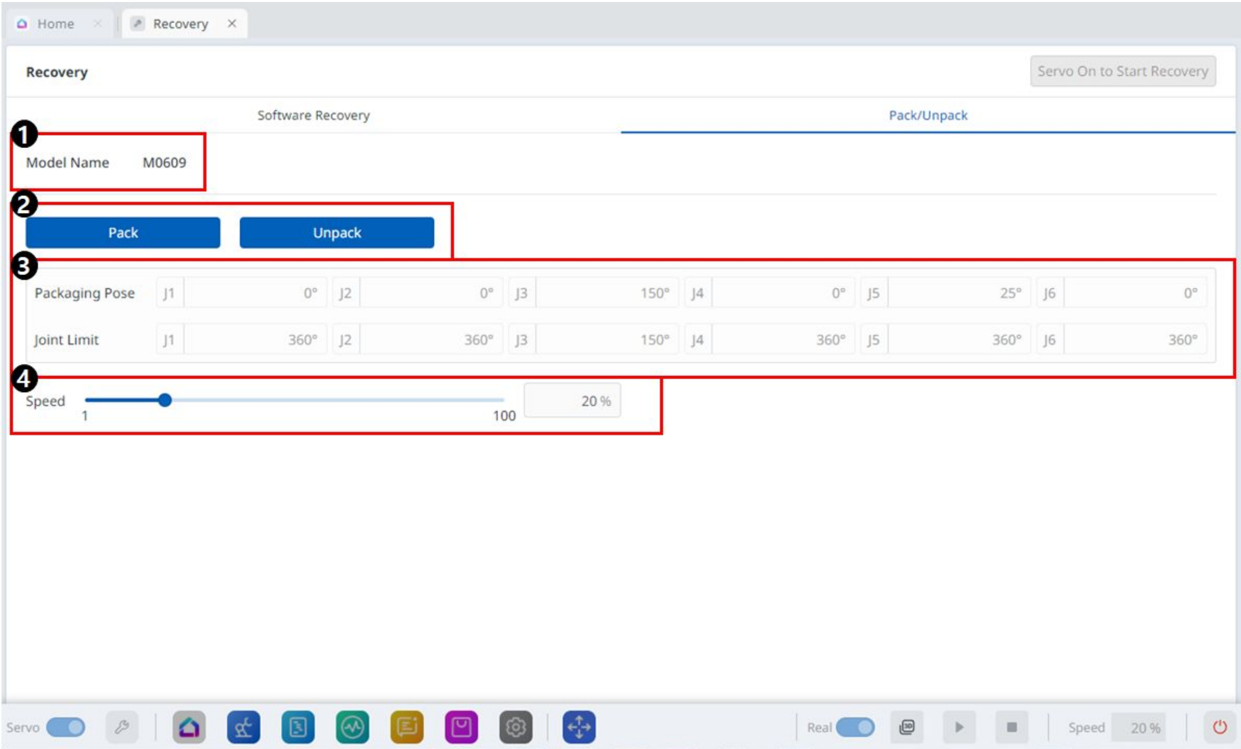
3.2.9 Disengage packaging pose

MANDATORY **EASY** **3 MIN**

The robot is in its packaging pose to allow easy transportation or packaging. To use the robot, it is necessary to disengage the packaging pose. As the robot maintains a pose that exceeds the Joint Angle Limit when in packaging pose, it is impossible to set Servo On status due to safety limit violation. The robot LED is illuminated red in this state.

> **Note**
>
> If there is a case in which you need to package the robot due to relocating, set the package pose by using move with packaging pose in the packaging mode.

The process of releasing the packaging pose is as follows:

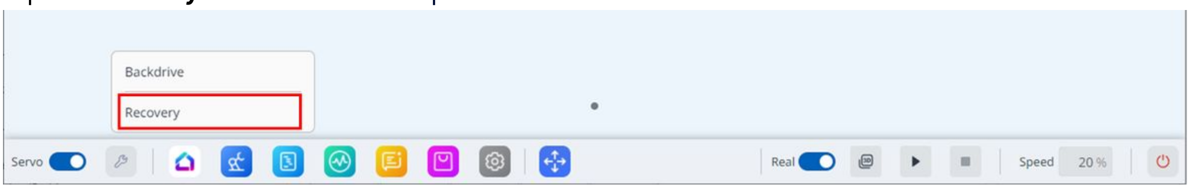


Menu Items

	Item	Description
1	Model Name	The name of the connected robot model appears.
2	Pack/Unpack	Either Pack or Unpack can be selected.
3	Packaging Pose/Joint Limit	The pose and joint limit values appear.
4	Speed Ratio	The speed of the pack or unpack mode can be adjusted via a slider or input.

To configure the packaging mode, follow these steps:

1. Tap the **Recovery** menu in the **header** pane.



2. Select the **Packaging Mode** tab.

3. Tap the **Servo On to Start Recovery** button to enable packaging mode.

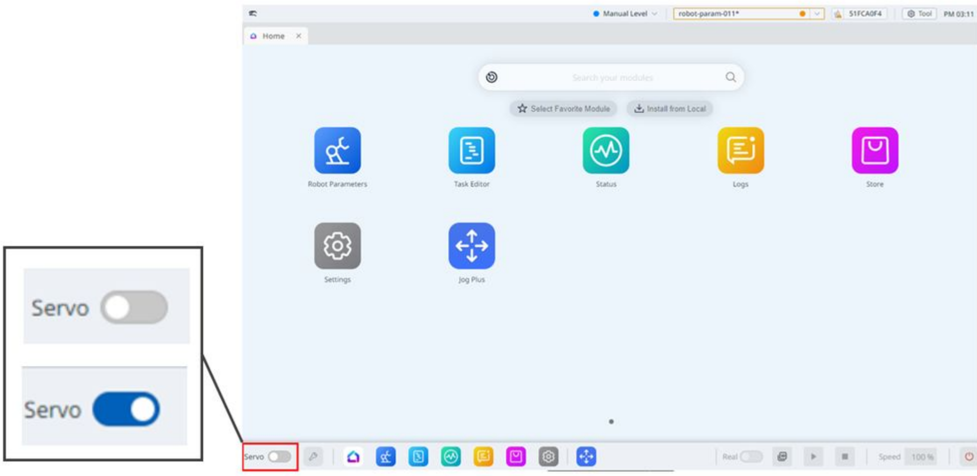
4. The robot automatically moves to the set packaging pose.
    - The **Pack** button allows you to put the robot in the Pack position and the Unpack button allows you to put the robot in the Default Home Position.

3.2.10 Servo Off

MANDATORY EASY 1 MIN

Servo on status is the status where the robot is ready with power supplied to robot joints to modify the robot pose.

Press Servo Off button to cut off power supplied to the robot joints and stop the robot. For more information, refer to Overview of Servo On(p. 238).



3.3 Step 2. Tool Installation and I/O Testing

In this step, you can learn how to install a tool on the flange at the end of the robot and how to perform the I/O test.

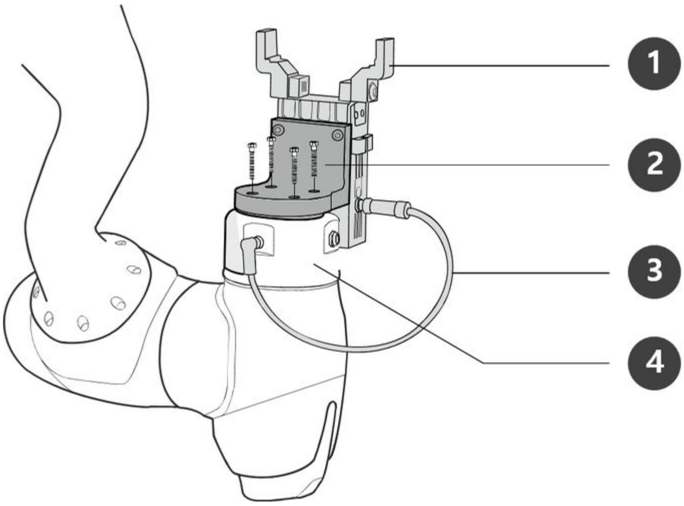
3.3.1 Install tool

MANDATORY EASY 5 MIN

Use four M6 bolts to secure the tool on the tool flange.

- It is recommended to use tightening torque of 9 Nm to tighten the bolts.
- Use a Φ6 place marker pin to accurately install the robot in a fixed location.

> **Note**
>
> - For more information about the tool flange, refer to Connecting the Robot and Tool(p. 148).
> - Methods of securing the tool may vary according to the tool. For more information about tool installation, refer to the manual provided by the tool manufacturer.



No.	Item
1	Tool
2	Bracket
3	Cable
4	Tool Flange

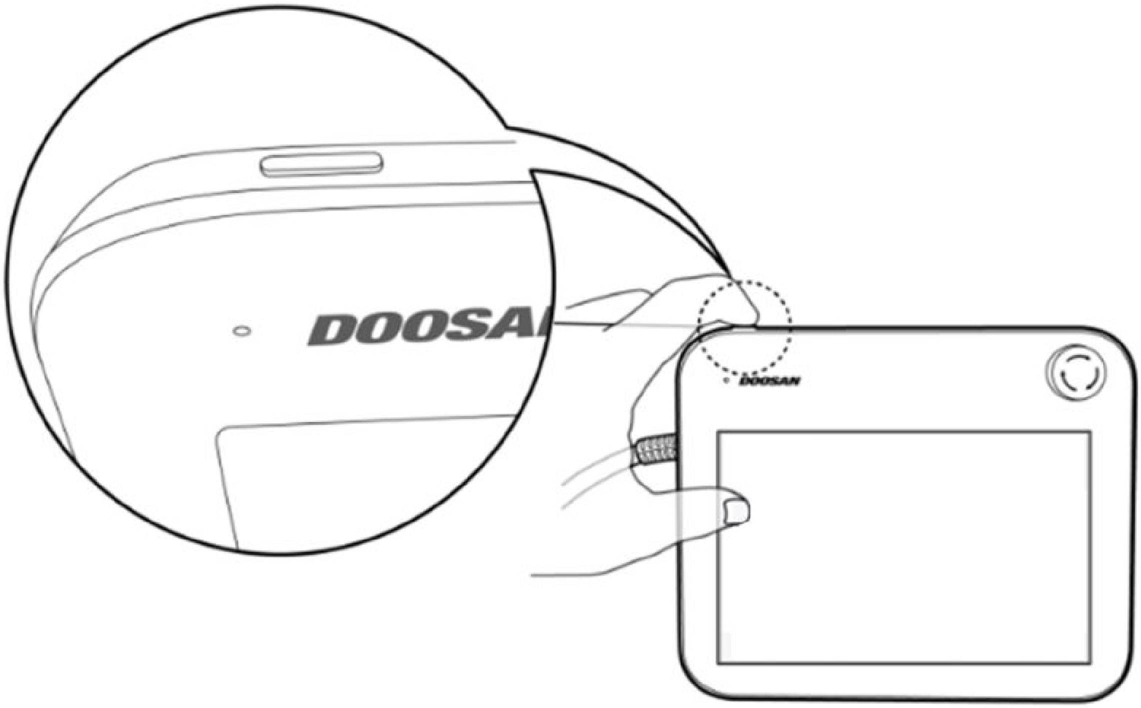
3.3.2 Turn system power off

MANDATORY EASY 1 MIN

Press the shutdown button on the teach pendant or press and hold the power button on the upper left of the teach pendant for 2 seconds to turn off the system.

1. The shutdown popup is displayed on the screen.

2. Press the OK button on the shutdown popup to properly shutdown the system.



Caution

- Press and hold the power button for more than 4 seconds to force system shutdown.
- Forced shutdown may cause robot and controller failure.

3.3.3 Connect wires

MANDATORY NORMAL 10 MIN

Connect the necessary cables to the flange I/O connectors after the tool is secured. The pin map of the flange I/O must be checked.

- When power is supplied to the robot, the fifth terminal of each connector always outputs 24V.
- For more information, refer to Flange I/O(p. 160).

Caution

- Make sure to cut off the robot's power when connecting the tool and gripper.
- Make sure to configure tool and gripper measures to prevent workpieces falling from the tool when the robot power is cut off.

Note

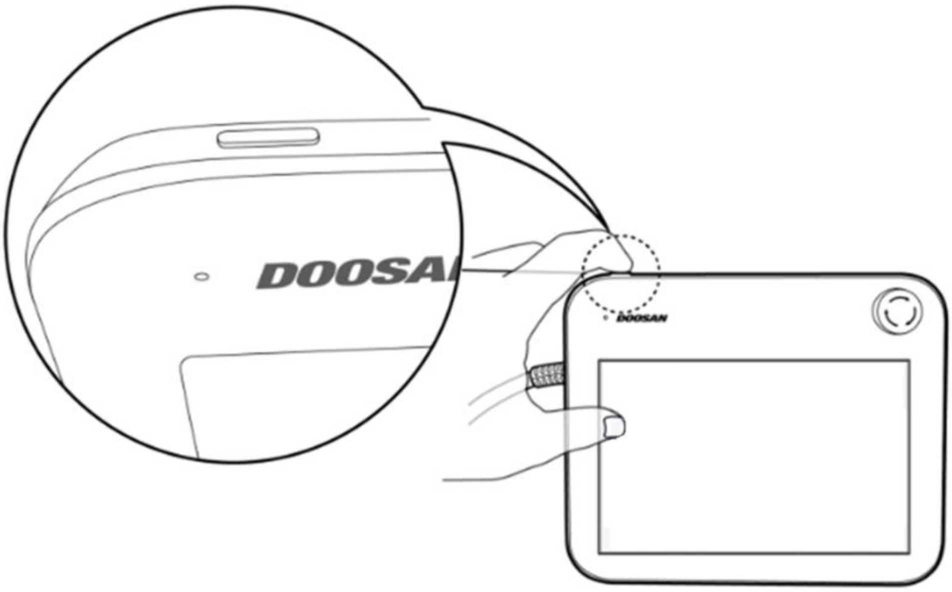
To control/monitor the robot using an external device, connect the controller I/O or connect to a network, such as Modbus TCP, PROFITNET or EtherNet/IP.

- For more information, refer to Controller I/O Connection(p. 167).
- For more information, refer to Network Connection(p. 185).

3.3.4 Turn system power on

MANDATORY EASY 1 MIN

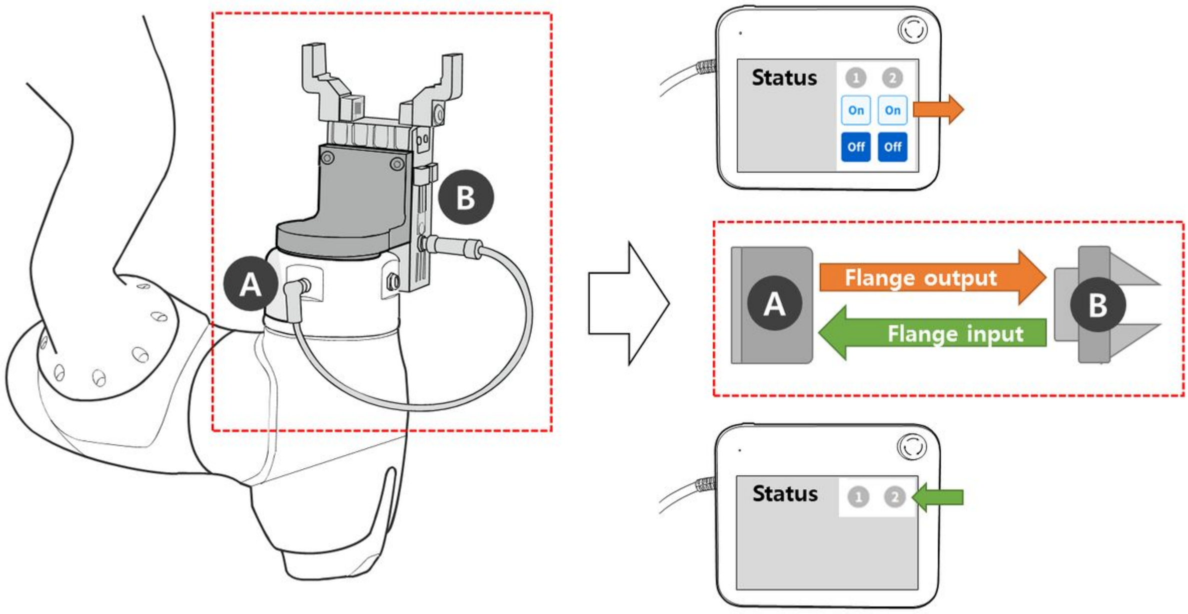
Turn the system power on again. Press and hold the power button until the teach pendant screen powers up.



3.3.5 Test controller and flange I/O

MANDATORY NORMAL 10 MIN

The teach pendant features a function capable of testing the operation of the tool connected to the flange I/O.



The following tests can be performed through **Status > I/O Overview** or **I/O Test** of the teach pendant screen. For more information, refer to each item.

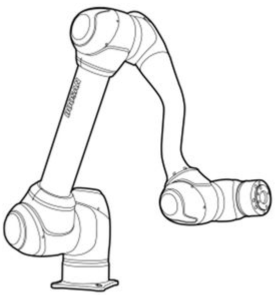
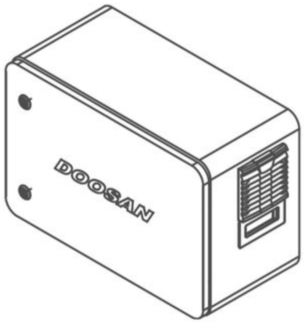
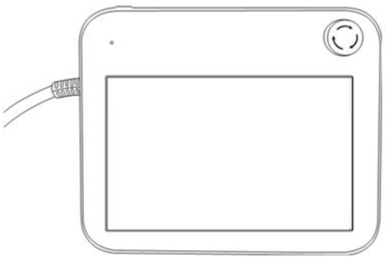
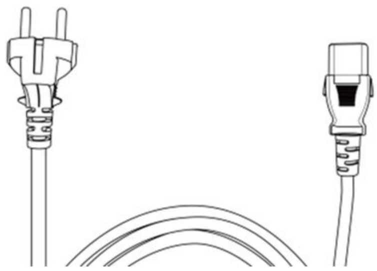
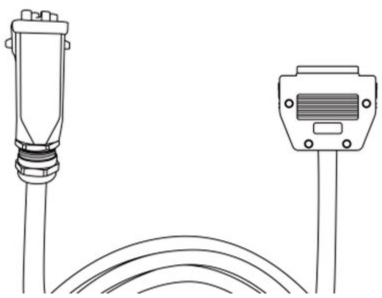
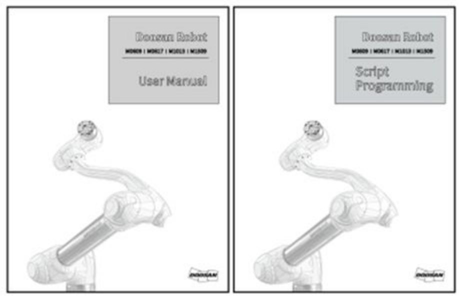
- Controller Digital Input(p. 347)
- Controller Digital Output(p. 348)
- Controller Analog Input(p. 348)
- Controller Analog Output(p. 349)

4 PART 3. Installation Manual

The installation manual describes how to install the robot and controller, as well as their specifications.

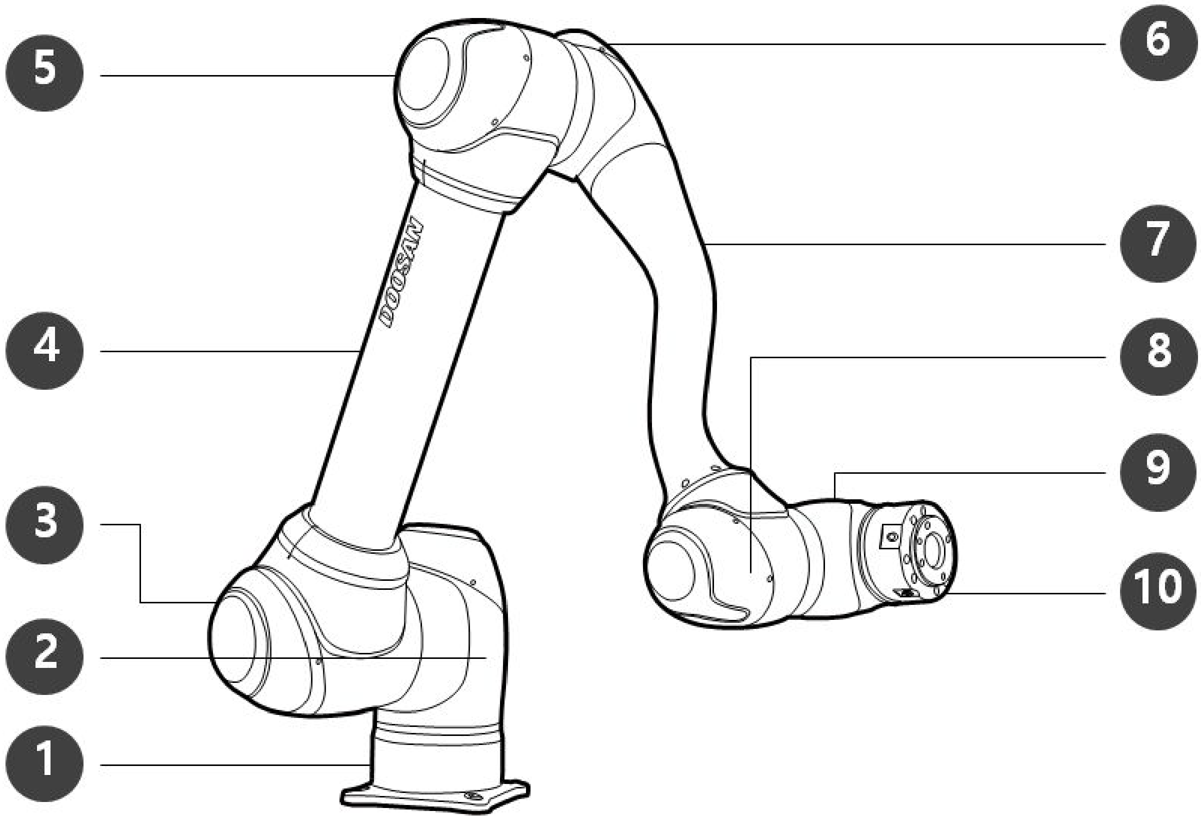
4.1 Product Introduction

4.1.1 Component Check

	
Manipulator	**Controller (optional: see Appendix)**
	
Teach pendant	**Controller power cable**
	
Manipulator connection cable	**User manual / quick guide**

4.1.2 Names and Functions

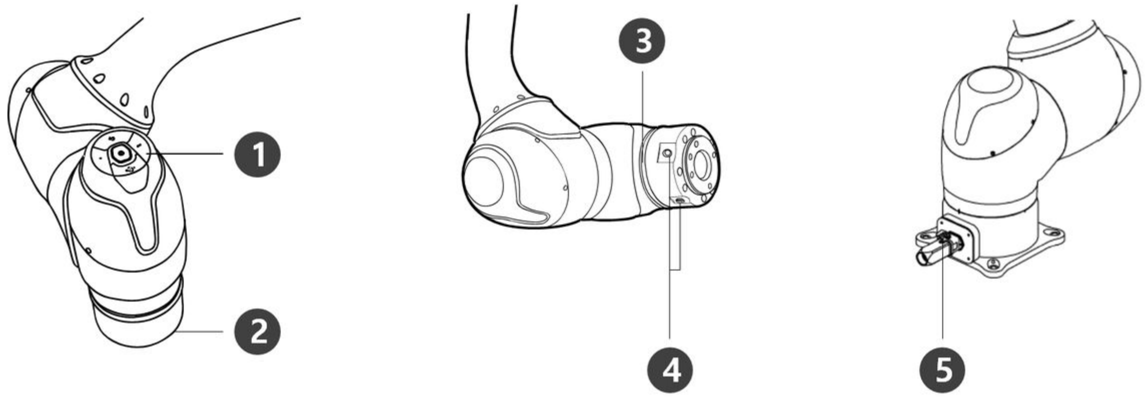
Manipulator



Names of Parts

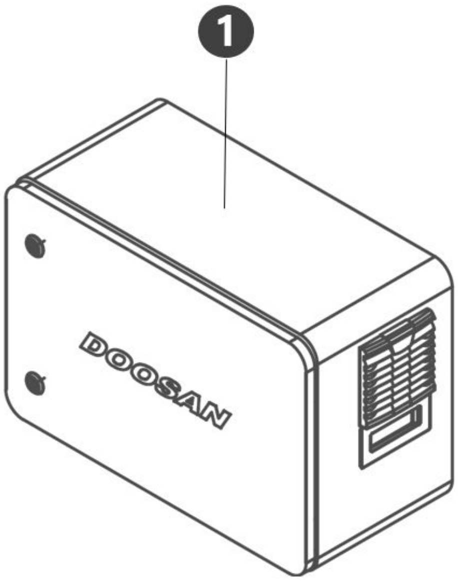
No.	Name	No.	Name
1	Base	6	J4
2	J1	7	Link2
3	J2	8	J5
4	Link1	9	J6
5	J3	10	Tool Flange

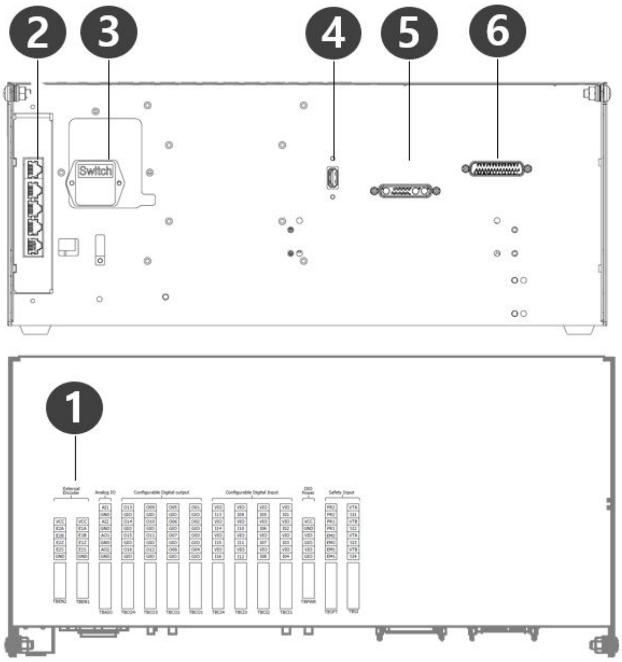
Key Features



No.	Item	Description
1	Cockpit	[Optional] Operation buttons for direct teaching and operation
2	Tool Flange	Area to install tools.
3	Flange LED	Displays the robot status with different colors. For more information about robot status, refer to the Status and Flange LED Color for Each Mode(p. 15). **Version: H Series** The H Series is supplied with an additional LED on the 1-axis indicating the same state and color.
4	Flange I/O	I/O port for tool control. (Digital input 3ch, output 3ch)
5	Connector	Used for supplying power to and communication of the robot.

Controller



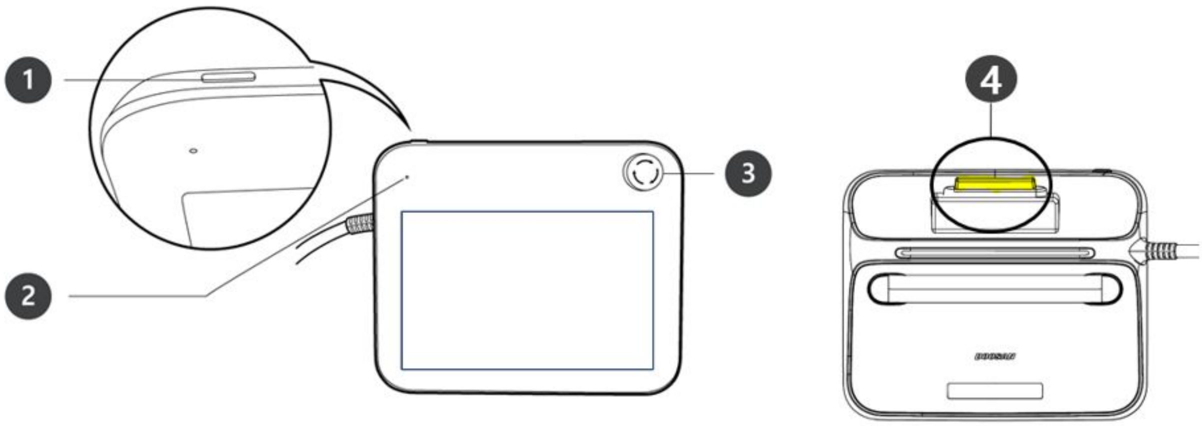


No.	Item	Description
1	I/O connection terminal (internal)	It can be connected with other robots' controllers or peripherals.
2	Network connection terminal	Used for connecting to the network connection terminal inside the controller to use Laptops, TCP/IP devices, and Modbus equipment.
3	Power connection terminal/switch	Used for connecting the mains power of the controller to turn it on or off. For more information, refer to Power on/off the system(p. 220).
4	USB connection terminal	Used to store logs created while the robot is operating in the USB storage, or export and import tasks.
5	Manipulator cable connection terminal	Used for connecting the manipulator cable to the controller.
6	Teach pendant cable connection terminal	Used for connecting the teach pendant cable to the controller.

Note

- If you choose an optional controller, check the user manual in the appendix to connect before use.

Teach pendant



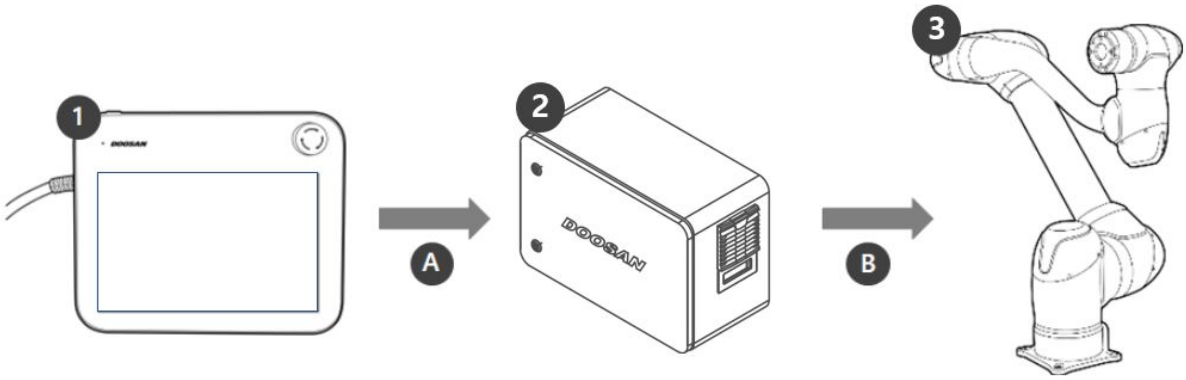
No.	Item	Description
1	Power Button	▪ Used to turn ON/OFF the main power of the teach pendant. ▪ For more information, refer to Power on/off the system(p. 220).
2	Power LED	▪ When power is applied, the LED will start flashing red, and will remain solid red once booting is complete.
3	Emergency stop button	▪ In case of an emergency, press the button to stop robot operation.
4	Hand-Guiding button (3PE 3 Position Enable) Switch)	▪ Press and hold the button to move the robot freely into a desired pose. ▪ If you press the button with strong force, the hand guide mode will be switched to OFF.

Note

- If the teach pendant needs to be protected and mounted during operation, the soft cover supplied by us makes it safer and easier to use.
- New TP (TP-02) added function: Hand Guide dual function

- The existing TP (TP-01) cannot be used in the integrated controller. (Pin Map changed due to 3PE Switch)
- The new TP (TP-02) can be used in the existing controller, but the LED is changed to a single color (red) and displayed, and additional functions cannot be used.

4.1.3 System Configuration



No.	Name	Description
1	Teach pendant	This device manages the entire system and is capable of teaching the robot specific poses or making settings related to the manipulators and controllers.
2	Controller	Used to adjust the robot's movement according to the pose or movement set by the teach pendant. It features various I/O ports that allow for the connection and use of various types of equipment and devices.
3	Manipulator	This is an industrial collaborative robot that can be used with a variety of tool attachments to transport objects or assemble parts.
A	Command/ Monitoring	
B	Power Supply/ Network	

4.1.4 Product Specifications, General

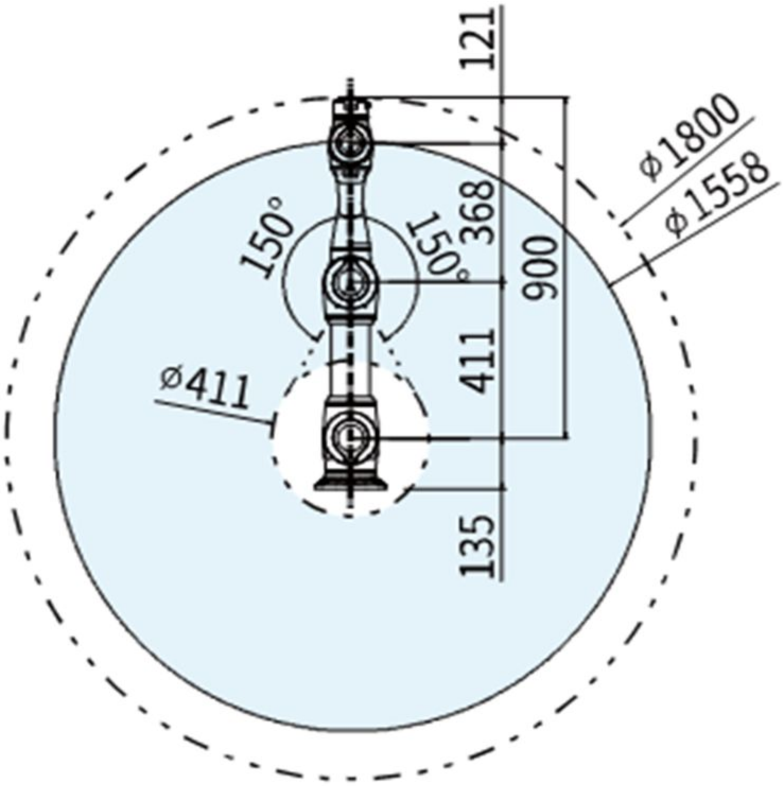
M Series	Technical Data
M0609	**Refer to** M0609(p. 195)
M0617	**Refer to** M0617(p. 198)
M1013	**Refer to** M1013(p. 197)
M1509	**Refer to** M1509(p. 196)

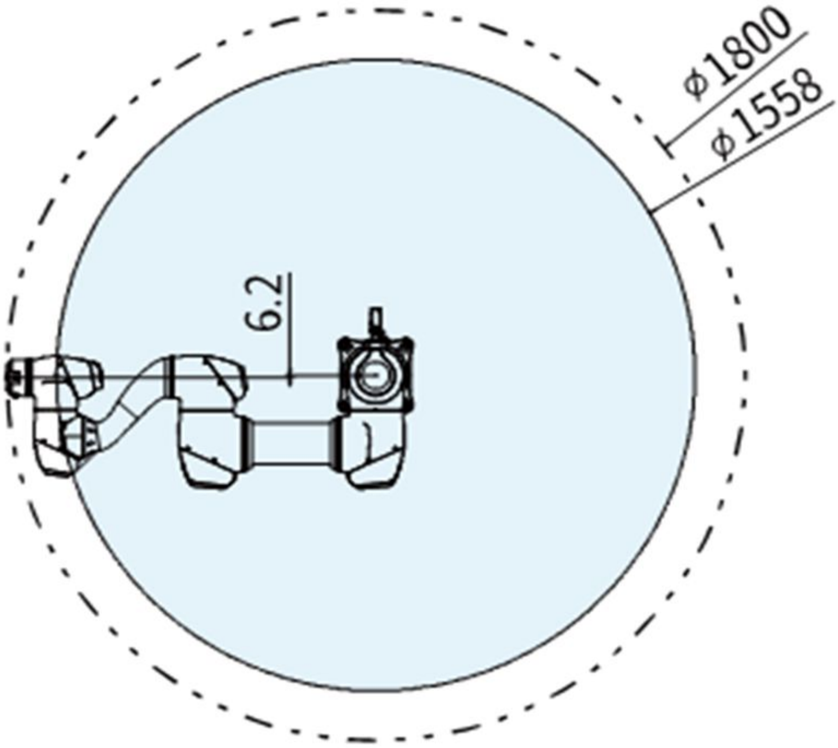
H Series	Technical Data
H2017	**Refer to** H2017(p. 200)
H2515	**Refer to** H2515(p. 201)

4.1.5 Robot Specifications

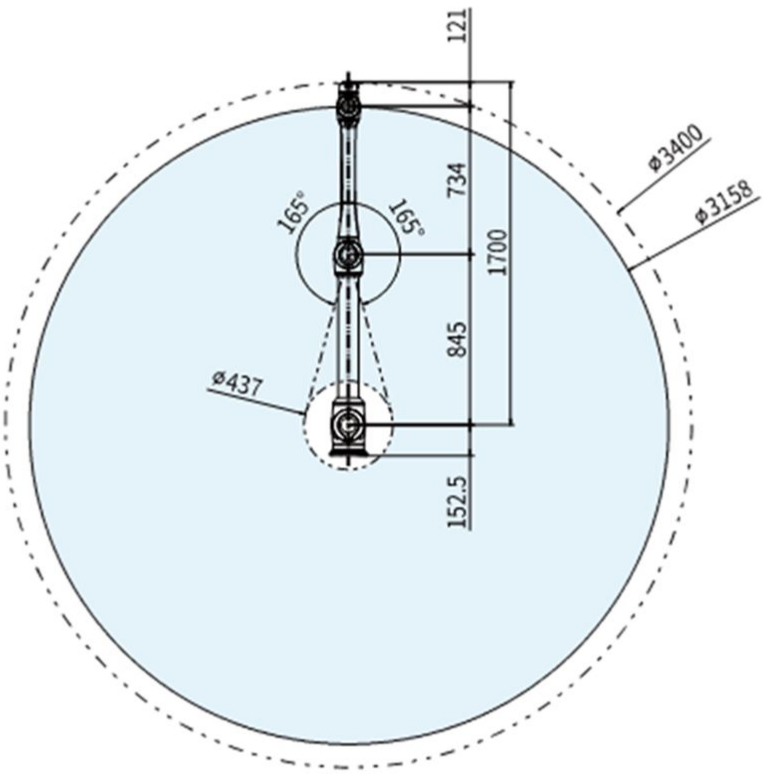
Robot operating space

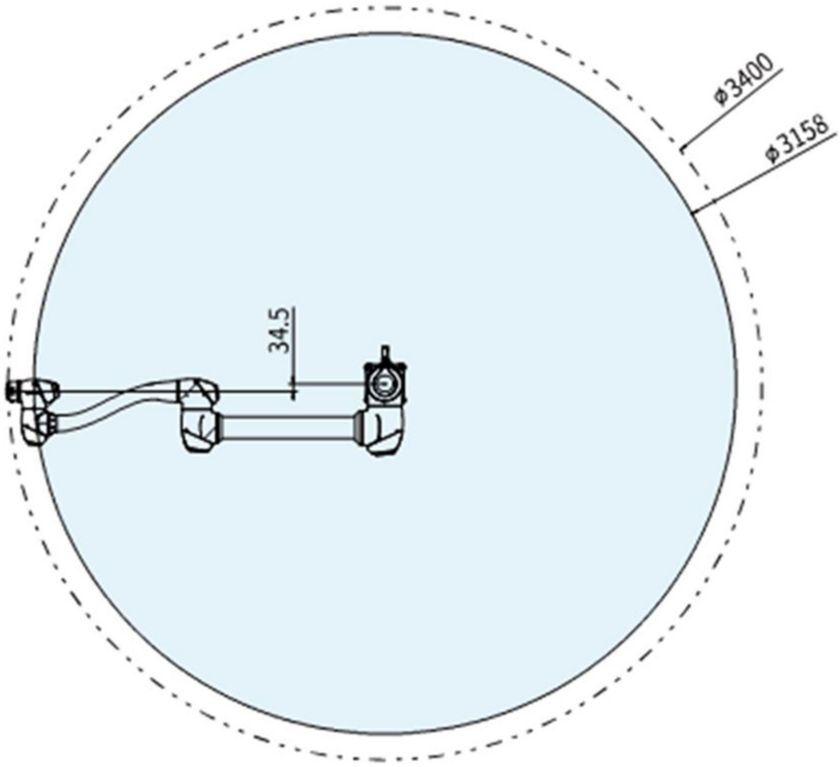
M0609



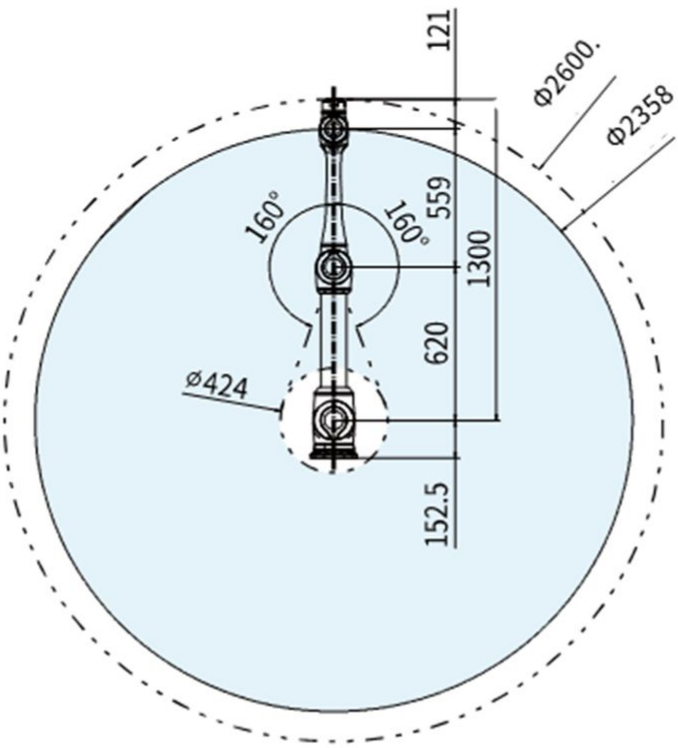


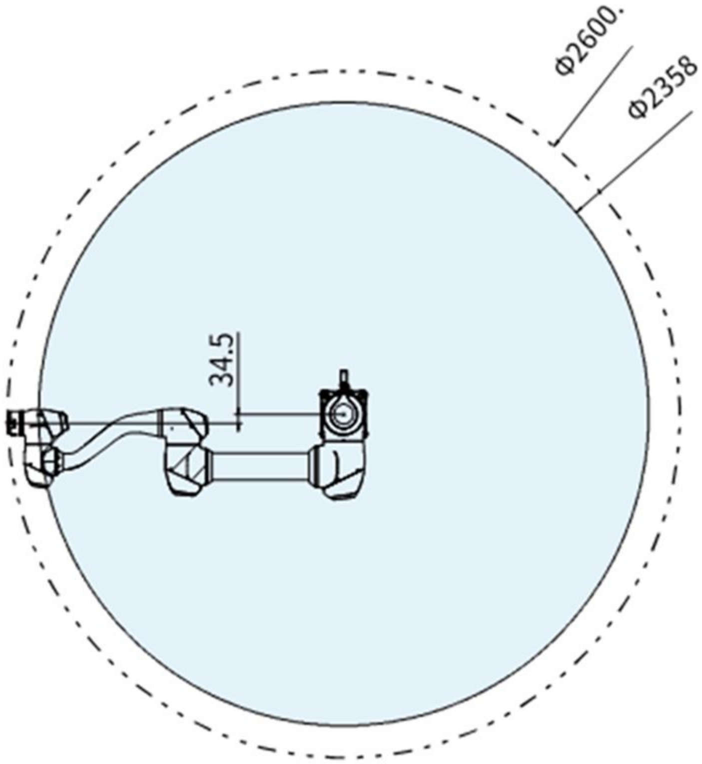
M0617



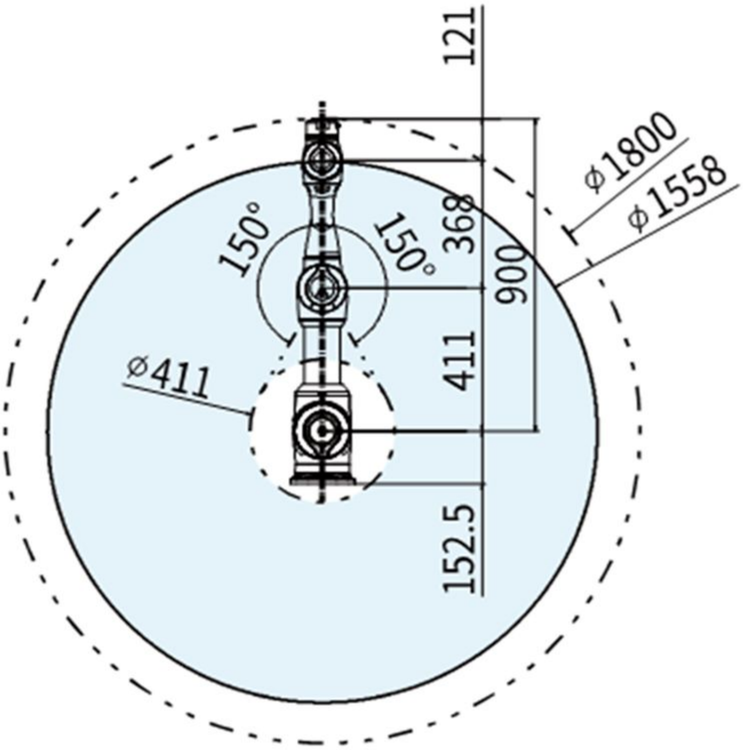

ϕ3400
ϕ3158
34.5

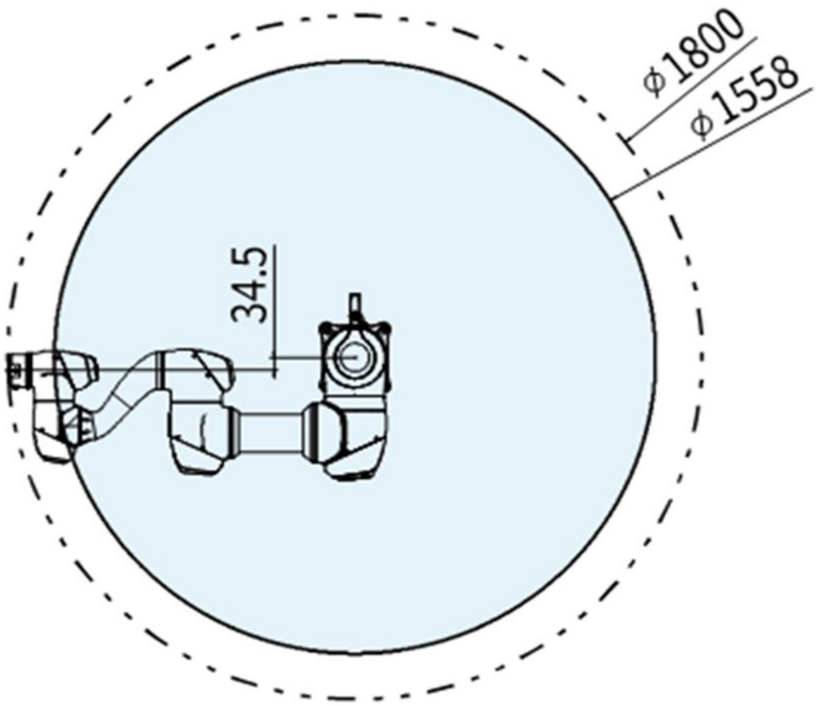
M1013


121
Φ2600.
Φ2358
160°
160°
559
1300
620
ϕ424
152.5

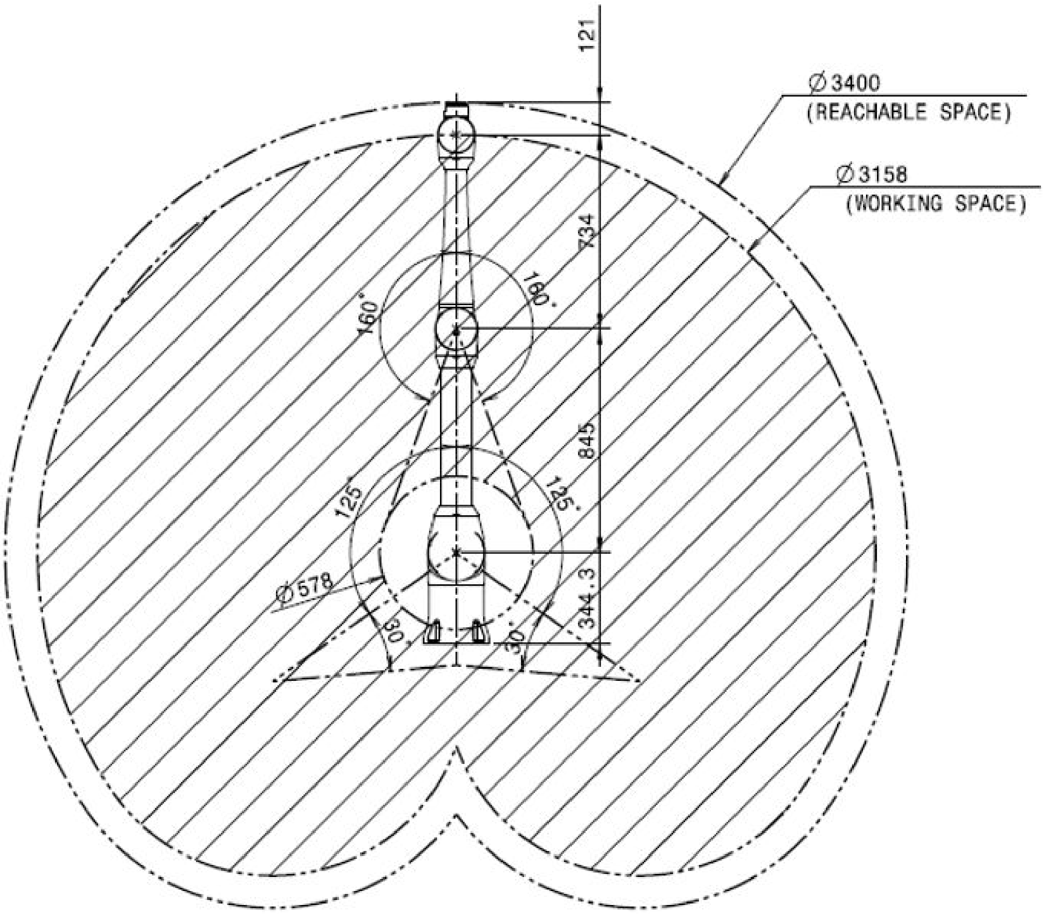

Φ2600.
Φ2358
34.5

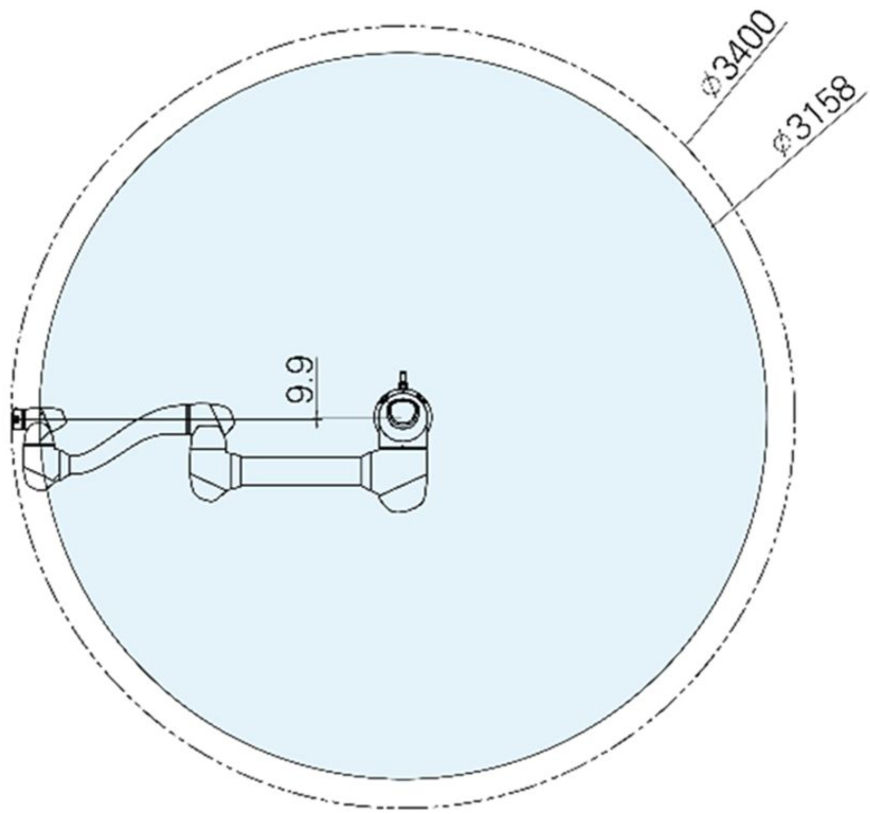
M1509



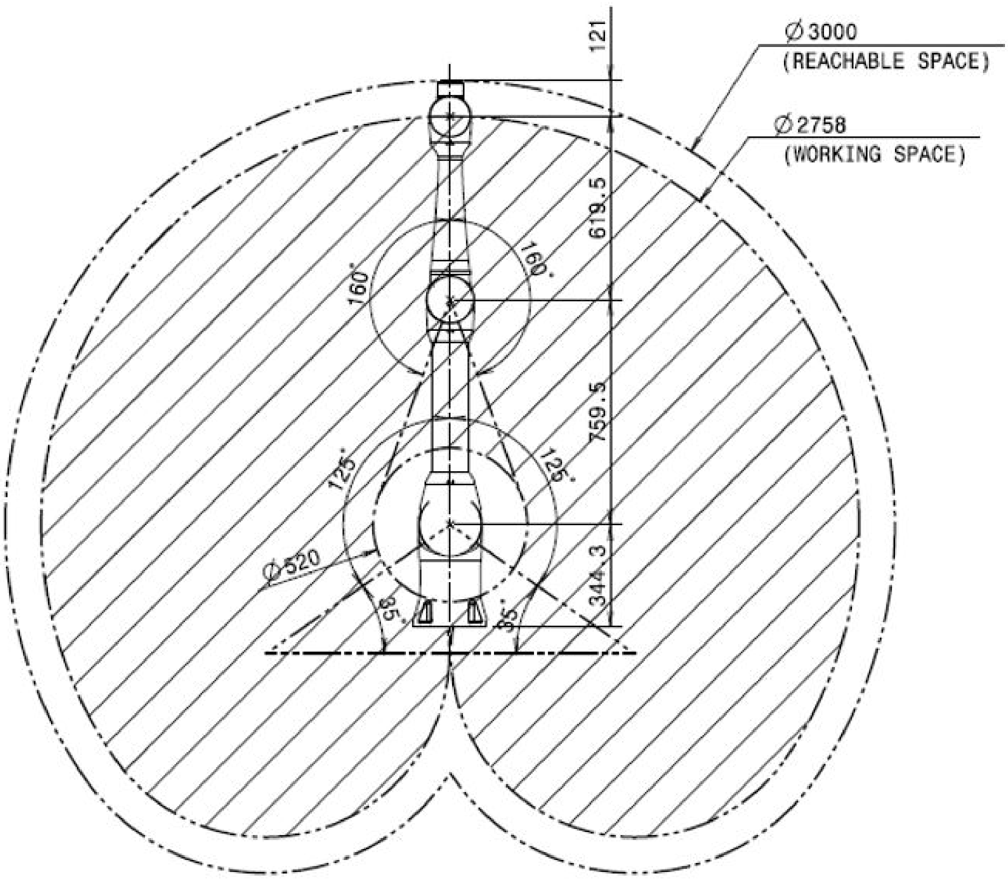


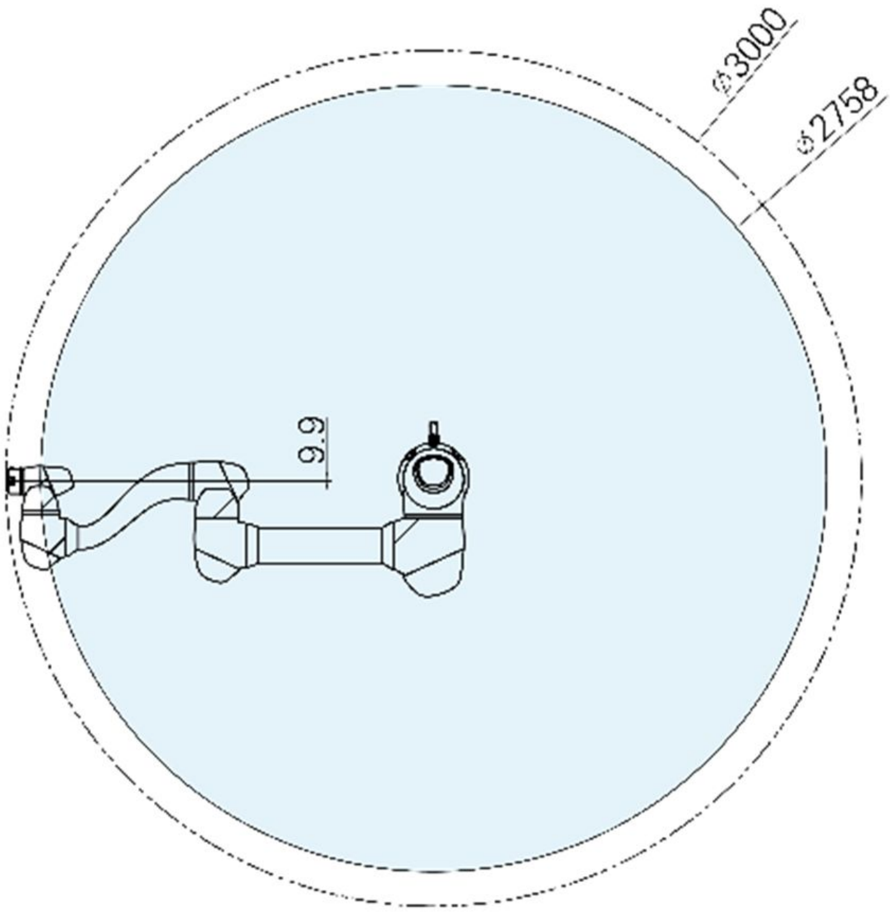
H2017


121
Ø3400
(REACHABLE SPACE)
Ø3158
(WORKING SPACE)
734
160°
160°
845
125°
125°
Ø578
30°
30°
344.3


ϕ3400
ϕ3158
9.9

H2515


∅3000
(REACHABLE SPACE)
∅2758
(WORKING SPACE)
121
619.5
759.5
344.3
160°
160°
125°
125°
∅520
35°
35°

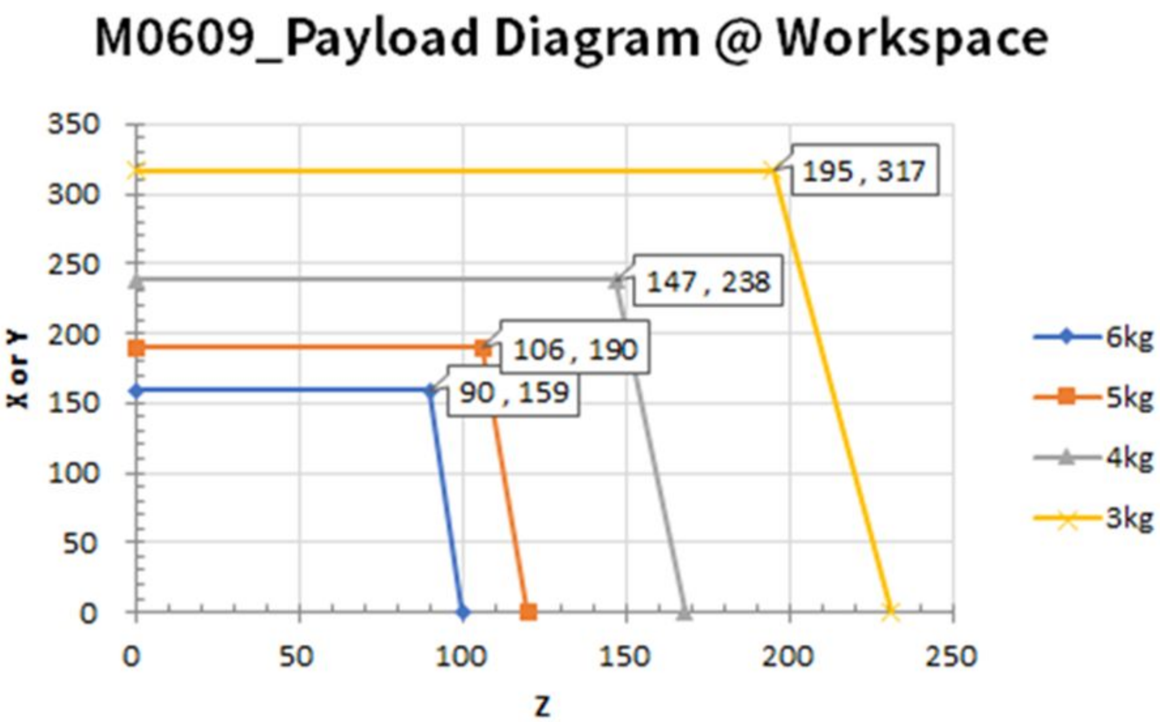


Max. Payload within operating space

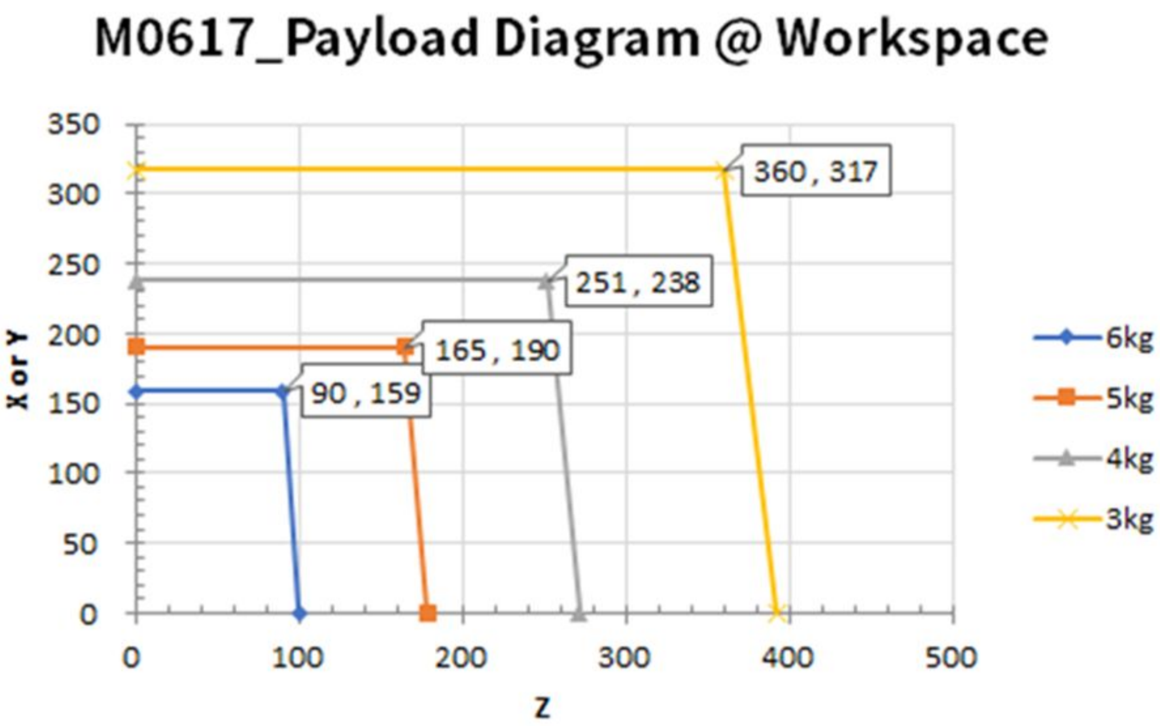
The maximum payload of the robot within its operating space changes according to the distance from the center of gravity. Payload per distance is as follows:

> **Note**
>
> This load diagram assumes a small tool load volume. Tools with a larger volume will have greater limitations in payload above the tool's center of gravity compared to a tool with an equal weight but smaller volume, and in such cases, vibration may occur.

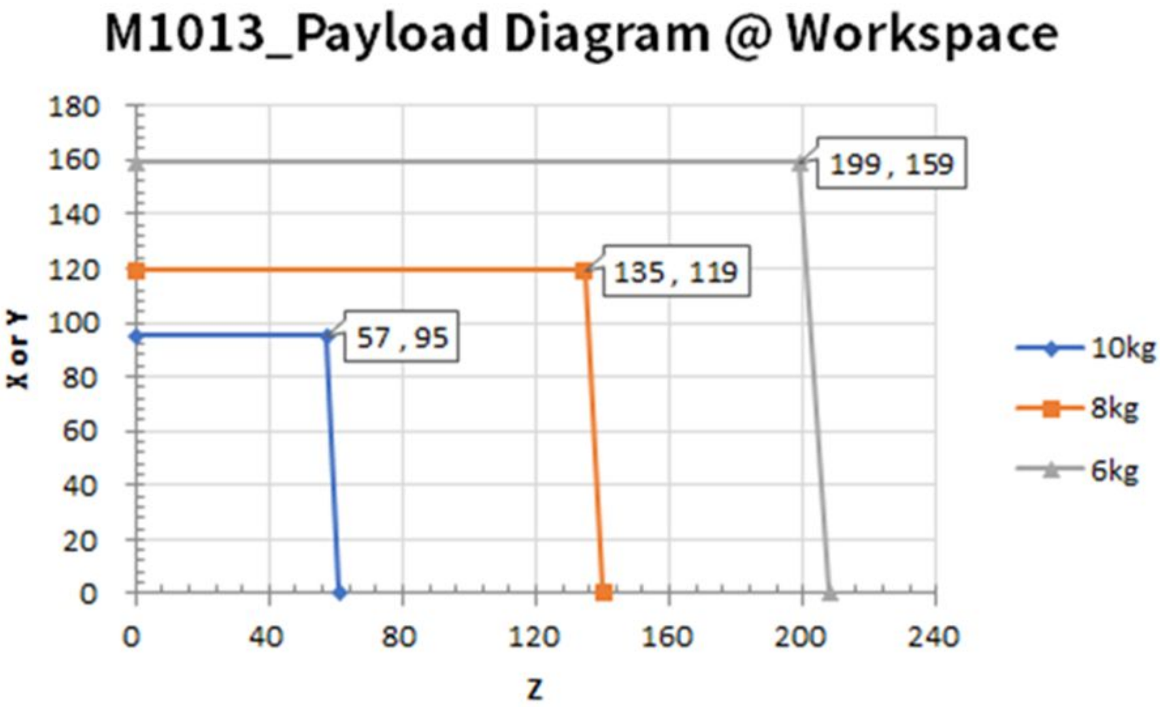
M0609


M0609_Payload Diagram @ Workspace
350
300
250
200
150
100
50
0
X or Y
0
50
100
150
200
250
Z
195 , 317
147 , 238
106 , 190
90 , 159
6kg
5kg
4kg
3kg

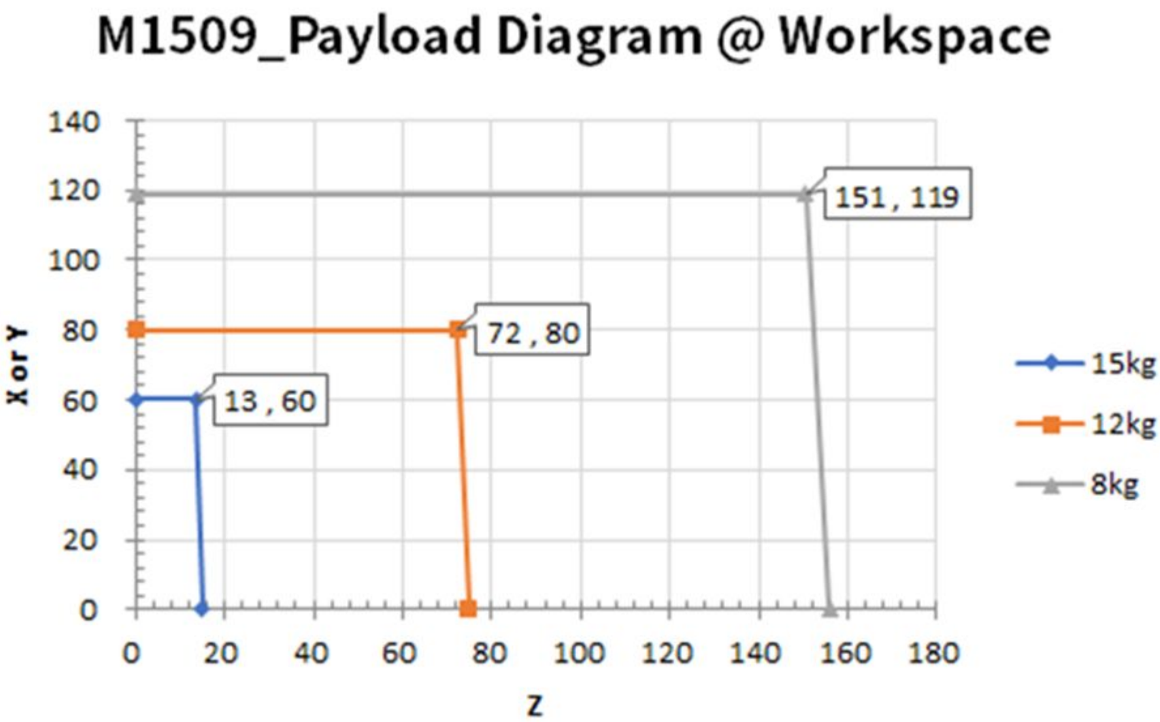
M0617


M0617_Payload Diagram @ Workspace
350
300
250
200
150
100
50
0
X or Y
0
100
200
300
400
500
Z
360 , 317
251 , 238
165 , 190
90 , 159
6kg
5kg
4kg
3kg

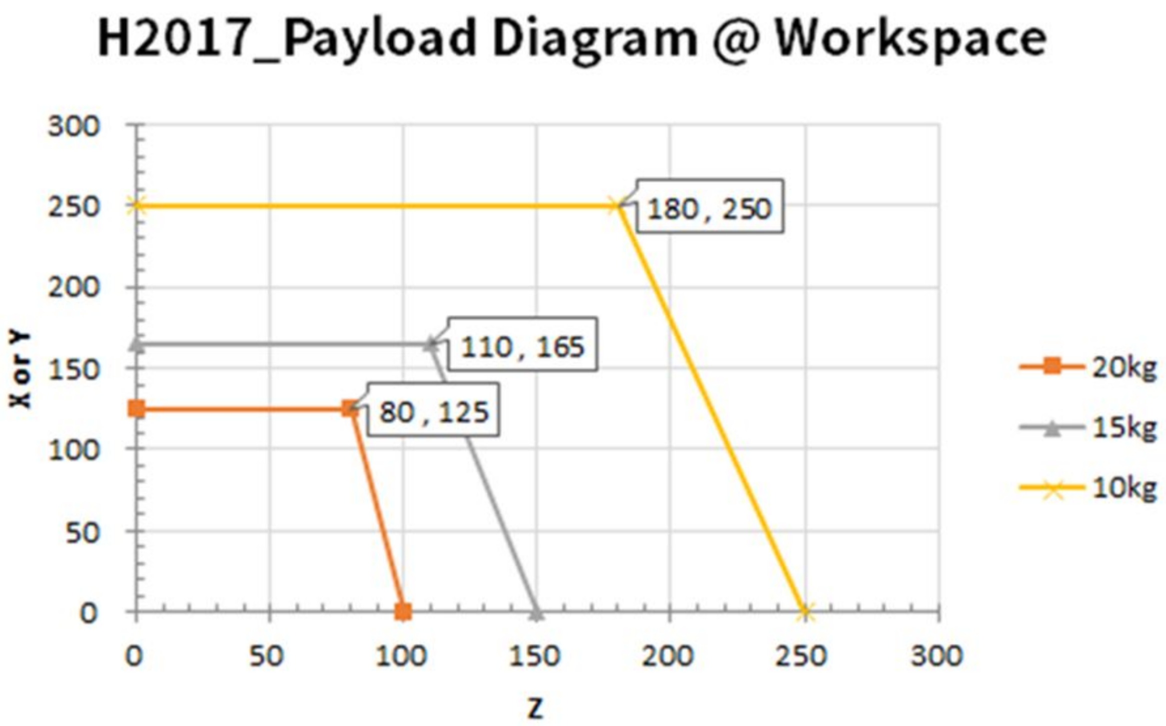
M1013


M1013_Payload Diagram @ Workspace
180
160
140
120
100
80
60
40
20
0
X or Y
0
40
80
120
160
200
240
Z
57 , 95
135 , 119
199 , 159
10kg
8kg
6kg

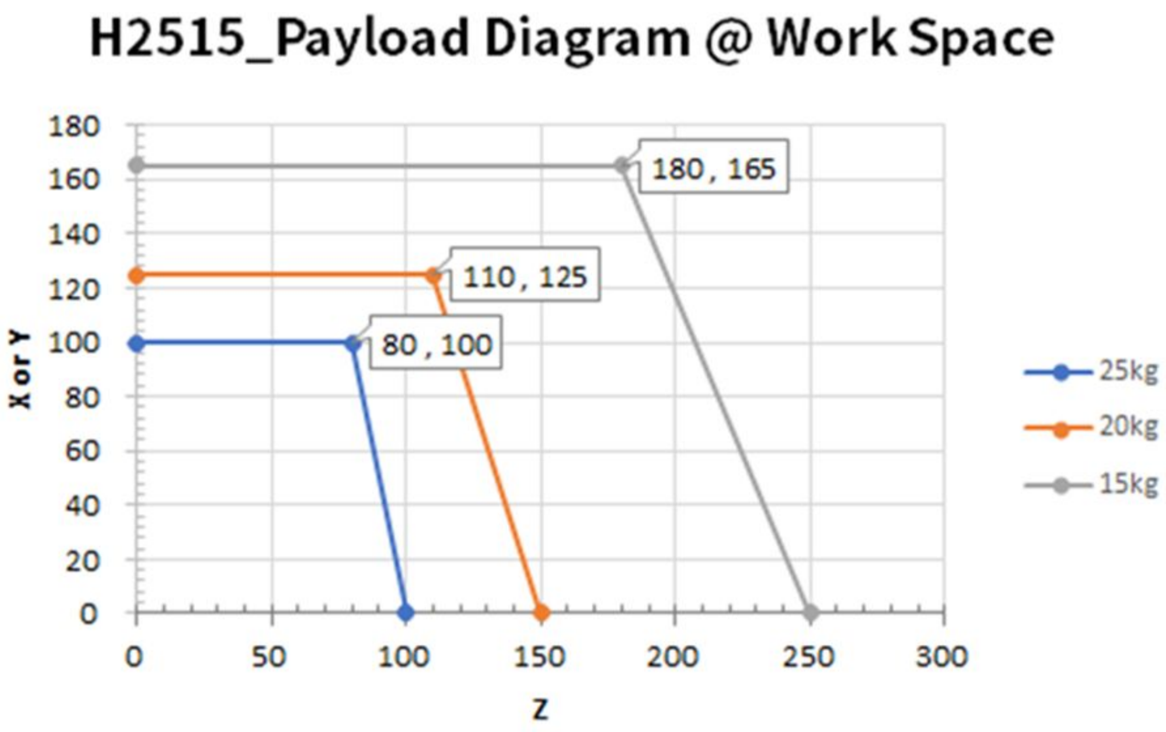
M1509


M1509_Payload Diagram @ Workspace
X or Y
Z
140
120
100
80
60
40
20
0
0
20
40
60
80
100
120
140
160
180
151 , 119
72 , 80
13 , 60
15kg
12kg
8kg

H2017


H2017_Payload Diagram @ Workspace
300
250
200
150
100
50
0
X or Y
180 , 250
110 , 165
80 , 125
0
50
100
150
200
250
300
Z
20kg
15kg
10kg

H2515



Allowed Moment and Inertia

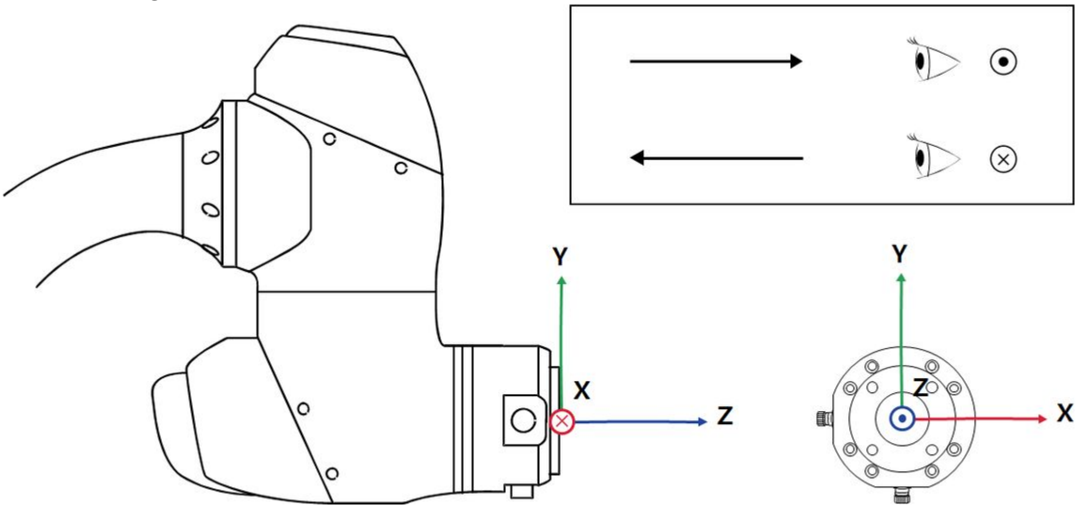
The allowed moment and inertia for the J4-J6 robot are as follows:

Model Name	J4		J5		J6	
	Allowed Moment	Inertia	Allowed Moment	Inertia	Allowed Moment	Inertia
M0609	36 Nm	1.6 kgm^2	36 Nm	1.6 kgm^2	36 Nm	1.6 kgm^2
M0617						
M1013						
M1509						
H2017	145 Nm	8.0 kgm^2	81Nm	4.5 kgm^2	36 Nm	2.0 kgm^2

Model Name	J4		J5		J6	
	Allowed Moment	Inertia	Allowed Moment	Inertia	Allowed Moment	Inertia
H2515						

Tool Center Point (TCP)

Refer to the figure below for TCP.



Axis Specification

Model Name	M0609	M0617	M1013	M1509	H2017	H2515
Operating Angle						
J1	±360° (TP: ±360°)	±360° (TP: ±360°)	±360° (TP: ±360°)	±360° (TP: ±360°)	±360° (TP: ±360°)	±360° (TP: ±360°)
J2	±360° (TP: ±95°)	±360° (TP: ±95°)	±360° (TP: ±95°)	±360° (TP: ±95°)	±125° (TP: ±95°)	±125° (TP: ±95°)
J3	±150° (TP: ±125°)	±165° (TP: ±145°)	±160° (TP: ±135°)	±150° (TP: ±125°)	±160° (TP: ±135°)	±160° (TP: ±135°)
J4	±360° (TP: ±360°)	±360° (TP: ±360°)	±360° (TP: ±360°)	±360° (TP: ±360°)	±360° (TP: ±360°)	±360° (TP: ±360°)

Model Name	M0609	M0617	M1013	M1509	H2017	H2515
J5	±360° (TP: ±135°)	±360° (TP: ±135°)	±360° (TP: ±135°)	±360° (TP: ±135°)	±360° (TP: ±135°)	±360° (TP: ±135°)
J6	±360° (TP: ±360°)	±360° (TP: ±360°)	±360° (TP: ±360°)	±360° (TP: ±360°)	±360° (TP: ±360°)	±360° (TP: ±360°)
Max. Speed per Axis (rated payload operation)						
J1	150 °/s	100 °/s	120 °/s	150 °/s	100 °/s	100 °/s
J2	150 °/s	100 °/s	120 °/s	150 °/s	80 °/s	80 °/s
J3	180 °/s	150 °/s	180 °/s	180 °/s	100 °/s	100 °/s
J4	225 °/s	225 °/s	225 °/s	225 °/s	180 °/s	180 °/s
J5	225 °/s	225 °/s	225 °/s	225 °/s	180 °/s	180 °/s
J6	225 °/s	225 °/s	225 °/s	225 °/s	180 °/s	180 °/s

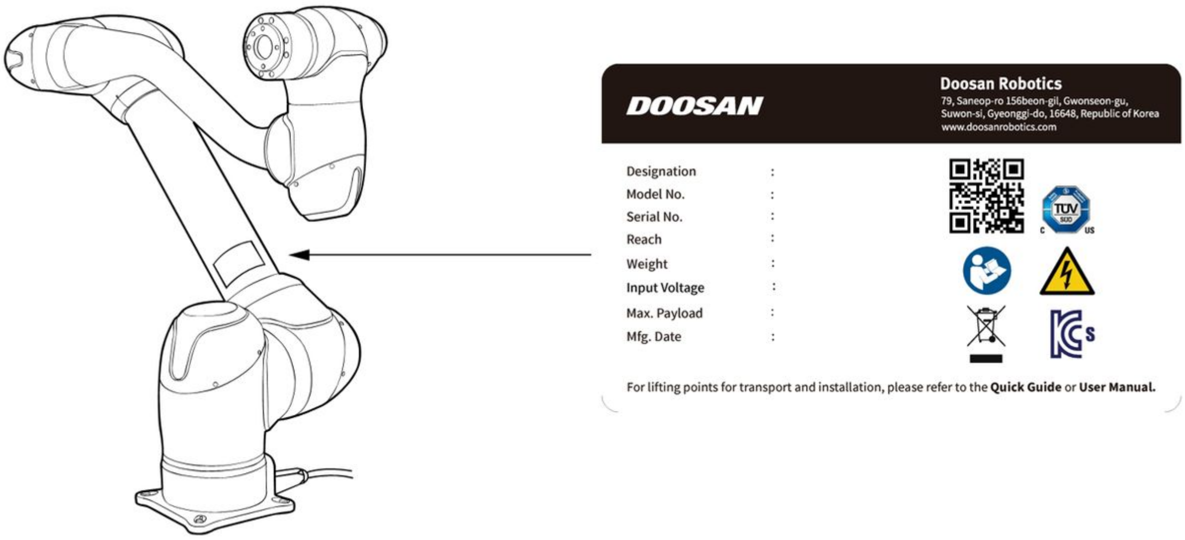
Basic specifications

Model Name	M0609	M0617	M1013	M1509	H2017	H2515
Weight	27 kg	34 kg	33 kg	32 kg	79 kg	77 kg
Payload within Work Radius	6 kg	6 kg	10 kg	15 kg	20 kg	25 kg
Max. Work Radius	900 mm	1700 mm	1300 mm	900 mm	1700mm	1500mm
Number of Axes	6					
Max. TCP Speed	Over 1 m/s					
Position Repeatability (ISO 9283)	±0.03 mm	±0.1 mm	±0.05 mm	±0.03 mm	±0.1 mm	
Protection Rating	IP 54					

Model Name	M0609	M0617	M1013	M1509	H2017	H2515
Noise	< 65 dB					
Installation Direction	Any Orientation				Floor Only	
Controller and Teaching Pendant	Doosan Controller & Teach Pendant					
Vibration and Acceleration	10≤f<57Hz - 0.075mm amplitude 57≤f≤150Hz – 1G					
Impact	Max Amplitude : 50㎨(5G) * Time :30㎳ , Pluse : 3 of 3 (X,Y,Z)					
Operating Temperature	0 ℃ ~45 ℃ (273K to 318K)					
Storage Temperature	-5 ℃ ~50 ℃ (268K to 323K)					
Humidity	20%~80%					

4.1.6 Nameplates and Labels

Be careful not to remove or damage labels attached to the robot and controller.



Note

If you choose an optional controller, the application position may differ, so check the user manual in the appendix.

4.2 Installation

4.2.1 Installation Environment

Secure sufficient space to allow the robot to move freely. Check the operating space of the robot to ensure that the robot does not collide with external elements.

Installation Location Check

Before installing the robot, secure sufficient space and consider the following:

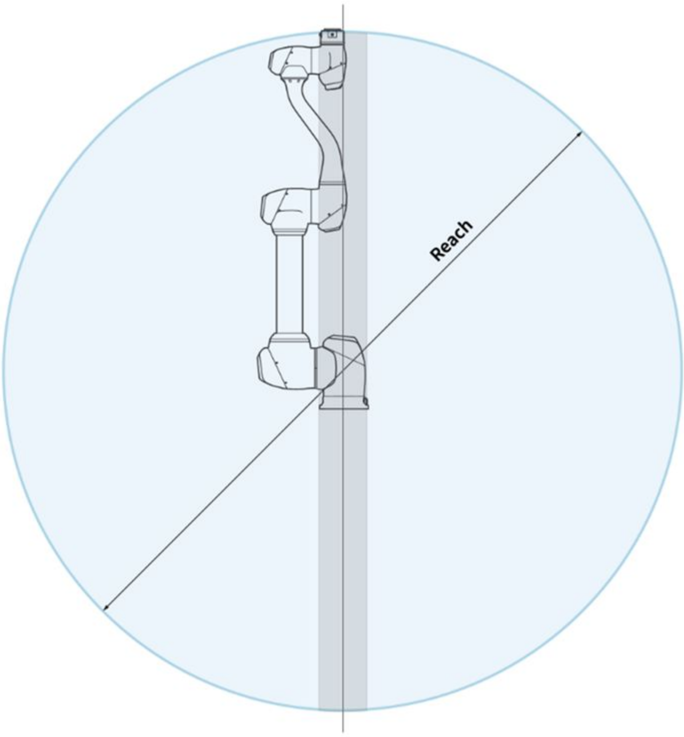
- Install the robot on a firm, even surface.
- Install the robot in a location with no water leakage and constant temperature and humidity.
- Check whether there are flammable and explosive materials near the installation location.

Caution

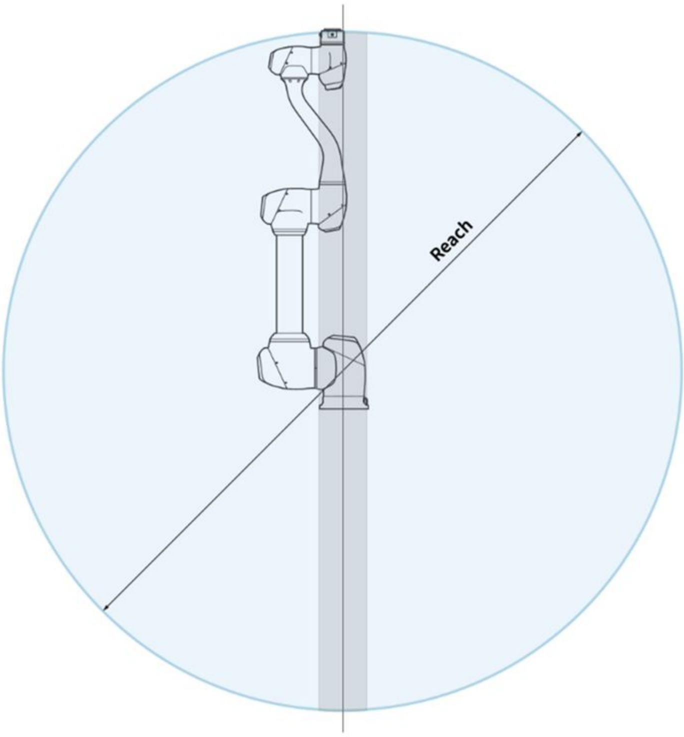
- Installing the robot in locations other than the recommended locations may result in reduced robot performance and product life.

Robot Work Area Check

Secure installation space considering the operating space of the robot. The operating space varies according to the robot model.



Check the robot's work area to ensure installation space. The work area varies depending on the robot model.

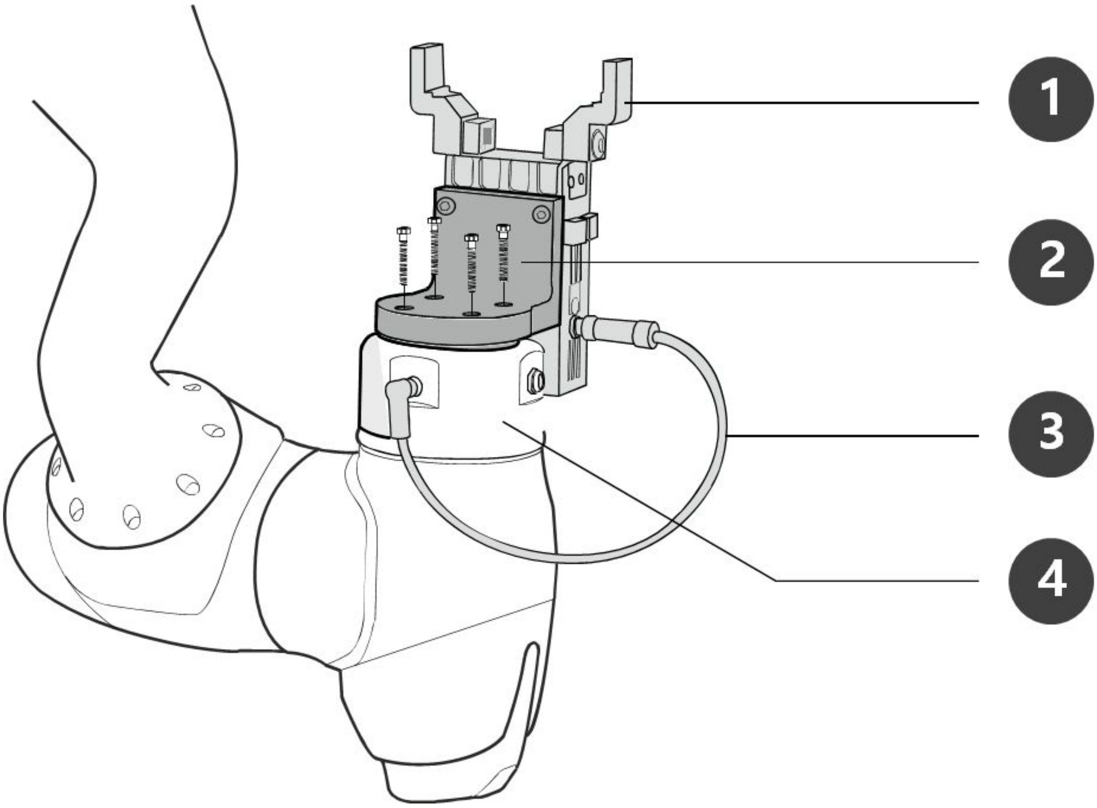


> **Note**
>
> - The grayed areas in the figure are areas where the robot has difficulty performing work. Within this area, the speed of tools is low but the speed of joints is high, so it becomes difficult to perform risk assessment in this area because the robot operates inefficiently. Therefore, it is not recommended to operate the tool passing through the cylindrical section on the top and bottom of the base.

4.2.2 Hardware Installation

Install the robot, controller and teach pendant, the key components of the system in the work area, and supply power to them before operating the robot. The installation of each component is as follows:

Connecting the Robot and Tool



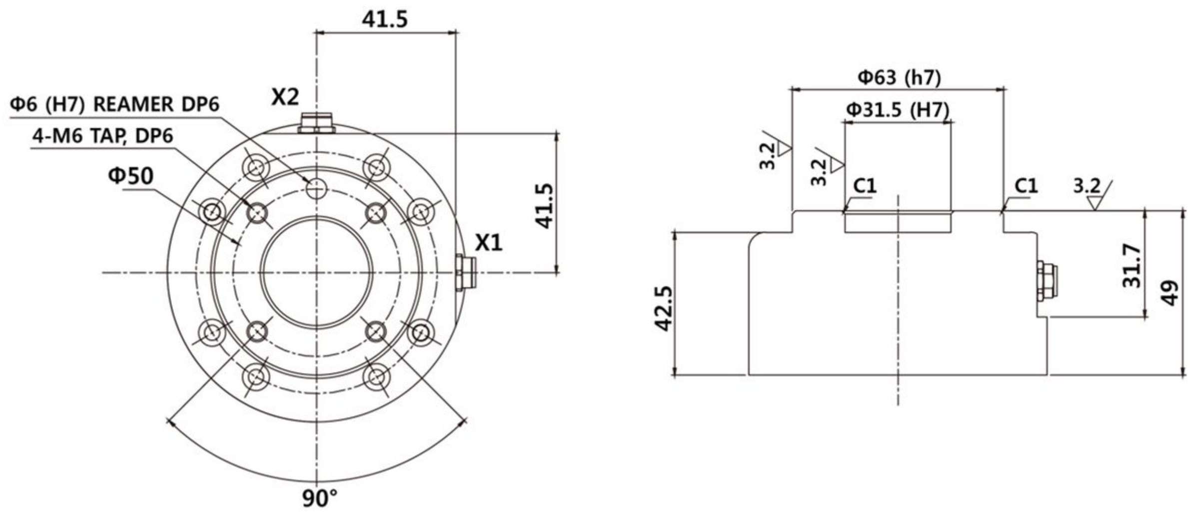
No.	Item
1	Tool
2	Bracke t
3	Cable
4	Tool flange

1. Use four M6 bolts to secure the tool on the tool flange.

- It is recommended to use tightening torque of 9 Nm to tighten the bolts.
- Use a Φ6 place marker pin to accurately install the robot in a fixed location.
- Connect the necessary cables to the flange I/O connectors after the tool is secured.

Note

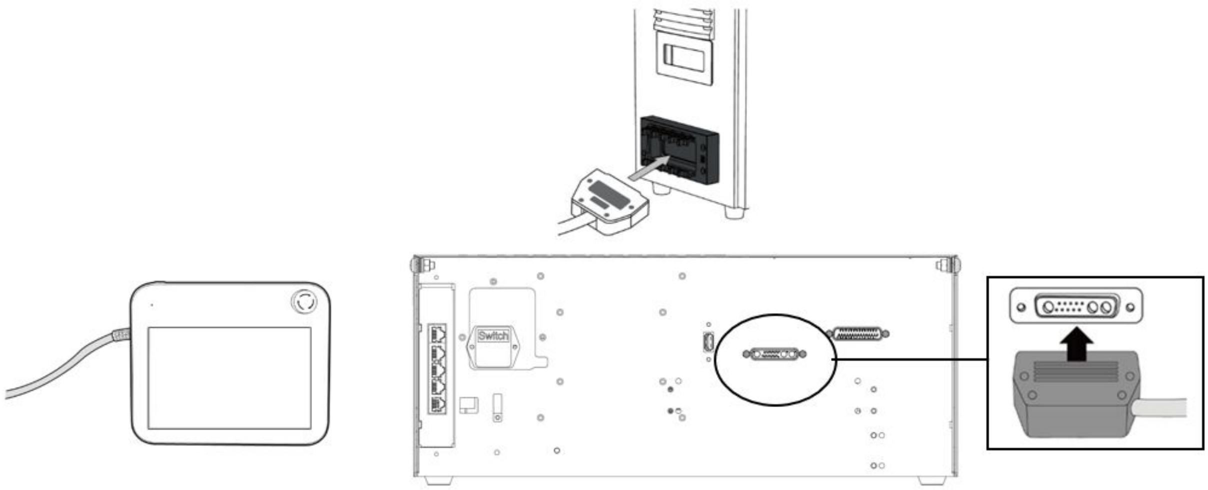
Methods of securing the tool may vary according to the tool. For more information about tool installation, refer to the manual provided by the tool manufacturer.



Tool output flange, ISO 9409-1-50-4-M6

Connect Controller to Teach Pendant

Push the teach pendant cable into the corresponding connections on the controller until it clicks into place to prevent the cable from becoming loose.

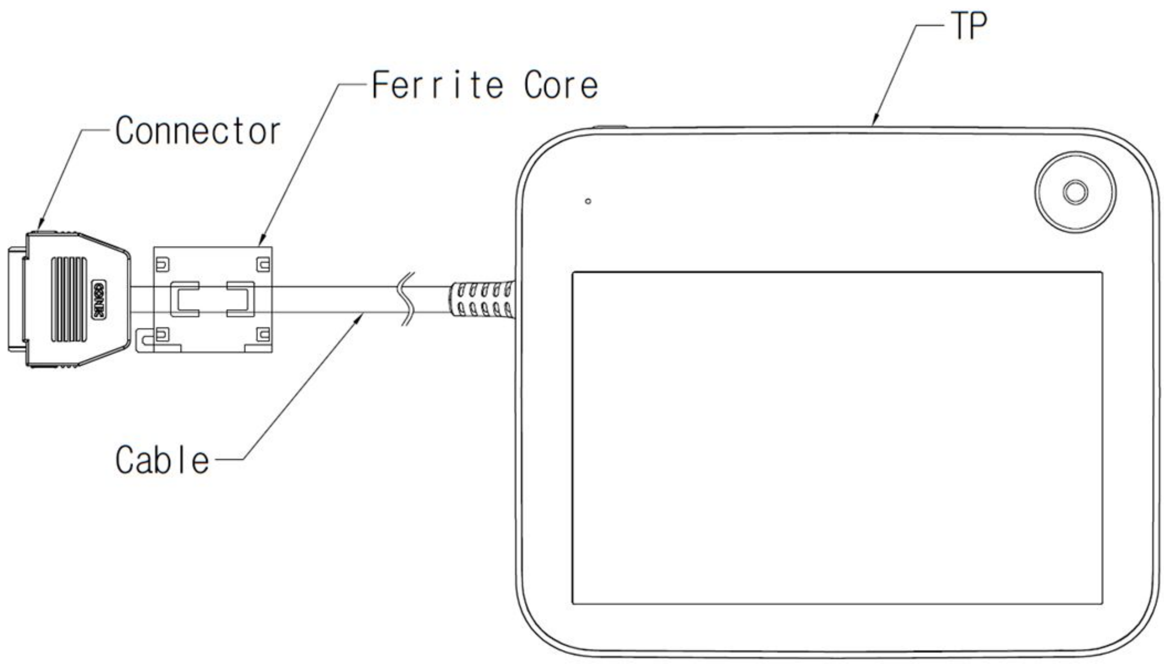


Caution

- Make sure to check that the pins in the cable end are not damaged or bent before connecting the cable.
- When using the Teach Pendant hanging on the wall or controller, be careful not to trip over the connecting cables.
- Be careful not to allow the controller, Teach Pendant or cable to come in contact with water.
- Avoid installing the controller or Teach Pendant in a dusty or wet environment.
- The control box and Teach Pendant must not be exposed to a dusty environment that exceeds the IP20 rating. Be especially careful in environments with conductive dust.

Note

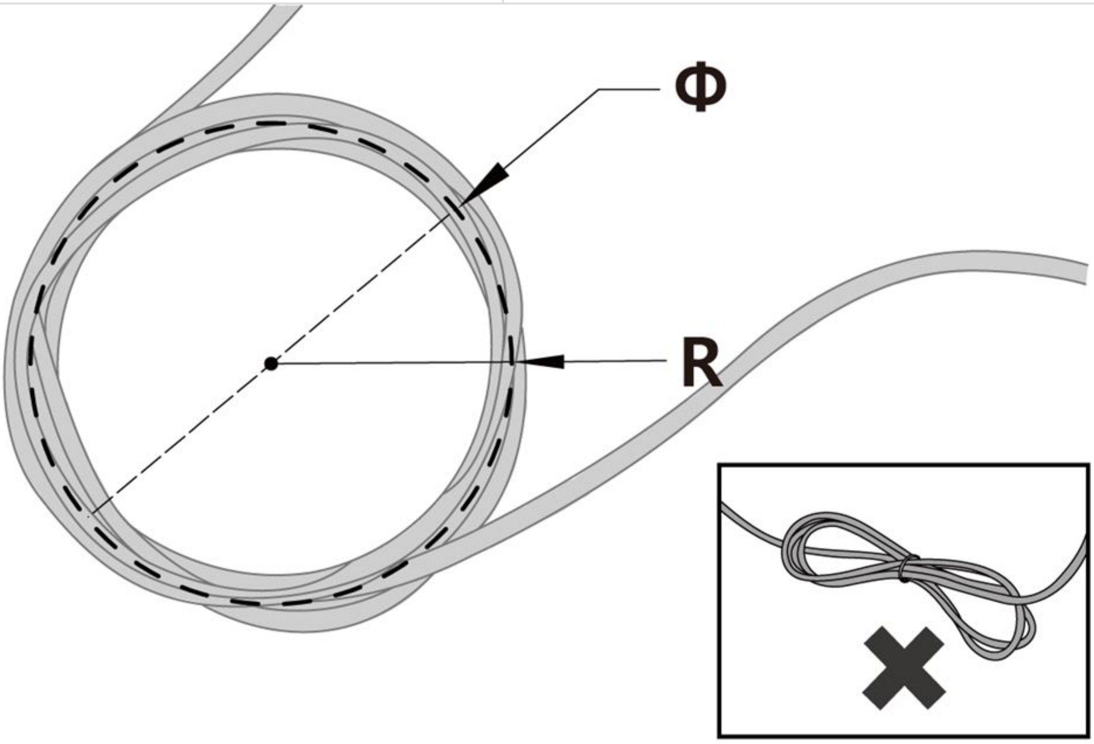
- When configuring the system, it is recommended to install a noise reducer to prevent noise influence among devices and system malfunctions.
- If it is affected by noise generated by electromagnetic waves, it is recommended that ferrite cores be installed on the connection parts of the Teach Pendant cable to ensure normal operation. The installation locations are as follows:



Routing of Manipulator Cable and Teach Pendant Cable

Ensure that the cable curvatures are greater than the minimum curvature radius. The minimum curvature radius of each cable is as follows:

Cable	Minimum curvature radius (R)
Teach pendant cable	120 mm
Robot cable	120 mm



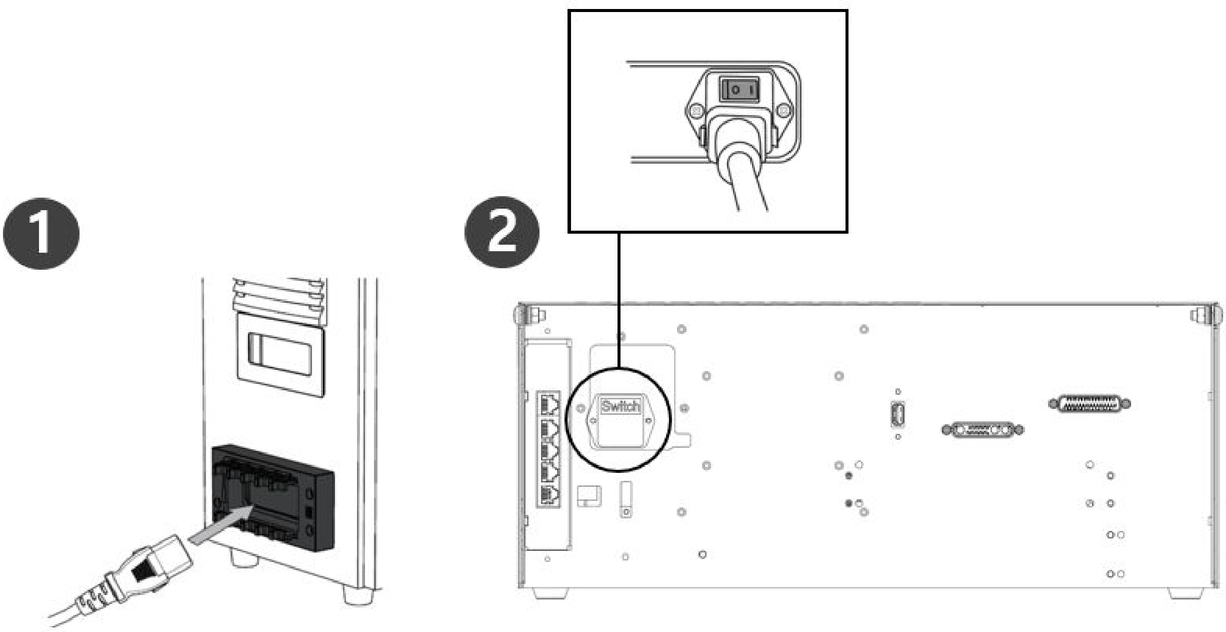
Caution

- Ensure that the curvature radius between the teach pendant cable and teach pendant connector is greater than the minimum curvature radius.
- If the curvature radius is smaller than the minimum curvature radius, cable disconnection or product damage may occur.
- In environments where electromagnetic noise can occur, proper cable installation must be taken to prevent malfunctions.

Connecting Power to Controller

To supply power to the controller, connect the power cable of the controller to a standard IEC power outlet.

- When connecting, use a cable with a standard power plug that matches the outlet of country of use.
- Push the plug completely into the corresponding connection of the controller to prevent the cable from becoming loose. Connect the standard IEC C14 plug under the controller to the corresponding IEC C13 cord.



Caution

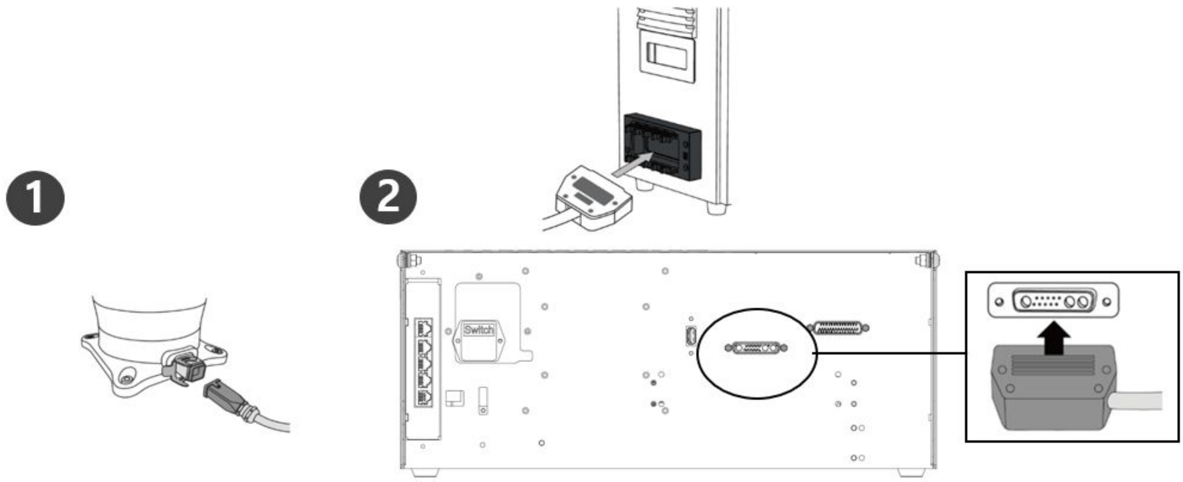
- After connecting the power cable, be sure to properly ground the robot (electrical ground connection). Establish a common ground for all equipment in the system with unused bolts associated with the ground symbol inside the controller. The ground conductor must satisfy the maximum current rating of the system.
- Protect the input power of the controller using a circuit breaker.
- Do not attempt any modifications or extensions to the power cable. Doing so may cause a fire or controller breakdown.
- Be sure to properly connect all cables before supplying power to the controller. Always use the original cable included in the product package.

Note

- When configuring the system, it is recommended to install a power switch capable of turning all devices off at once.
- The power supply must satisfy minimum requirements such as grounding and circuit breakers. The electrical specifications are as follows: (For optional controllers, refer to their respective appendices.)

Parameter	Specifications
Input Voltage	100 – 240 VAC
Input Power Fuse (@100-240V)	15 A
Input Frequency	47 – 63 Hz

Connecting Manipulator to Controller



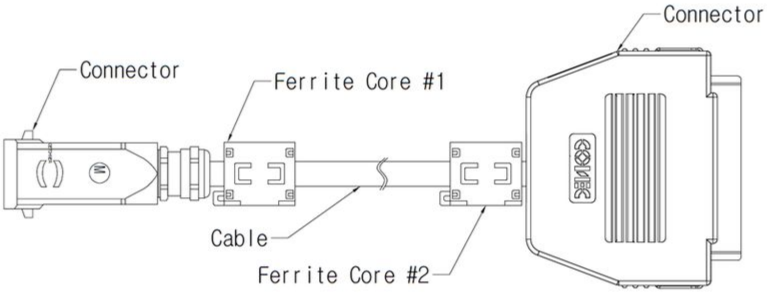
	Description
1	Engaging the securing ring after connecting the manipulator connection cable • Connect the manipulator connection cable to the corresponding connections on the controller and install the snap ring to prevent the cable from becoming loose
2	Connecting the manipulator connection cable's opposite end to the controller • Push the other end of the manipulator connection cable to the corresponding connection on the controller until it clicks into place to prevent the cable from becoming loose.

⚠ **Caution**

- Do not disconnect the manipulator cable while the robot is turned on. This may cause the robot to malfunction.
- Do not attempt any modifications or extensions to the manipulator cable.
- When installing the controller on the floor, secure at least 50 mm of clearance on each side to ensure adequate ventilation.
- Be sure to properly lock the connectors before turning on the controller.

Note

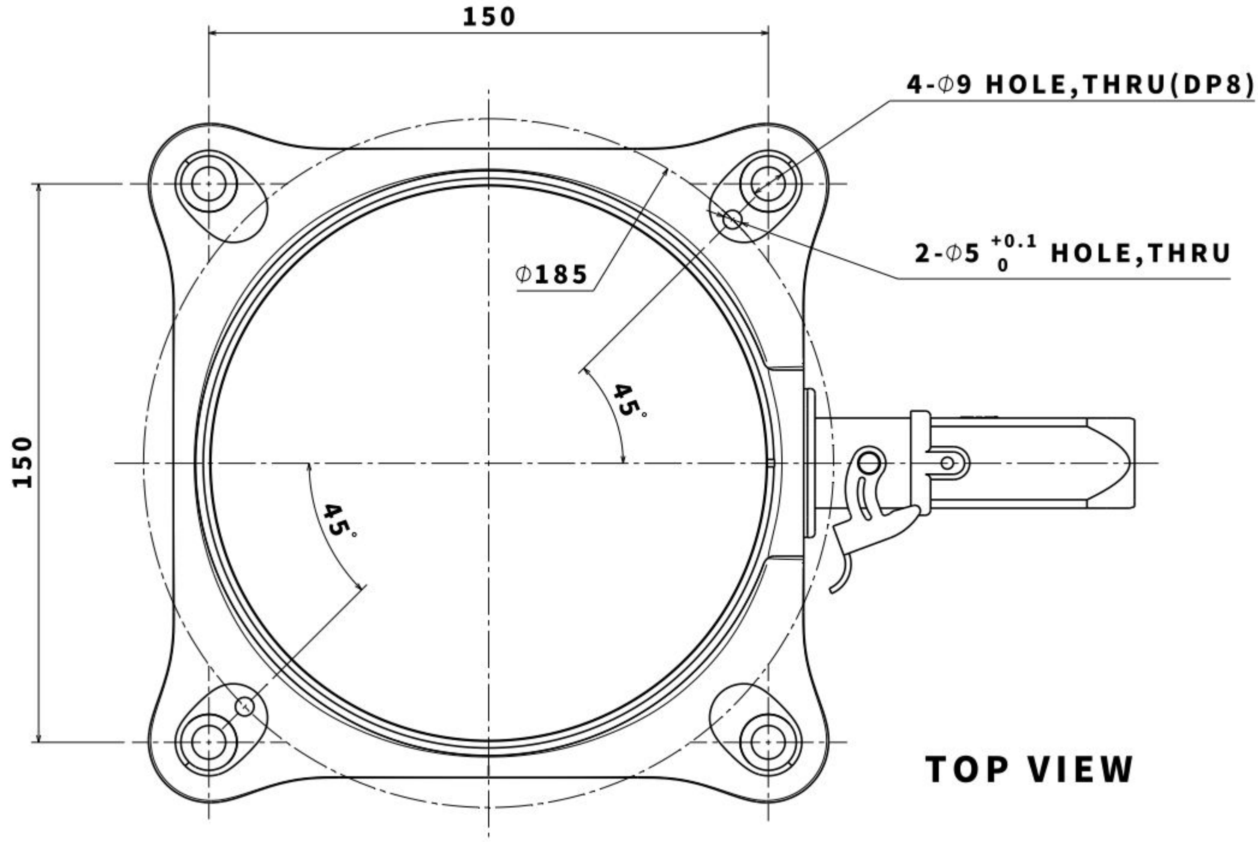
- When configuring the system, it is recommended to install a noise reducer to prevent noise influence among devices and system malfunctioning.
- If the controller is affected by the noise generated by electromagnetic waves, it is recommended that ferrite cores be installed on both ends of the manipulator cable to ensure normal operation. The installation locations are as follows:



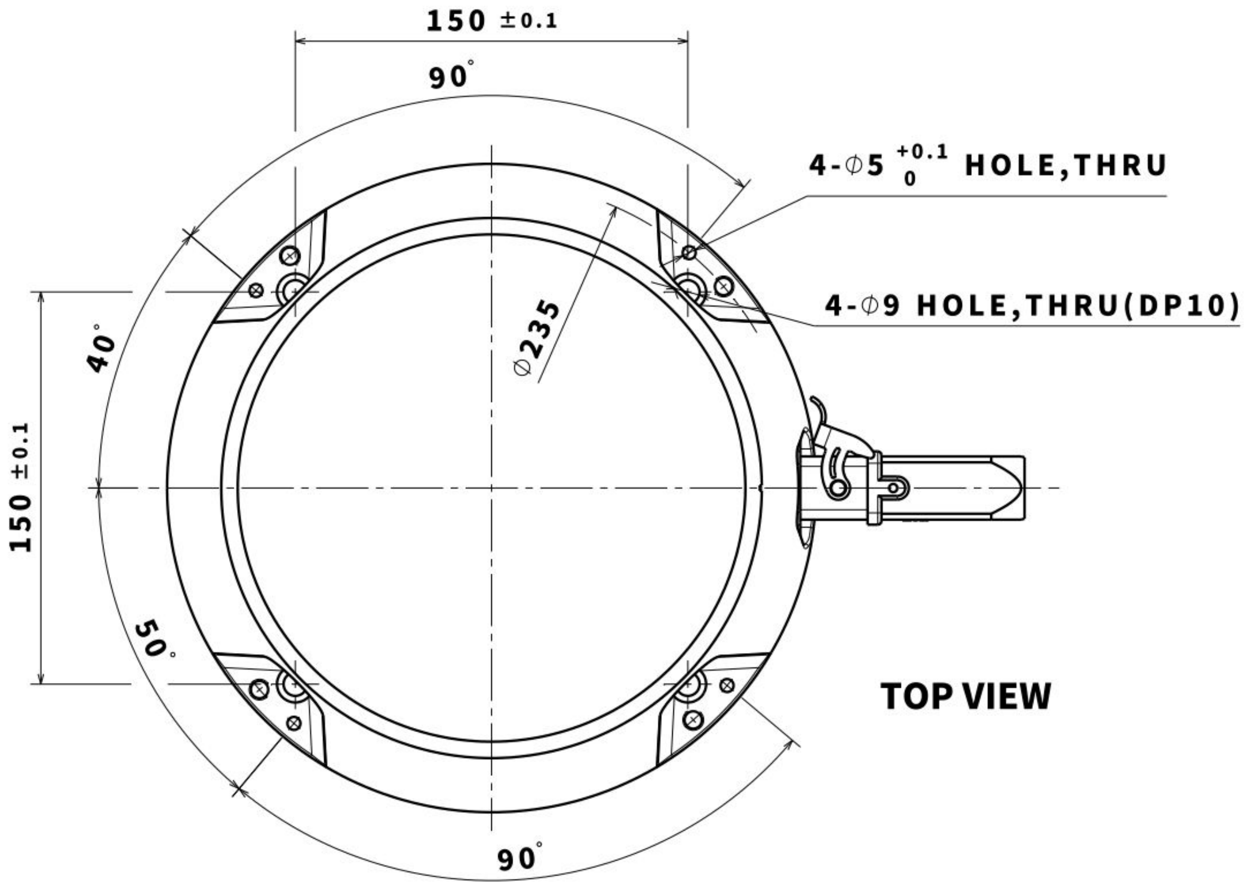
Securing the Robot

Use M8 bolts in the four 9.0 mm holes on the manipulator base to secure the robot.

- It is recommended to use tightening torque of 20 Nm to tighten the bolts.
  And use a washer(plain or spring) to prevent loosening of the tension caused by vibration.
- Use a Φ5 place marker pin to accurately install the manipulator in a fixed location.



The manipulator base drawing and four M8 bolts are used (M series). Unit [mm]



The manipulator base drawing and four M8 bolts are used (H series). Unit [mm]

Warning

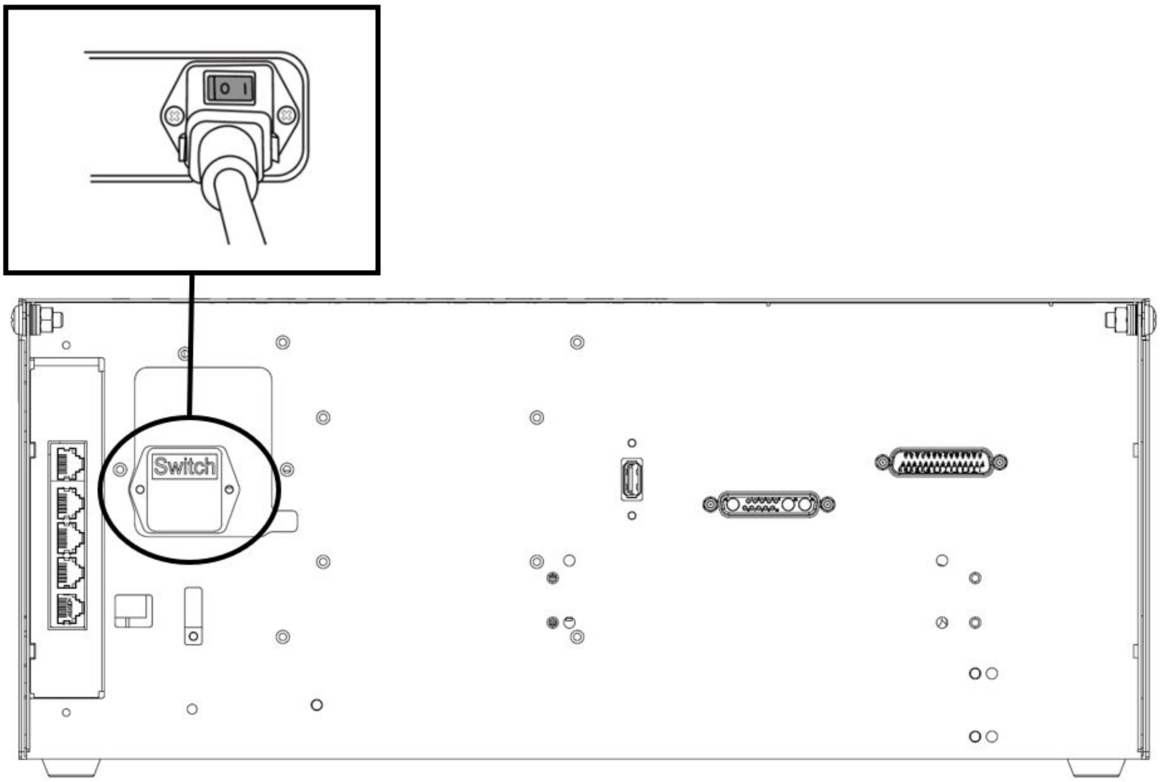
- Tighten the bolts all the way to prevent loosening during manipulator operation.
- Install the manipulator base on a solid surface that can withstand the load generated during operation (10 times the maximum torque and five times the weight of the robot).
- The robot will interpret manipulator base vibration as a collision and engage the emergency stop. Therefore, for installation locations that automatically shift position, do not install the robot base in a location with high movement acceleration.
- Mount the manipulator arm in a specific location using appropriate methods. The mounting surface must be solid.
- The manipulator will be damaged if it comes in contact with water for an extended period of time. Do not operate the robot in conditions where it can get wet or under water.

4.2.3 Power On/Off Controller Switch

Turn system power on

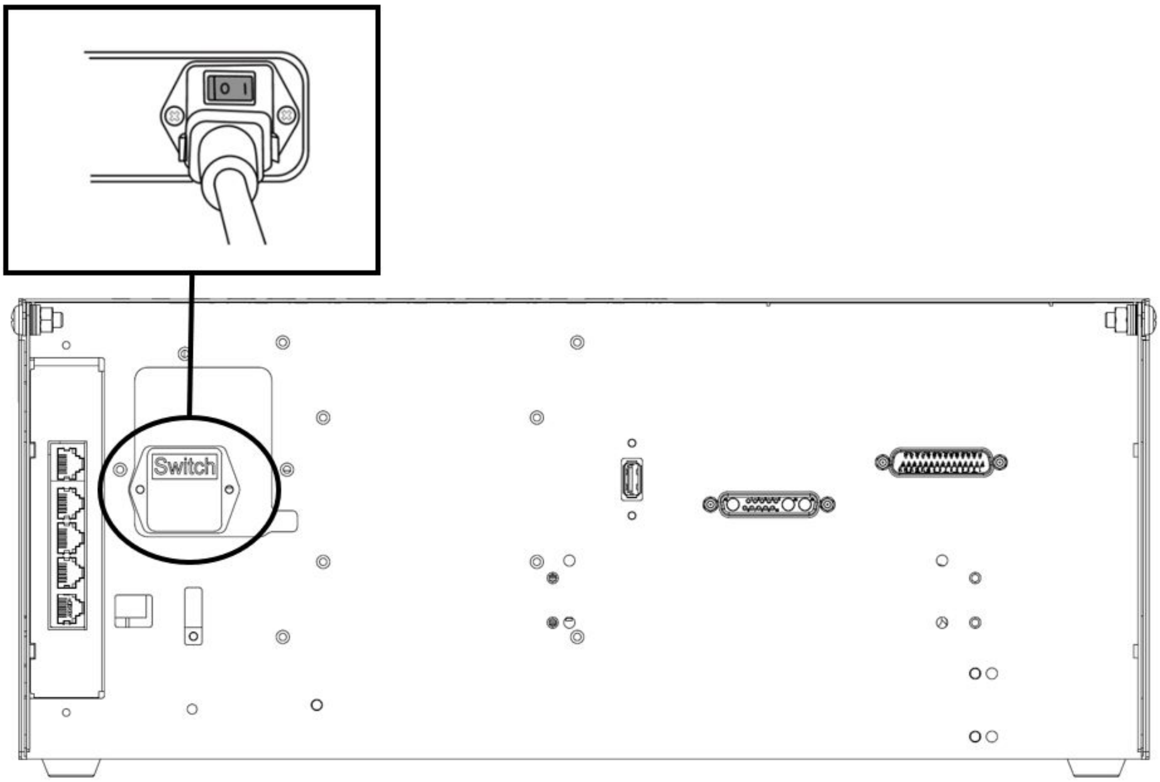
A power switch is installed on the bottom of the controller to cut off system power. Press the power button on the bottom of the controller.

- The power for systems such as the robot, controller, teach pendant is turned on.



Turn system power off

Before cleaning or servicing the robot or controller, or before disassembling the system, cut off system power using the power switch.



4.2.4 Cautions during Installation

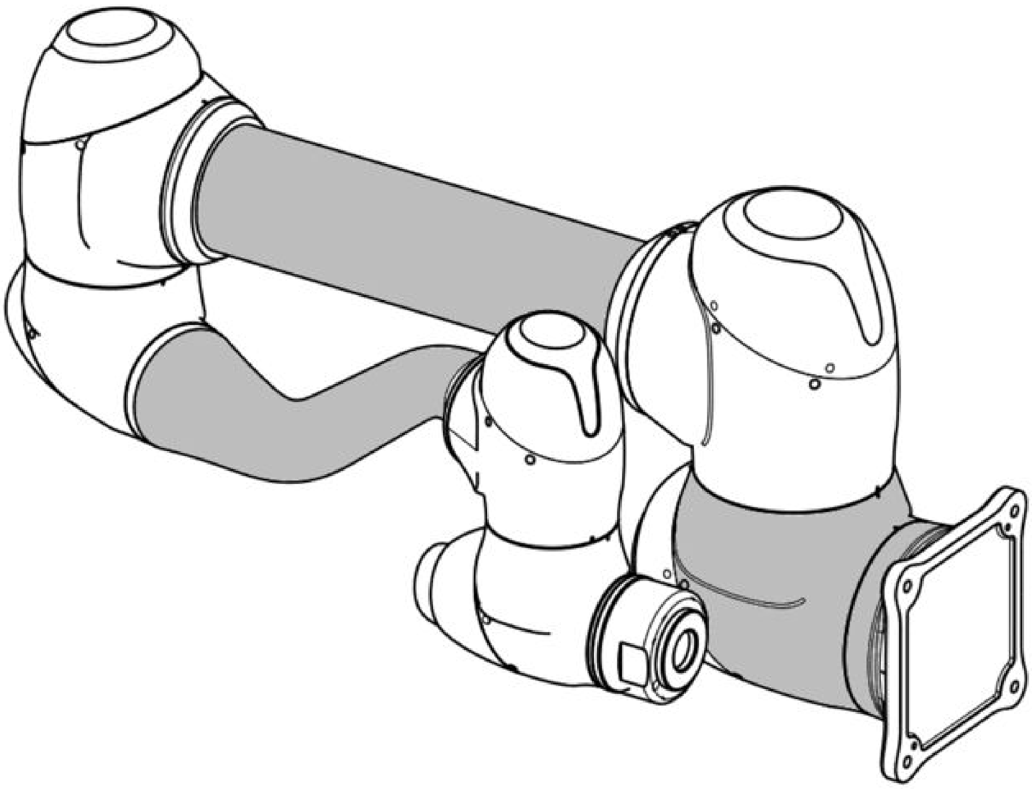
Warning

- Industrial robots must be installed with careful consideration given to the inspection standards defined by the Regulations and Safety Inspection of the Occupational Safety and Health Standards Announcement (if the robot is subject to inspection).
- Secure sufficient space for installation before installing the robot. Installing the robot in a place where sufficient space is not secured may result in damage to the robot or injury to the user.

- When connecting the power plug and power cable to the product, do not touch them with wet hands. This may cause electrocution or injury. Please use the tool center position information provided as the maximum payload of the robot within the work area may vary depending on the center of gravity distance.
- Safety devices to be connected to the controller must be connected to a safety contact input terminal or a #configurable# digital I/O set as #Safety I/O# using dual signals. Safety devices to be used in connection with the controller must be connected to the safety contact input terminal or the configurable digital IO set as Safety IO (input/output) using dual signals.
- The operating handle of the power disconnect should be installed so that it is easily accessible, considering that it depends on the location where the plug is connected and the environment in which the robot is installed.
- In the case of the H series, it is possible to use only the floor standard, and to prevent safety accidents, be sure to refer to the “H Series Handling Guide” in Appendix F provided in consideration of the dead load of the robot during installation.

Lifting points for transport and installation

- In case of relocating the M series to an installation location, please carry it by lifting the shaded area described below. To prevent accidents, please lift and carry the robot with sufficient personnel (2 or more people) simultaneously considering the weight of each type of robot.

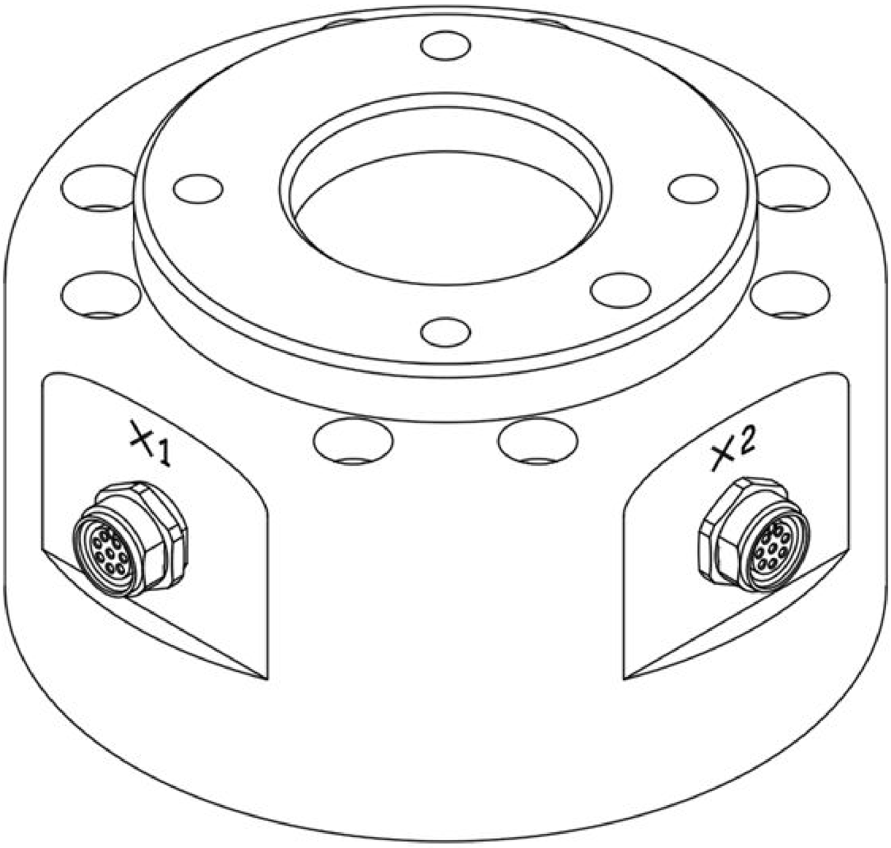


- Please be careful of the accidents caused by falling while carrying the robot.

4.3 Interface

4.3.1 Flange I/O

The end flange cover of the robot has two M8 spec 8-pin connectors, and refer to the figure below for the location and shape.

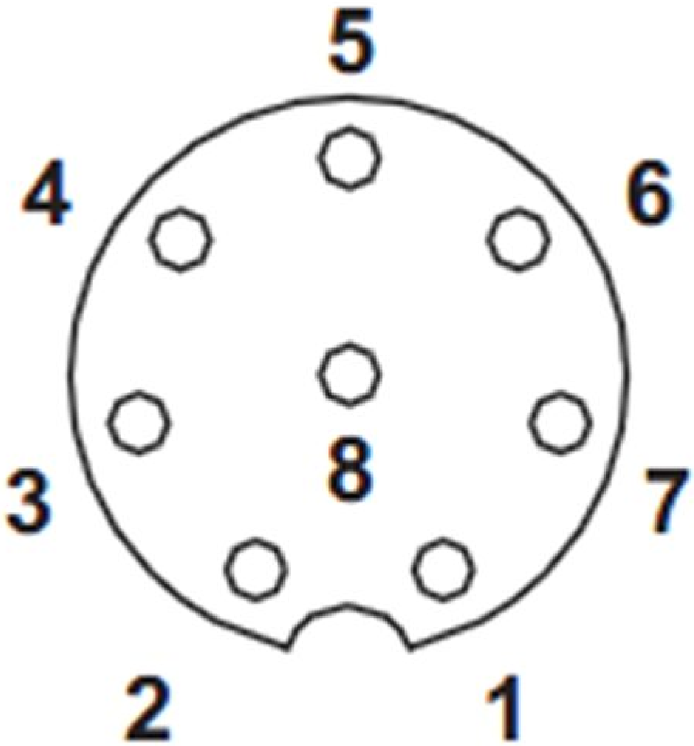


The connector supplies power and control signals necessary to operate the gripper or sensors embedded within specific robot tools. The following are sample industrial cables (equivalent cables can be used):

- Phoenix contact 1404178, male (Straight)
- Phoenix contact 1404182, male (Right Angle)

The pin map of each connector is as follows:

Schematic Diagram



I/O functions provided through X1 and X2 connectors are different from each other, and refer to the table below for detailed I/O settings.

X1 Setting (Digital IN/OUTPUT)

No	Signal
1	Digital Input 1
2	Digital Output 1
3	Digital Output 2
4	Digital Output 3
5	+24V
6	Digital Input 3

No	Signal
7	Digital Input 2
8	GND

X2 Setting (Digital IN/OUTPUT)

No	Signal
1	Digital Input 4
2	Digital Output 4
3	Digital Output 5
4	Digital Output 6
5	+24V
6	Digital Input 6
7	Digital Input 5
8	GND

Internal power of flange I/O is set to 24V, and refer to the table below for detailed power specifications during I/O connection

Parameter	Min	Type	Max	Unit
Supply voltage	-	24	-	V
Supply current	-	-	3	A
Digital output	-	6	-	EA
Digital input	-	6	-	EA

The setting has been charged as follows since March 22, 2024

X1 Setting

No	Signal
1	Digital Input 1
2	Digital Output 1
3	Digital Output 2
4	Analog Input 1 / RS-485 +
5	+24V / +12V / 0V (off)
6	Analog Input 2 / RS-485 -
7	Digital Input 2
8	GND

X2 Setting

No	Signal
1	Digital Input 3
2	Digital Output 3
3	Digital Output 4
4	Analog Input 3 / RS-485 +
5	+24V / +12V / 0V (off)
6	Analog Input 4 / RS-485 -
7	Digital Input 4
8	GND

I/O functions description

Type	Description
Power	Set the internal power supply to 0V (default), 12V or 24V
Digital Output	set to either PNP (Source Type, default) or NPN (Sink Type)
Digital Input	PNP (Source Type, default)
Analog Input	set to either Voltage (0-10V) or Current (4-20mA, default)
RS-485	Max 1M baud rate

Set the internal power supply to 0V, 12V or 24V.

The electrical specifications are shown below:

Parameter	Min	Type	Max	Unit
Supply voltage (12V mode)	11.4	12	12.6	V
Supply voltage (24V mode)	22.8	24	25.2	V
Supply current	-	-	3	A

Warning

- Set up the tool and gripper so that they do not cause any hazards when power is cut off. (e.g., workpiece falling from the tool)
- The No. 5 terminal of each connector outputs 24V at all times while power is supplied to the robot, so make sure to cut the power supply to the robot when setting up the tool and gripper.

Flange Digital Output Specifications

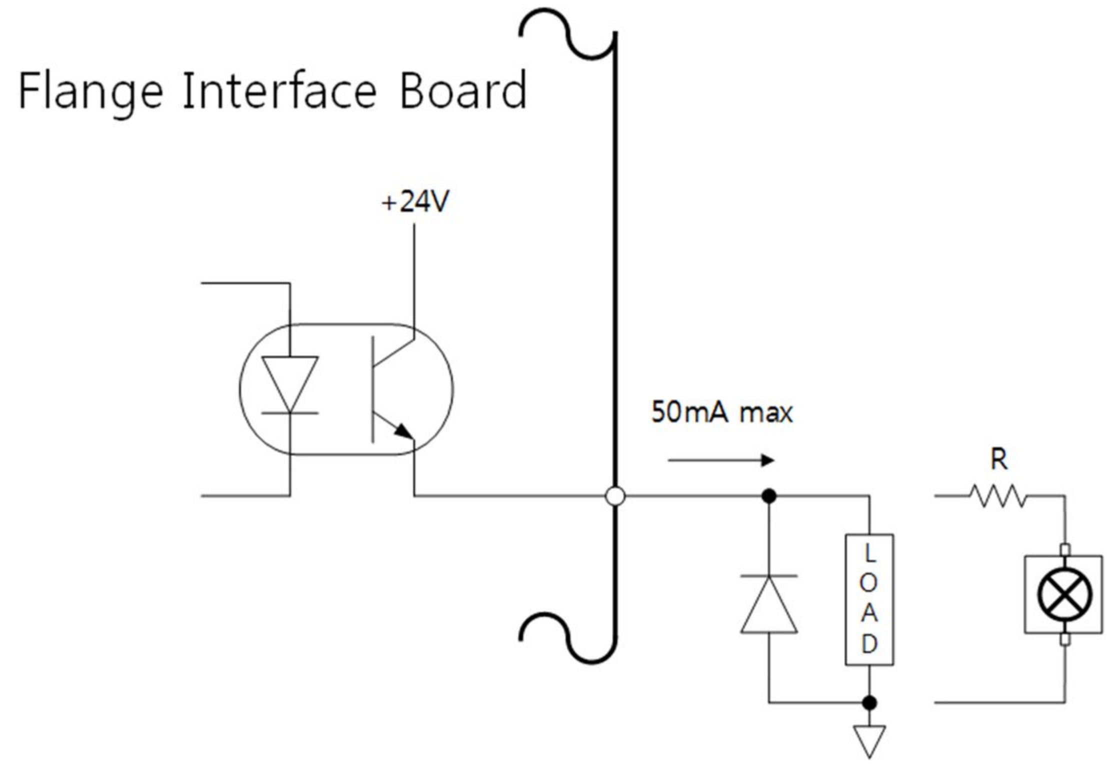
Flange digital output is a PNP specification, and photo coupler output is set up in the output.

The corresponding output channel becomes +24V when digital output is activated. The corresponding output channel becomes open (floating) when digital output is deactivated.

The electrical specifications of the digital output are as follows:

Parameter	Min	Typ	Max	Unit
Voltage when driving 10mA	23	-	-	V
Voltage when driving 50mA	22.8	-	23.7	V

Parameter	Min	Typ	Max	Unit
Current when driving	0	-	50	mA



The setting has been charged as follows since April 11, 2024

Digital Outputs support two different modes:

Mode	Active	Inactive
PNP (Source Type, default)	High	Open
NPN (Sink Type)	Low	Open

Digital Outputs initial power is set to 0V, and can be set to 12V or 24V.

When digital output is disabled, the state of the corresponding output channel is open (floating).
The electrical specifications are shown below:

Parameter	Min	Typ	Max	Unit
Voltage when driving 12V mode	11.4	12	12.6	V
Voltage when driving 24V mode	22.8	24	25.2	V

Parameter	Min	Typ	Max	Unit
Current when driving	0	-	50	mA

Caution

- Digital output is not subject to current limitation. Ignoring the specifications presented above during operation may cause permanent damage to the product.
- The figure below is an example of a digital output setup, so refer to it while connecting the tool and gripper.
- Make sure to disconnect the power from the robot when setting up the circuit.

Flange Digital Input Specifications

Flange digital input features a photo coupler input.

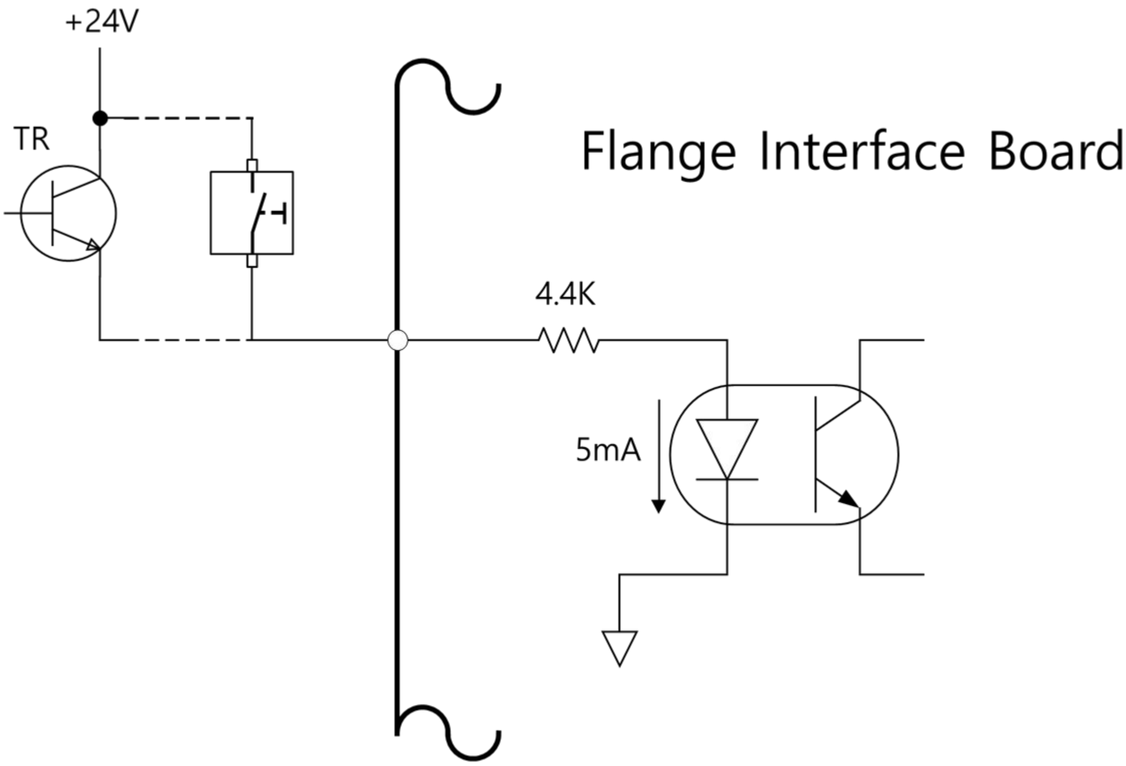
The current based on 24V input is limited to 5mA by internal resistance.

The electrical specifications of the digital input are as follows:

Parameter	Min	Typ	Max	Unit
Input voltage	0	-	26	V
Logical high	4.4	-	-	V
Logical low	0	-	0.7	V
Input resistance	-	4.4k	-	Ω

Caution

- The figure below is an example of a digital input setup, so refer to it while connecting an input device.
- Make sure to disconnect the power from the robot when setting up the circuit.



Flange Analog Input Specifications

Receives voltage or current signals from external devices.

Analog Input can be set to voltage (0-10V) or current (4-20mA).

The electrical specifications are shown below.

Parameter	Min	Type	Max	Unit
Input voltage in voltage mode	0	-	10	V
Input current in current mode	4	-	20	A
Resolution	-	12	-	bit

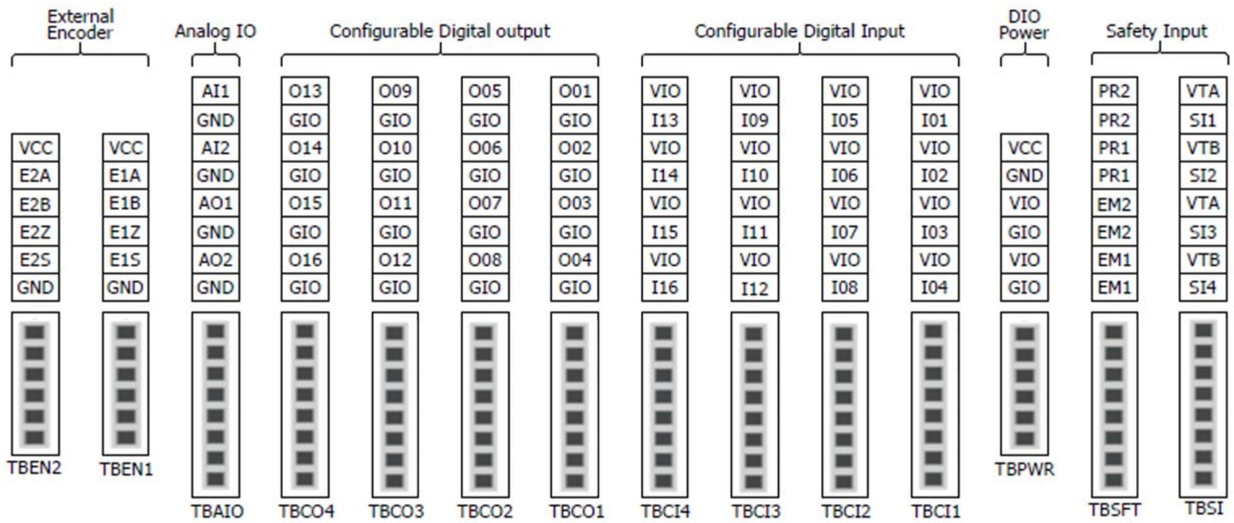
4.3.2 Controller I/O Connection

The controller I/O terminals can be used to connect external equipment other than manipulators and teach pendant to the controller. In addition to safety devices such as emergency stop switch, light curtain, and safety mats, various peripherals required to configure a robot work cell, such as pneumatic solenoid valves, relays, PLCs, and conveyor belt encoders can be connected.

The controller I/O is organized as follows.

- Terminal Block for Safety Contact Input (TBSFT): for connecting devices required for emergency stopping and protective stopping
- Digital I/O Power Terminal Block (TBPWR)
- Configurable Digital I/O Block (TBCI1- 4, TBCO1– 4): for connecting peripherals required for robot operation
- Analog I/O Terminal Block (TBAIO)
- Terminal Block for Encoder Input (TBEN1, TBEN2)
- Safety Input Terminal Block (TBSI): Used to directly connect safety sensors that generate OSSD signals to the controller safety signals (OSSDs are typically used with safety sensors and light curtains or as safety control outputs).

The figure below depicts the layout of the electric interface inside the controller.



Caution

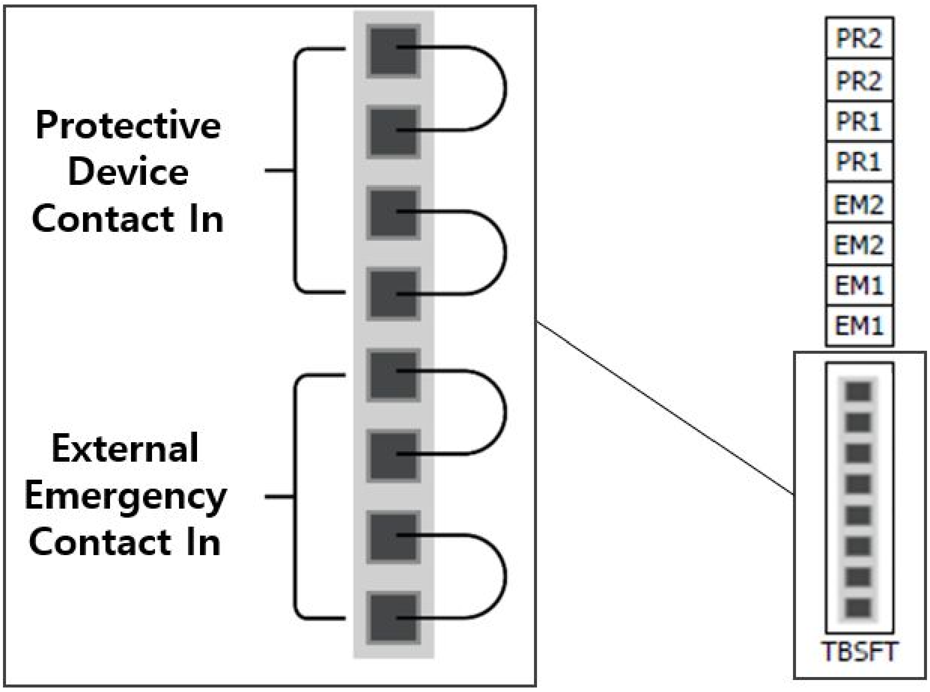
- To prevent the risk of damage and malfunction to the product, be sure to turn off the power when connecting terminals to the controller I/O.
- Doosan Robotics will not compensate for any damage to the product due to improper connection of terminals or negligence of the user.
- When turning off the power to the controller, be sure to turn off the external power source as well.

Setting the Terminal Block for Contact Input (TBSFT)

The safety I/O of the controller consists of redundant dedicated contact input terminals for connecting safety devices. These terminals are categorized into two groups depending on their use.

- Two pairs of External Emergency Contact In on the bottom: Used to connect devices required for emergency stopping such as external emergency switch.
- Two pairs of Protective Device Contact In on the top: Used to connect devices for protective stopping such as light curtain and safety mat.

If this is used without an external safety device connected, connect each contact input as follows:



The external safety device signal recognized by the #safety controller# depending on the normally closed contact status, where all four contact inputs are normally closed, is as follows:

Contact Status	EM1 contact	EM2 contact	PR1 contact	PR2 contact
Close	Normal	Normal	Normal	Normal
#Open#	Emergency Stop	Emergency Stop	#Protective Stop#	#Protective Stop#

Warning

- Do not connect the safety signal to regular PLCs that are not safety PLCs. Failure to do so may cause improper operation of the Safety Stop function, resulting in severe injury or death to the user.
- If any of the contacts are open, the robot will stop operation according to the safety stop mode setting, and the LED on the right side of the TBSFT lights up. #EMGA (Red), EMGB (Red), PRDA (Yellow), PRDB (Yellow)#

Note

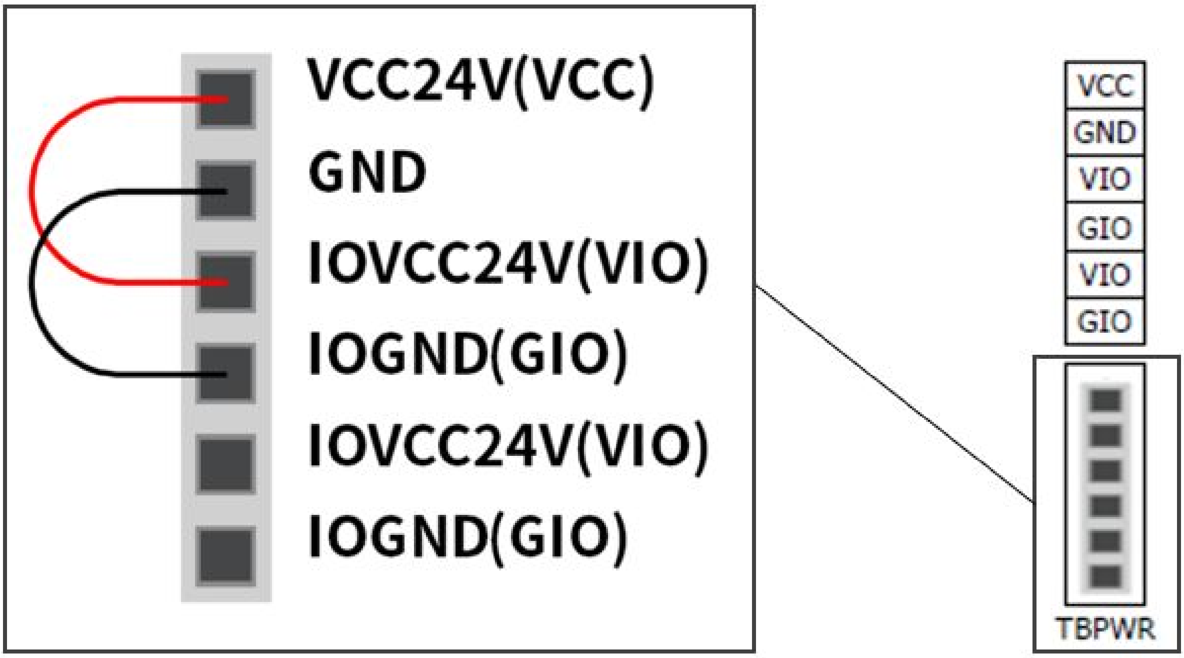
- EMGA: Emergency Stop Channel A (EM1) LED
- EMGB: Emergency Stop Channel B (EM2) LED
- PRDA: Protective Stop Channel A (PR1) LED
- PRDB: Protective Stop Channel B (PR2) LED

Caution

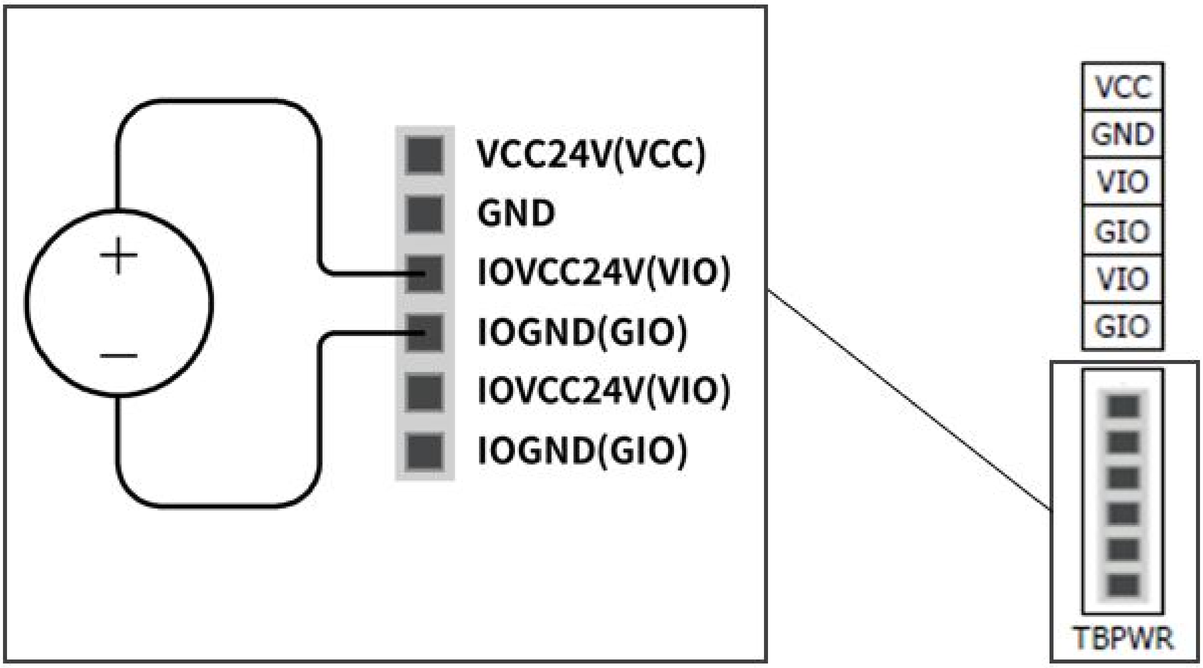
- To check for connection losses and connection shortages, this terminal must be connected to devices that output a safety signal as contacts. To connect a peripheral device that outputs a safety signal as a voltage to the Safety Controller, see Configuring Configurable Digital I/O (TBCI1 - 4,TBCO1 - 4)(p. 172).

Configuring the Digital I/O Power Terminal (TBPWR)

VIO and GIO are power sources used for the digital I/O of the safety controller located in the front of the controller, and are separated from VCC24V and GND supplied by SMPS inside the controller. If the user uses a current of 2A or less for the configurable digital I/O and does not require insulation between the connected I/O device and controller, the internal power supply of the controller can be used as the I/O power supply, as shown in the figure below. (factory default setting)



If a current greater than 2A is required, it is necessary to connect a separate external power source (24V) to the VIO and GIO terminals.



When the VIO power is supplied, the “IOPW (green)” LED on top of the TBPWR block lights up.

Caution

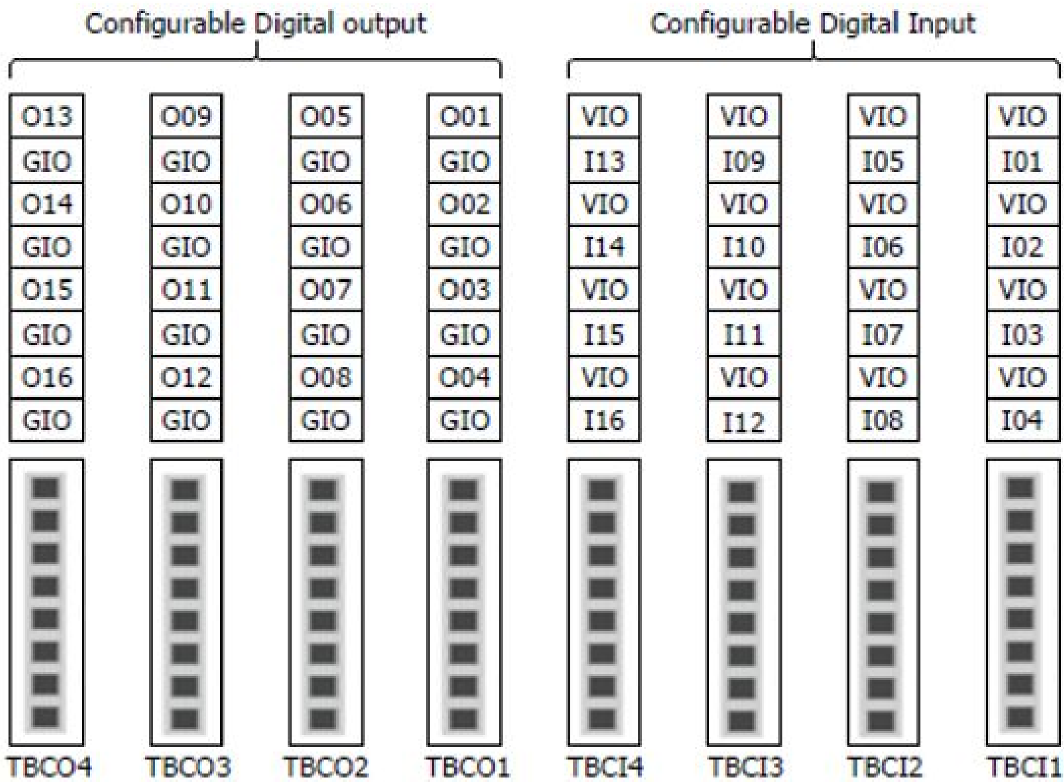
- When turning off the power for the controller, be sure to turn off the external power source (SMPS).

Note

- If a current greater than 2A is connected to VCC and GND of TBPWR, the fuse in front of the terminal power output shorts to ensure the safety of the internal system of the controller connected to the same SMPS.
- If a current greater than 2A is required for the configurable digital I/O, be sure to connect additional external power source (24V) to VIO and GIO.

Configuring Configurable Digital I/O (TBCI1 - 4,TBCO1 - 4)

The controller is configured with 16 digital inputs and 16 digital outputs. The digital I/Os shown in the figure below can be connected to peripherals required for robot control, or can be set as redundant Safety IOs to be used as safety signal I/O purposes.



The electrical specifications of the #configurable# digital I/O are as follows:

#Terminal#		Parameter	Specifications
Digital Output	**[Oxx]**	**Voltage**	0 - 24 V
	[Oxx]	**Current**	0 - 1 A
	[Oxx]	**Voltage Drop**	0 - 1 V
	[Oxx]	**Leakage Current**	0 - 0.1 mA
Digital Input	**[Ixx]**	**Voltage**	0 - 30 V
	[Ixx]	OFF Range	0 - 5 V
	[Ixx]	ON Range	11 - 30 V
	[Ixx]	**Current**	2 – 15 mA

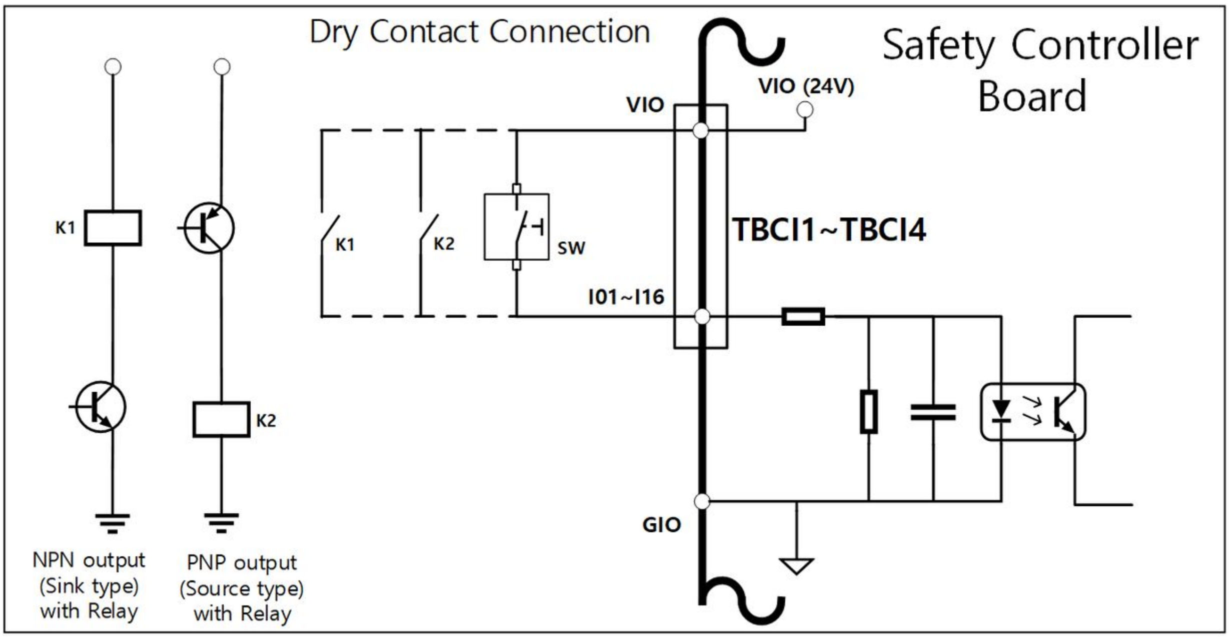
Caution

- The VIO (IO 24V) and GIO (IO GND) terminals, which can be used as power supplies for digital I/O, are separated from the other power supplies, VCC (24V) and GND, on the safety I/O circuit. Use caution, as the diagnostic functions of the robot will detect errors and cut off the power to the robot if the internal power supply is connected as a digital I/O power supply through the Terminal Block for Digital I/O Power (TBPWR) or if the 24V power is not supplied to the VIO and GIO terminals through an external power supply, the configurable digital I/O will not operate.

When configurable digital I/O is used as a general digital I/O, it can be used in various ways such as operating low-current equipment such as solenoid valves for voltage or exchanging signals with PLC systems or peripherals. The following is how to use the configurable digital I/O:

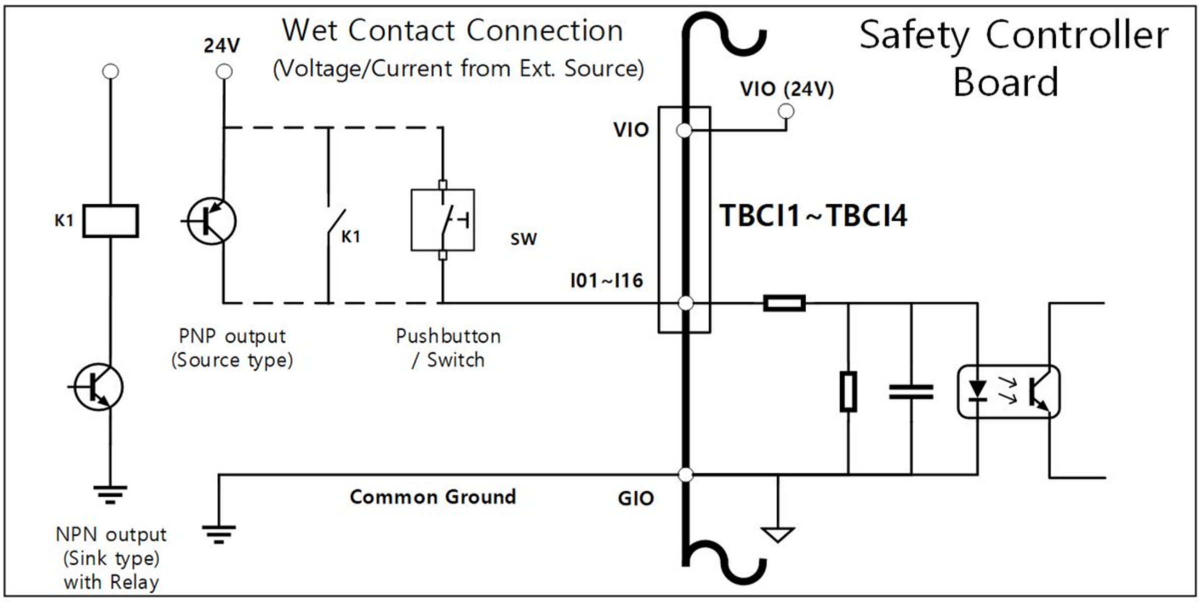
If #dry contact# input is received

This is a method of connecting a #switch# or #contact# between the VIO terminal of terminal blocks TBCI1-TBCI4 and Ixx terminals. The output of the external device only acts on the #open/close# of the contact through the relay, so it is electrically insulated from external devices.



If #wet contact# input is received

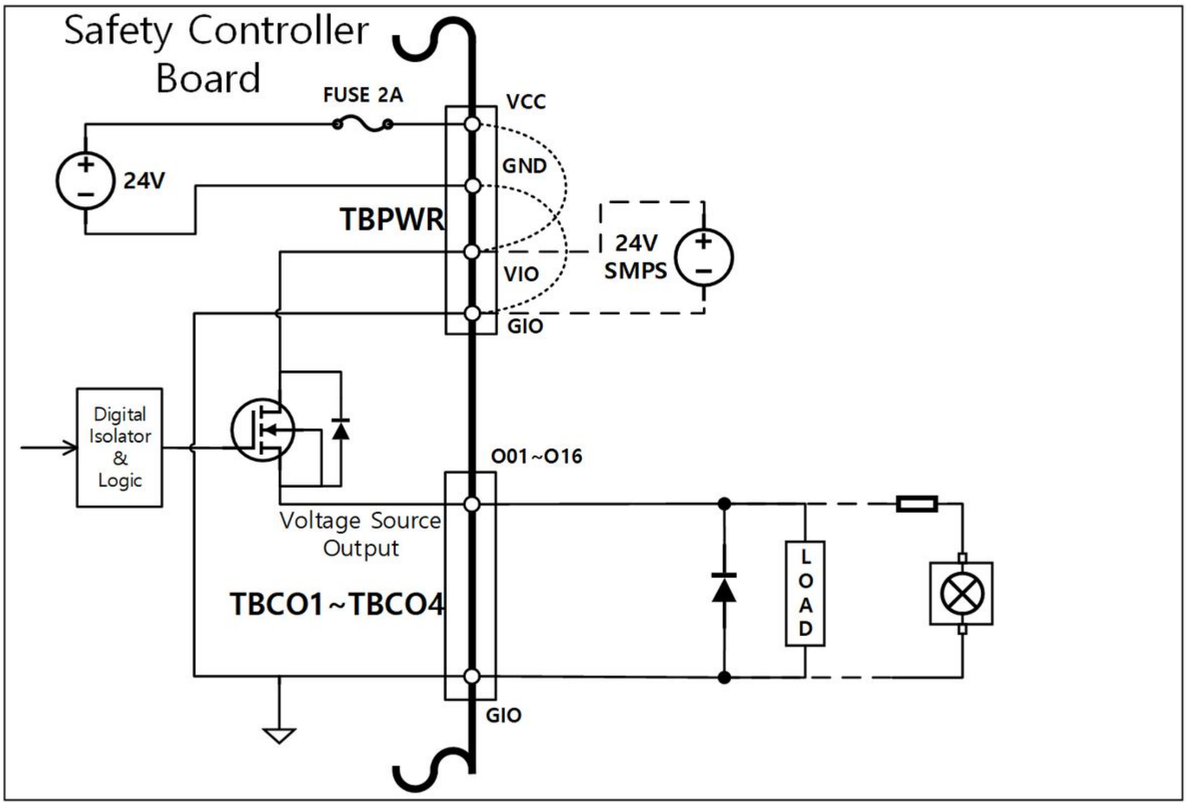
It receives voltage-type signals from external devices. If the output of the target device is source type, it receives a voltage of 24V/0V as input. If the output of the target device is #sink type#, a relay can be added to receive voltage of 24V/0V as input. Because voltage input requires a reference, the external devices and the external power supply must be connected to a common #ground#.



If a simple load is operated

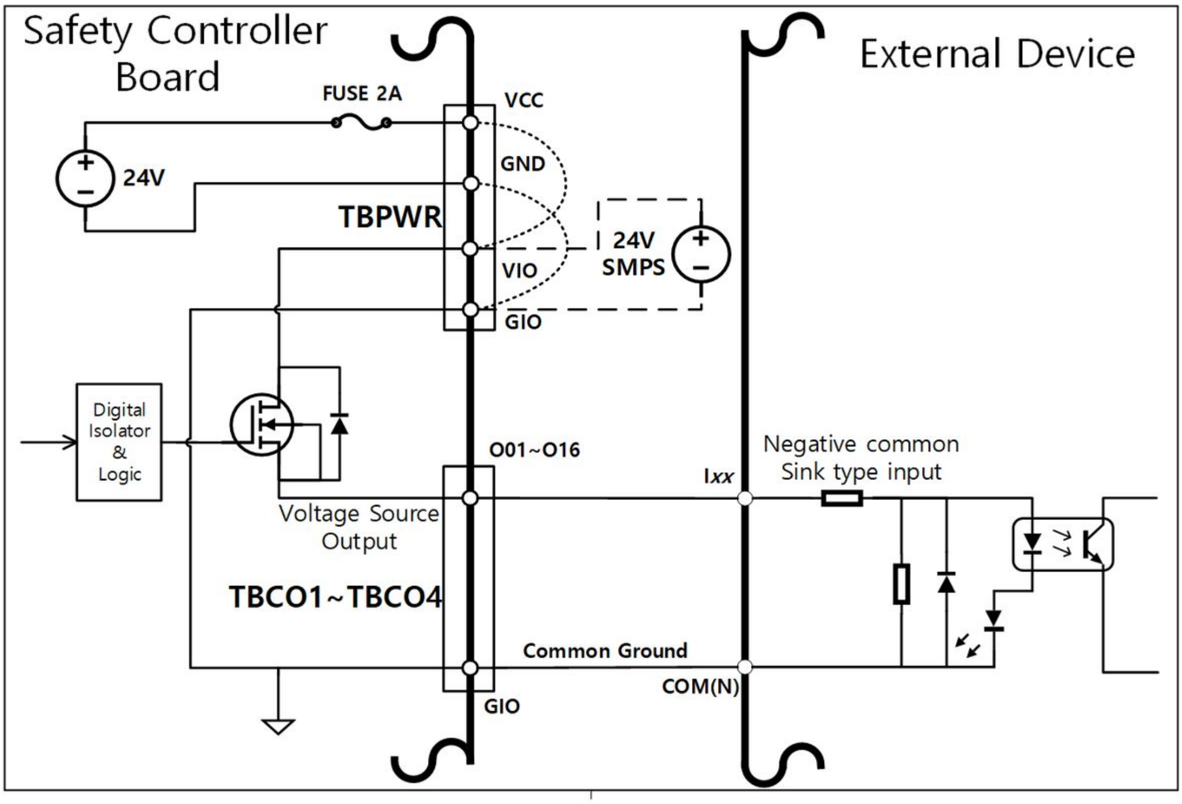
It is a method of connecting loads between Oxx terminals of TBCO1-TBCO4 terminal blocks and the GIO terminal. Each terminal is capable of outputting a maximum of 1A, but the overall current may be limited according to the calorific value and load.

If digital I/O power (VIO/GIO) is supplied through the internal power supply as in the factory default setting, up to 2A of VIO current can be used. If a total current greater than 2A is required, remove the connection between the digital I/O power supply (VIO/GIO) of the Terminal Block for Digital I/O Power (TBPWR) and the internal power supply (VCC/GND) and connect an external power supply.



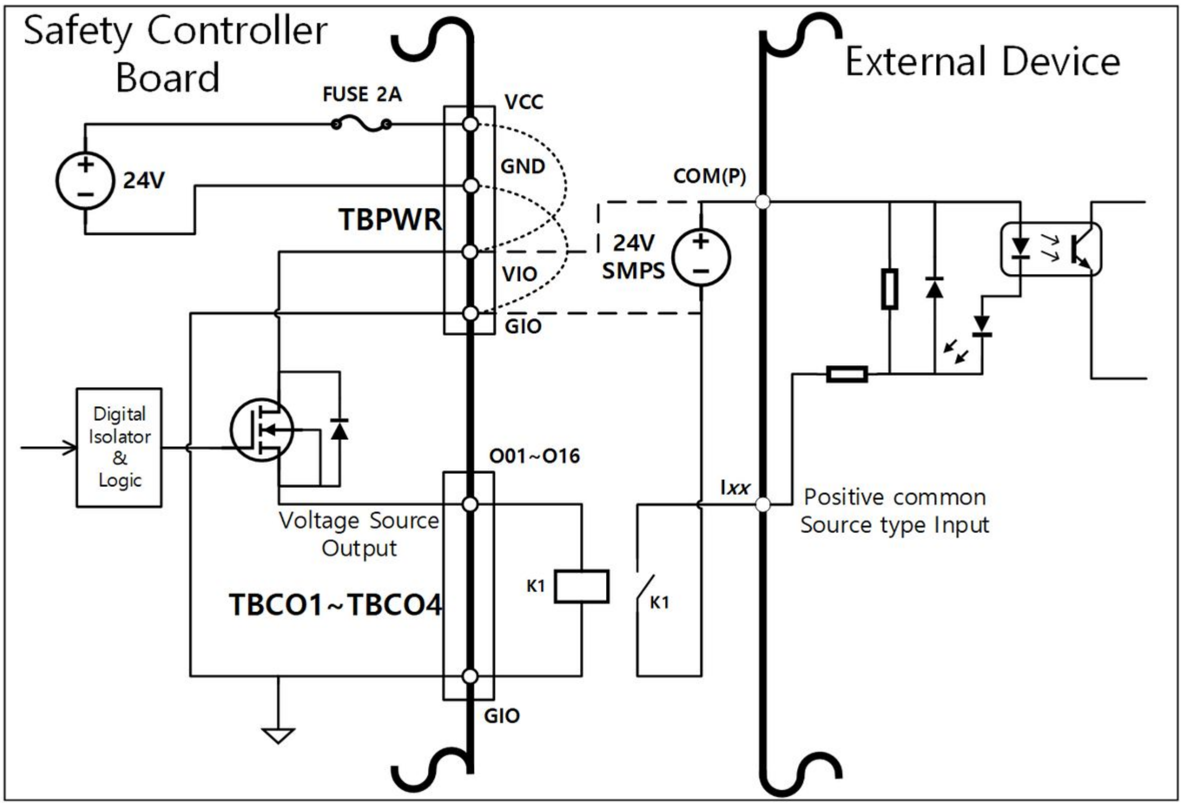
If a #negative common & sink type# input device is connected

When connecting the output of the digital IO to a sink-type input device, connect the Oxx terminals of TBCO1 - TBCO4 terminal blocks to the input terminal of the external device, and connect GIO to the negative common of the external device to establish a common ground.



If a #positive common & source type# input device is connected

Connect a relay between the Oxx terminal of TBCO1-TBCO4 terminal blocks and the GIO terminal to supply input signals as contacts to the external device. If necessary, an external power supply can be connected to the external device.



Caution

- The operation of the general digital IO devices can be interrupted at any time by cutting off the power to the controller, detecting errors by self-diagnosis, and settings of the task program. Therefore, perform a risk assessment before configuring the robot work cell and be sure to implement additional safety measures if additional risks, such as falling of the workpiece, stopping, negligence of the digital input due to digital outputs being switched off or synchronization errors due to misunderstanding, are foreseen.
- The #general# digital I/O is a single connection type I/O and any short circuits or breakdown can result in the loss of safety functions, so it cannot be used for safety purposes. If the connection of a safety device or safety-related signal I/O is required, be sure to set the corresponding terminal as redundant Safety I/O on the teach pendant.

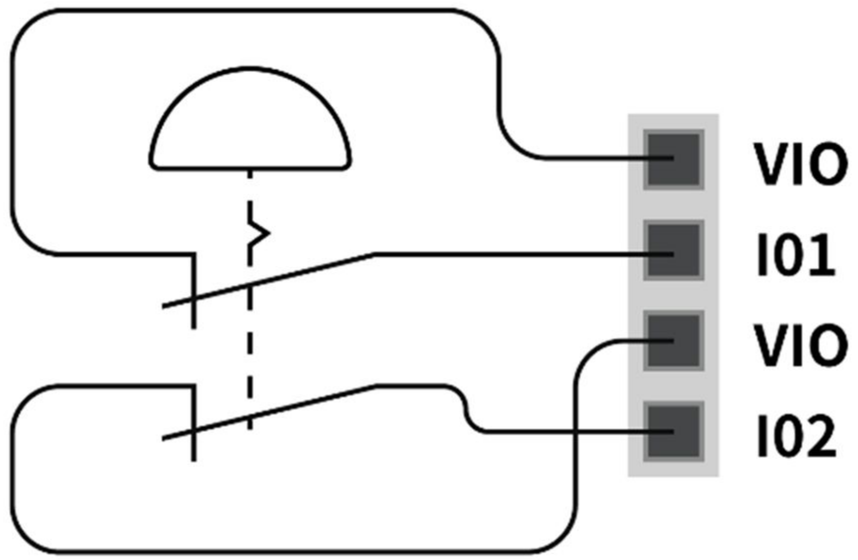
When configurable digital IO is used as Safety IO

O01 & O02, … , O15 & O16, I01 & I02, .. I15 & I16, can use identical safety signals to form a dual safety I/O.

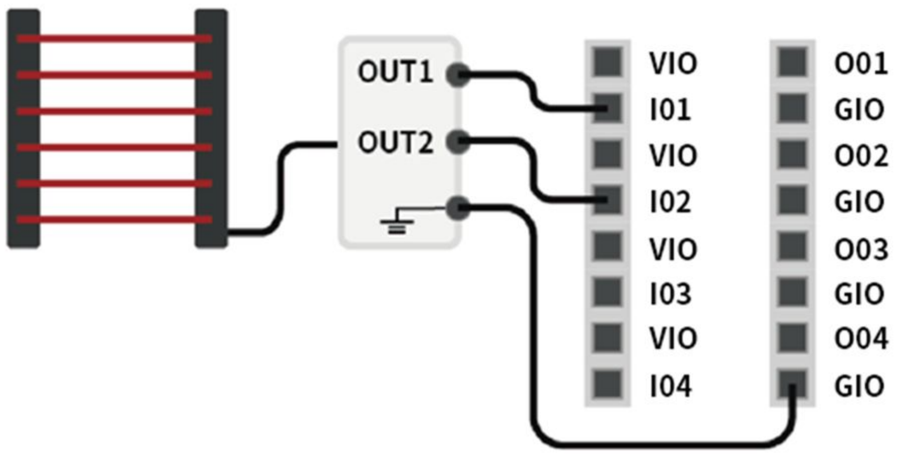
The dedicated input terminal of the Safety Contact Output Terminal (TBSFT) can only connect a dry contact signal, but the input set as Safety IO can connect both contact-type (dry contact) and voltage-type (wet contact) signals. The output set to Safety I/O outputs voltage, but if necessary, a relay can be added externally to configure a contact type output.

The following is an example of connecting a safety device for operation.

- Connect a contact type (Dry Contact) signal emergency switch as a safety input terminal



- Connect a voltage type (Wet Contact) signal light curtain as a safety input terminal (common ground)



Setting Analog I/O Terminal (TBAIO)

The controller has two analog I/O terminals that can be set to voltage mode or current mode. It can output voltage/current through an external device operated using analog I/O or receive signals from sensors outputting analog voltage/current.

To ensure maximum input accuracy, observe the following:

- Use shielded or twisted pair cables.

- Connect the cable shield to the ground terminal inside the controller.
- Current signals are relatively less sensitive to interference, so use devices operating in current mode for analog I/O terminals. Current/voltage input modes can be set with the software.

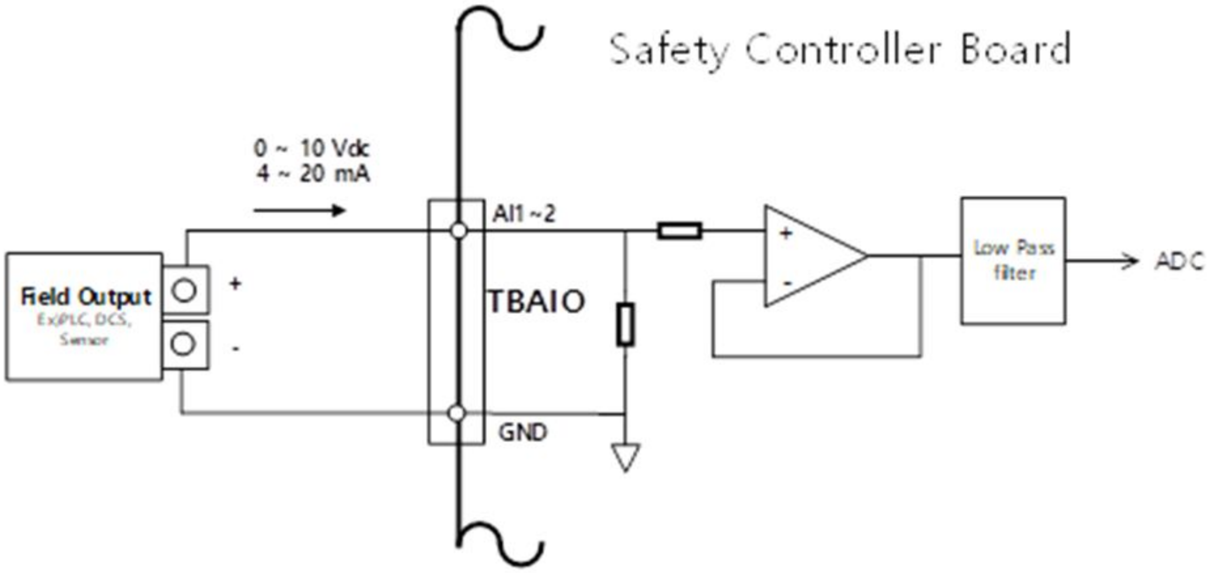
The electrical specifications of the analog I/O terminal are as follows:

Terminal		**Parameter**	**Specification**
Current mode analog input	**[AIx-GND]**	**Voltage**	-
	[AIx-GND]	**Current**	4 - 20 mA
	[AIx-GND]	**Resistance**	300 ohm
	[AIx-GND]	**Resolution**	12 bit
Voltage mode analog input	**[AIx-GND]**	**Voltage**	0 - 10 V
	[AIx-GND]	**Current**	-
	[AIx-GND]	**Resistance**	1M ohm
	[AIx-GND]	**Resolution**	12 bit
Current mode analog output	**[AOx-GND]**	**Voltage**	-
	[AOx-GND]	**Current**	4 - 20 mA
	[AOx-GND]	**Resistance**	50M ohm
	[AOx-GND]	**Resolution**	16 bit
Voltage mode analog output	**[AOx-GND]**	**Voltage**	0 - 10 V
	[AOx-GND]	**Current**	-
	[AOx-GND]	**Resistance**	1 ohm
	[AOx-GND]	**Resolution**	16 bit

Voltage/current input

It receives voltage or current signals from an external device between the Alx terminal of the TBAIO terminal block and the GND terminal. If the output of the device is a voltage signal, it receives a signal of 0-10Vdc. If the output of the device is a current signal, it receives a signal of 4-20mA.

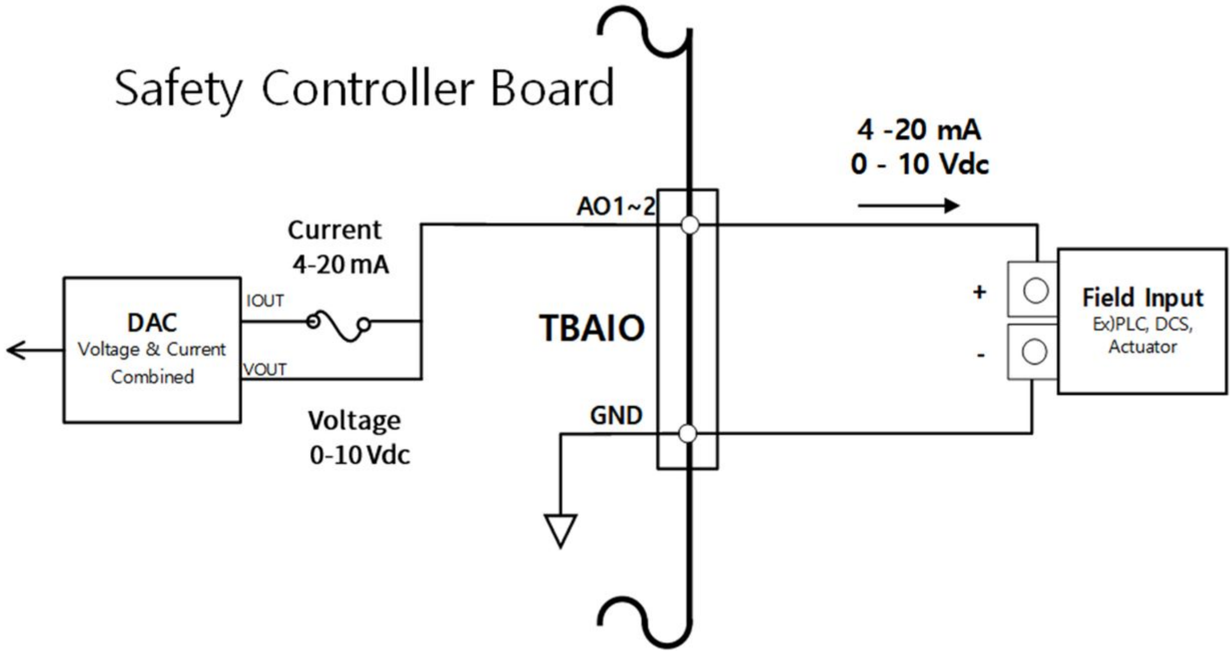
- Depending on the output signal (voltage/current) of the device, it is necessary to set the controller analog input as “Voltage” or “Current” on the teach pendant.



Voltage/current output

It supplies voltage or current signals to an external device between the AOx terminal of TBAIO terminal block and GND terminal. If the input of the device is voltage signal, it supplies a signal of 0-10Vdc. If the input of the device is current signal, it supplies a signal of 4-20mA.

- Depending on the input signal (voltage/current) of the device, it is necessary to set the controller analog output as “Voltage” or “Current” on the teach pendant.



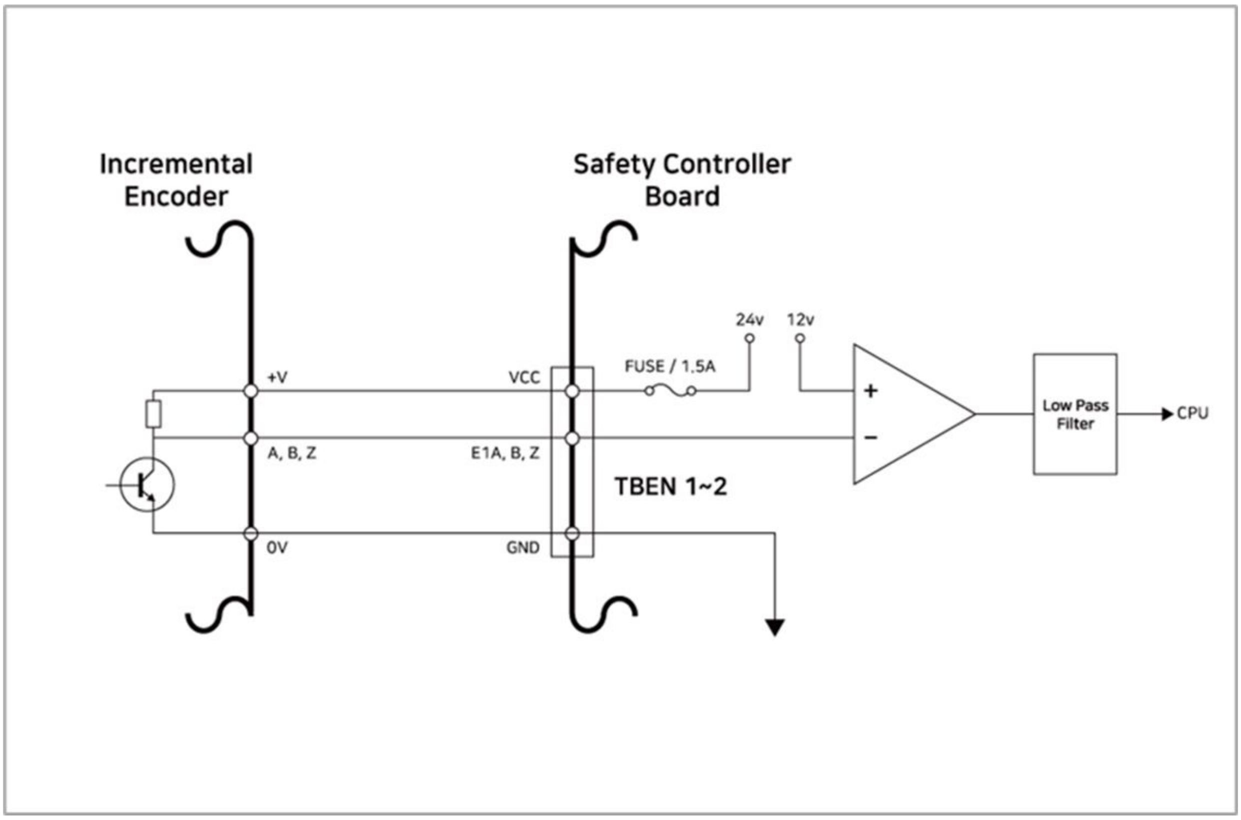
Setting Encoder Input Terminal (TBEN1, TBEN2)

The controller provides two TBEN terminals that allow the input of external encoders. They support A, B and Z phases as inputs, and perform counts based on 12Vdc. In addition, S phase can be used as the conveyor's Start sensor.

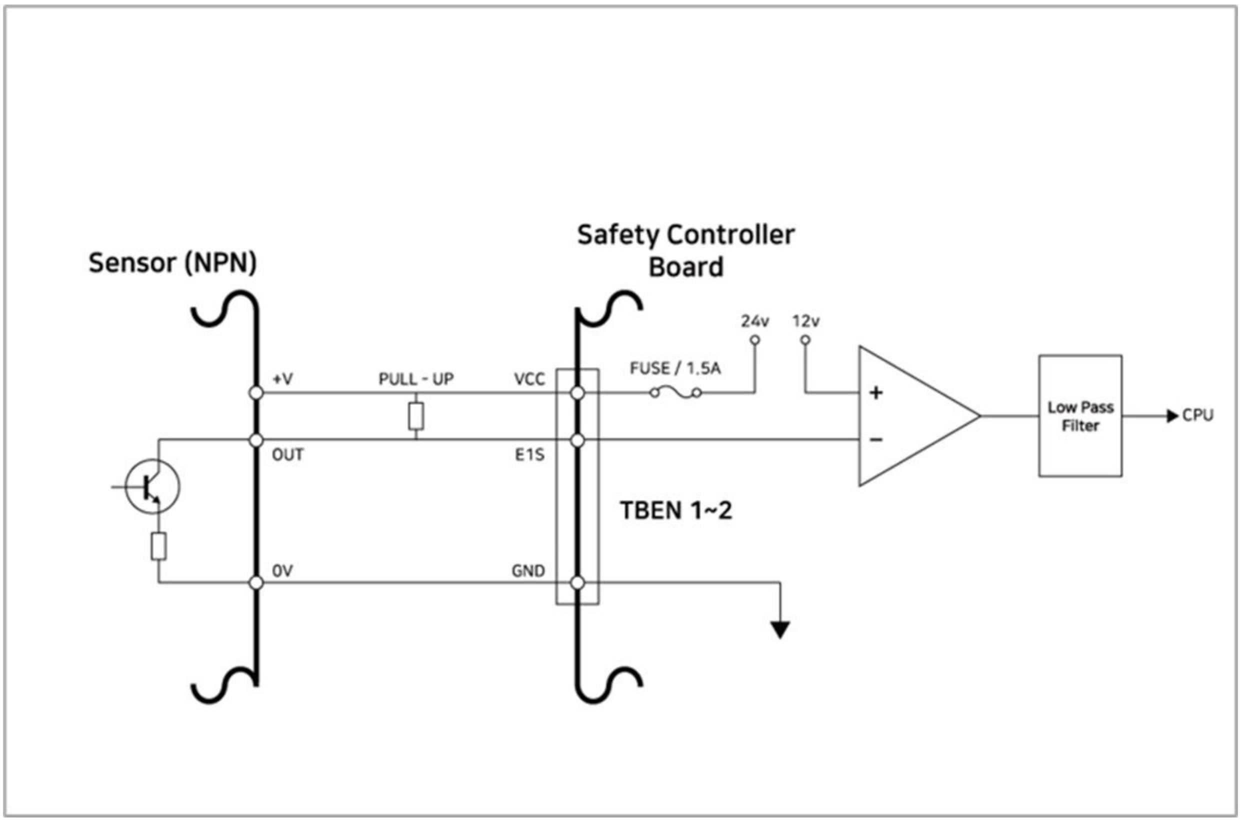
- To ensure maximum input accuracy, observe the following: Use shielded, twisted pair cables to reduce noise.
- Connect the cable shield to the ground terminal inside the controller.
- In the case of S phase inputs, connect a pull-up or pull-down resistance according to the sensor type(NPN/ PNP) to prevent floating.

The figure below shows a sample encoder and sensor configuration, so refer to it while establishing connections.

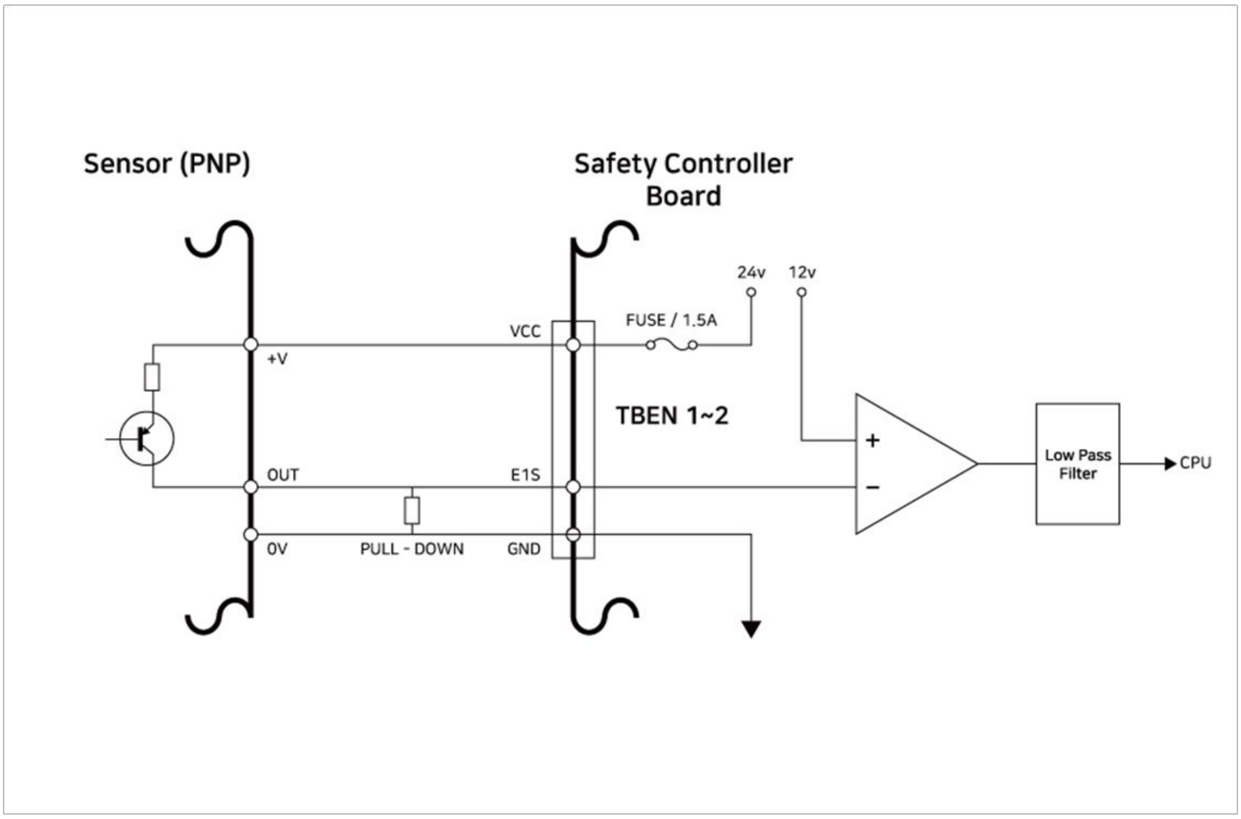
Connecting Incremental Encoder A, B, Z phase



Connecting NPN Sensor



Connecting PNP Sensor

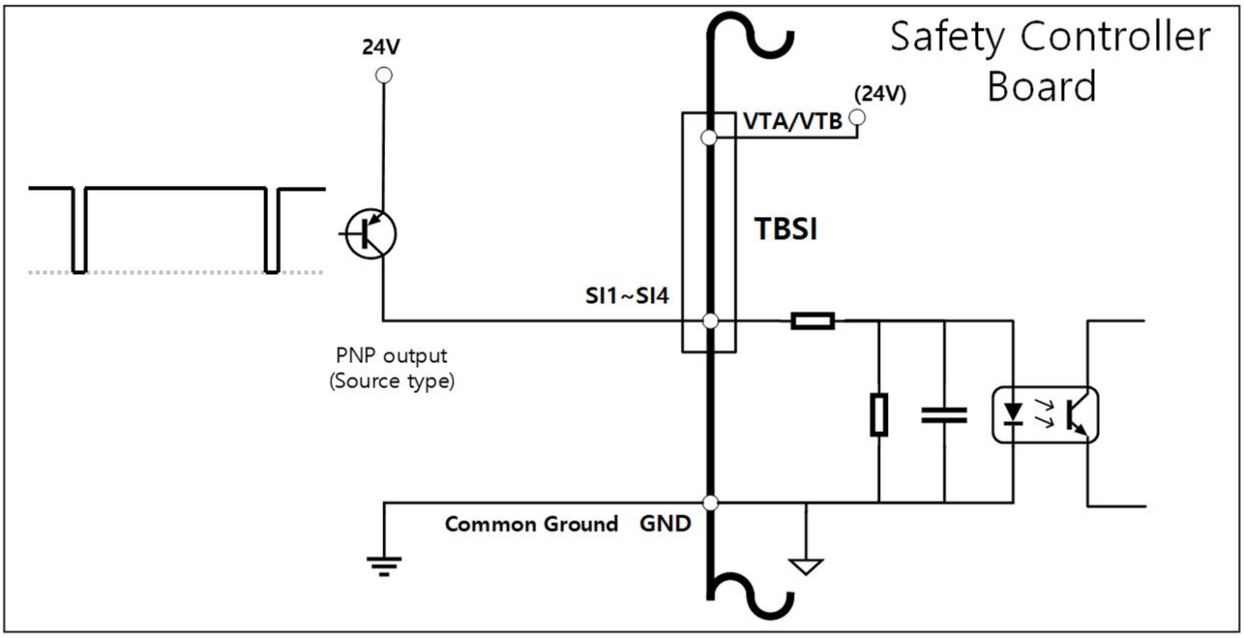


Setting the Terminal Block for Voltage Input (TBSI)

The Safety Controller provides dedicated safety inputs (SI1, SI2, SI3, SI4) to connect safety signals with test pulses.

The Protective Device has the output to send the signal to a machine such as a robot when it detects a hazadous situation.

The Protective Device may also include a test pulse in the signal to verify that the output function of this signal is working properly, in which case this dedicated safety input can be used.



> **Note**
>
> Each port of the TBSI terminal accepts a maximum of one test pulse of 1 ms every 20 ms.
> The test pulses are allowed only for the Low active signal (normally High and switches to Low when an event occurs) among the Safety Input signals.

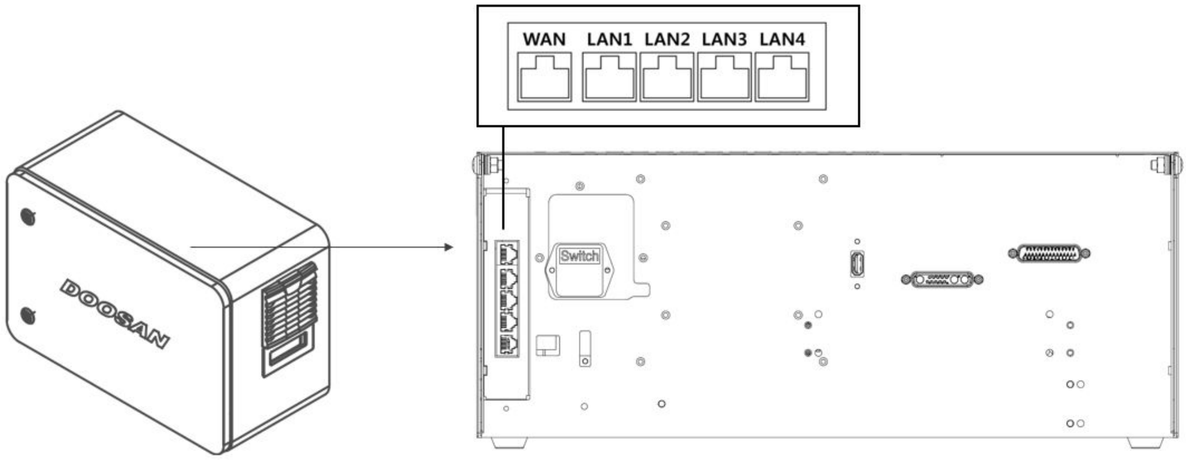
4.3.3 Network Connection

Laptops, TCP/IP devices, Modbus equipment and SVMs can be used by connecting them to the network connection terminal inside the controller.

Connect cables to dedicated ports according to the network application.

- WAN: Connecting external Internet
- LAN: Connecting peripherals using TCP/IP or Modbus protocol

Connecting the cable to the network connection terminal shown in the figure below connects the network.



Caution

In that the LAN4 port is for connecting with the internal controller, be careful not to connect it to other equipment.

Connecting External Devices - Vision Sensor

The robot can be connected with a vision sensor (2D camera for object position measurement), and vision sensor measurements can be transferred to the robot through a network to link with commands of the robot.

Vision Sensor Setting

Communication Connection Setting

Connect the LAN ports of the devices and apply TCP/IP communication to transfer vision sensor measurements to the robot. (refer to LAN port connection "**4.3 Network Connection**") Set the IP address of the vision sensor to TCP/IP 192.168.137.xxx band to allow TCP/IP communication.

Vision Work Setting

To perform object position measurement, it is necessary to have an image input and vision teaching of the target object using the vision sensor. Refer to the dedicated vision work setting program provided by the vision sensor manufacturer.

Measurement Data Format Setting

To use vision sensor measurement data in robot work, it is necessary to perform vision- robot coordinates calibration, and this must be performed before initiating work using the vision sensor setting program. The vision sensor measurement data must be transferred using the following format settings:

Format	pos	,	x	,	y	,	angle	,	var1	,	var2	,	…

- pos: Separator indicating the start of measurement data (prefix)
- x: X coordinate value of the object measured using vision sensor
- y: Y coordinate value of the object measured using vision sensor
- angle: Rotation angle value of the object measured using vision sensor
- var1…varN: Information measured using vision sensor (e.g., object dimension / defect check value)

Example) pos,254.5,-38.1,45.3,1,50.1 (description: x=254.5, y=-38.1, angle=145.3, var1=1, var2=50.1)

Robot Program Setting

When the physical communication connection between the vision sensor and robot and vision sensor setting are completed, a program must be set to allow the vision sensor and robot program to be linked. It is possible to connect/communication/control functions of the external vision sensor using Doosan Robot Language (DRL), and it is possible to set up the program in the Task Writer.

Details and comprehensive examples of Doosan Robot Language (DRL) on external vision sensor functions are provided in the Programming(p. 186)

Connecting External Device – DART Platform

The DART Platform is a software that runs on a Windows OS-based desktop or laptop. Once the controller and Desktop/Laptop are connected through the LAN Port, all functions of the teach pendant are available from the time the DART Platform is executed. At this time, the following setup procedure is required to connect with sub-controllers within the controller.

IP Address Search and Connection Setting

Communication Connection Setting

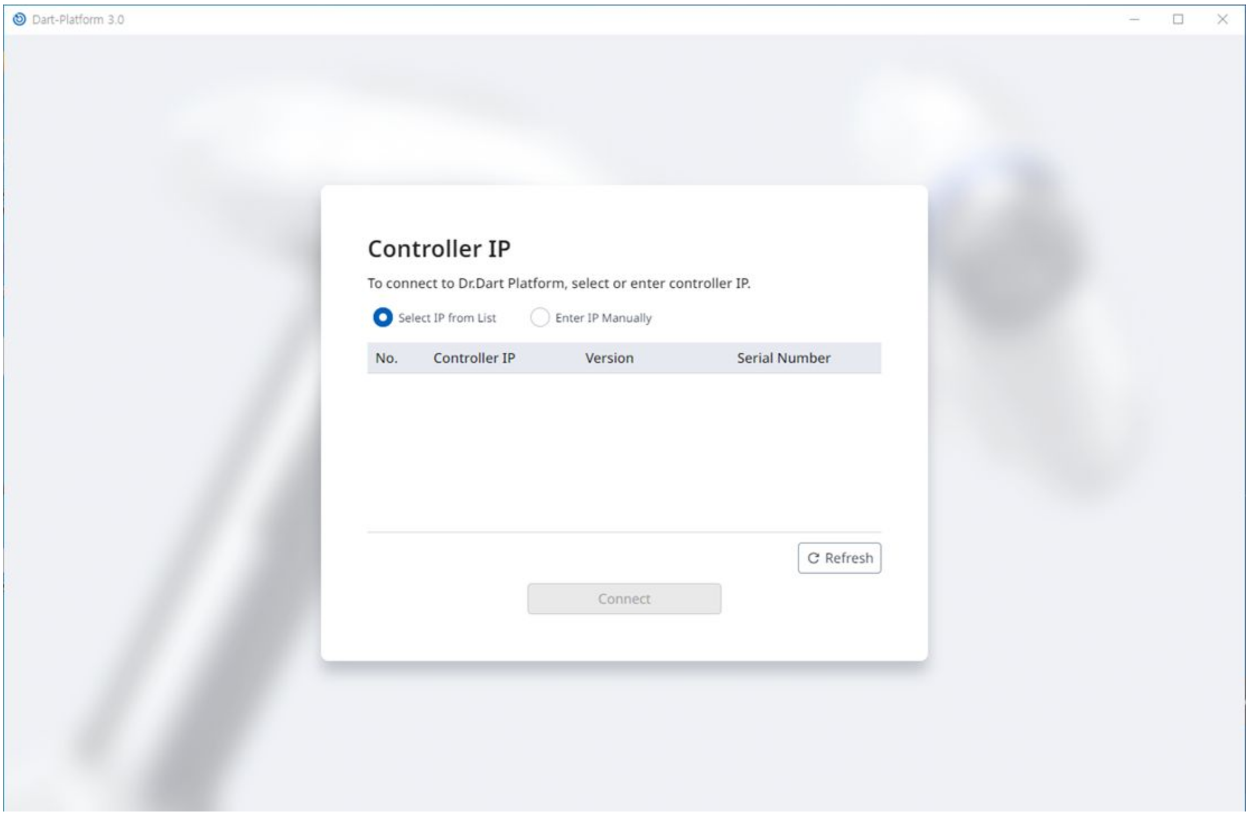
When the DART Platform is executed after connecting the laptop to the LAN port of the controller, the controller IP address, the version information of the sub-controller and the robot serial number required for establishing a connection are automatically searched.

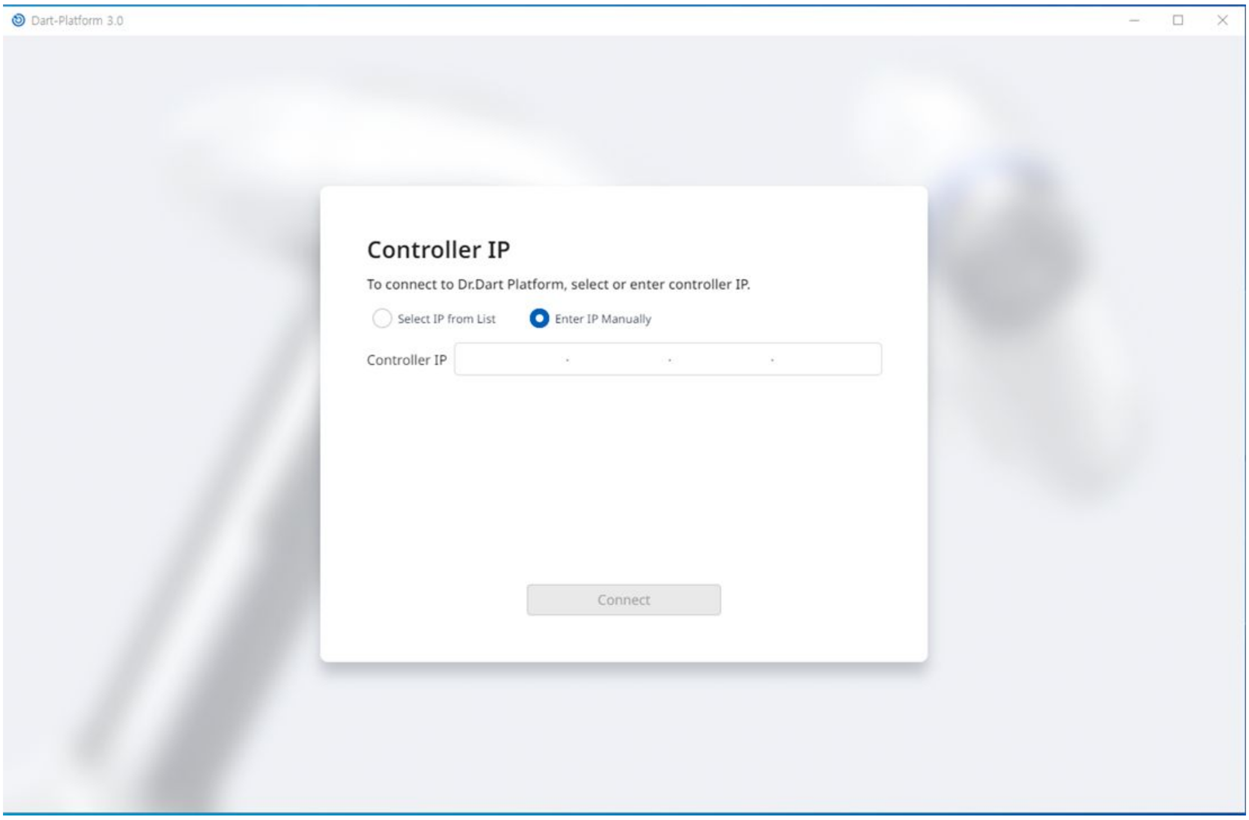
If the search fails, press the Refresh button to refresh or tap Enter IP Manually to manually enter the IP of the controller.

Selecting the serial number of the robot to be connected and pressing the Connect button establishes a connection between the DART Platform and the sub-controller and allows the robot to be operated normally.

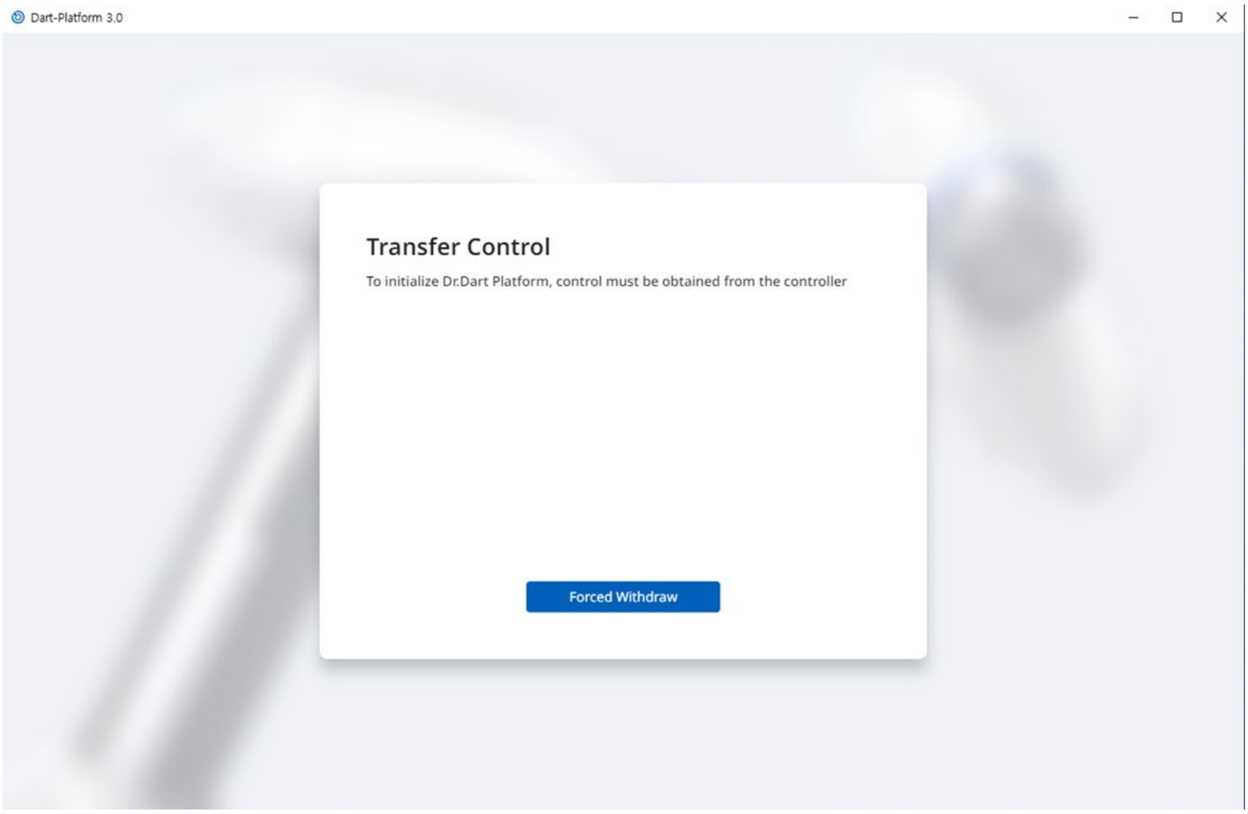
If there is an issue with the connection, try the procedure below, but if this issue is persistent, contact the sales or service staff for assistance.

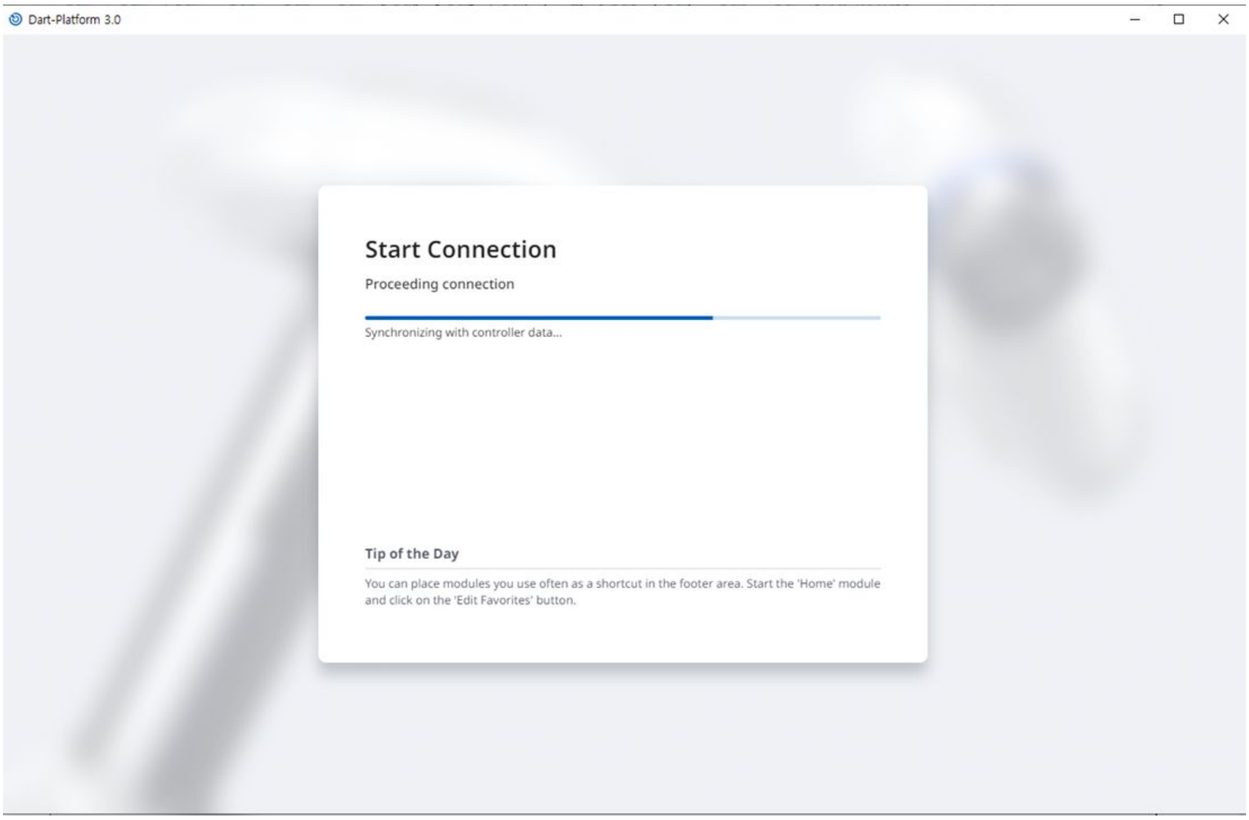
- If the search results for connectable controller IP address, sub-controller version information, and robot serial number are not displayed: Press the Refresh button to search again and try to connect again according to the procedure above.


Dart-Platform 3.0
Controller IP
To connect to Dr.Dart Platform, select or enter controller IP.
Select IP from List
Enter IP Manually
No.
Controller IP
Version
Serial Number
Refresh
Connect


Dart-Platform 3.0
Controller IP
To connect to Dr.Dart Platform, select or enter controller IP.
Select IP from List
Enter IP Manually
Controller IP
Connect

Then, if you see the Transfer Control page as shown below, tap the Forced Withdraw button to attempt to connect with the Platform.





ModbusTCP Slave Setup

The ModbusTCP Slave function of Doosan Robotics supports robot parameter monitoring, and General Purpose Register (GPR) (refer to Using General Purpose Register(GPR)(p. 191)) function. This function automatically starts when the robot controller boots up normally. Therefore, the user can use it after matching the Master IP of the robot controller with the same bandwidth.

Note

- The related I/O Table is provided as a separate file.
- Please refer to the Programming Manual for DRL to use the GPR function.
- Unsurpported Function Code
  - 0x07 Read Exception Status (Serial Line only)
  - 0x0F Write Multiple Coils
  - 0x10 Write Multiple registers
  - 0x11 Report Server ID (Serial Line only)

Expanded Protocol - PROFINET IO Device(pnio device) Setup

The robot controllers of Doosan Robotics support the PROFITNET IO Device (Slave) function, which allows data modification after reading the Parameters of the robot from an external device (PROFINET IO Controller/ Master). (i.e., robot parameter monitoring, General Purpose Register (Bit, Int, Float) – refer to Using General Purpose Register(GPR)(p. 191)). For more information about PROFINET, refer to www.profibus.com[4].

Expanded Protocol - EtherNet/IP Adapter(EIP adapter) Setup

The robot controllers of Doosan Robotics support the EtherNet/IP Adapter (Slave) function, which allows data modification after reading the Parameters of the robot from an external device (EtherNet/IP Scanner / Master). (i.e., robot parameter monitoring, General Purpose Register (Bit, Int, Float) – refer to Using General Purpose Register(GPR)(p. 191)).

For more information about EtherNet/IP, refer to www.odva.org[5].

Note) The initial Default IP is 192.168.137.50. After that, you can change the controller IP depending on the use of the PLC control application.

Using Expanded Protocol

The PROFINET IO Device (PNIO device) and EtherNet/IP Adapter (EIP adapter) functions start together at controller startup, and are in connection standby state with the Master device. Therefore, in order to use the function, it is necessary to connect and set up the Master. Each Master device has different characteristics, so it is necessary to check them.

Note

The following are descriptions of the implementation characteristics of general functions for Industrial Ethernet.

- The Industrial Ethernet function of Doosan Robotics controllers does not use a separate ASIC, but implements its function based on TCP/IP, so it does not support real-time performance.
- Data output to external devices has identical markings (PNIO, EIP), but data input to the robot only has identical structures and does not link. Therefore, data output from the PNIO controller does not synchronize with output data from the EIP scanner.
- For the I/O table of PNIO and EIP, please refer to a separate document (or attachment).

Using General Purpose Register(GPR)

The GPR function is the memory of the PNIO device and the EIP adapter predefined by the user for use. It allows exchange of user data between external devices and the robot.

4 http://www.profibus.com/
5 http://www.odva.org/

Note

The GPR function is only provided through DRL, and the DRLs used are as follows: For more information about DRL, please refer to the Programming Manual.

- set_output_register_bit(address, val)
- set_output_register_int(address, val)
- set_output_register_float(address, val)
- get_output_register_bit(address)
- get_output_register_int(address)
- get_output_register_float(address)
- get_input_register_bit(address)
- get_input_register_int(address)
- get_input_register_float(address)

4.4 Transportation

4.4.1 Caution during Transportation

Caution

- If the robot is wrapped in packaging materials and transported, store the robot in a dry location. If the robot is stored in a location with high humidity, condensation may occur inside the packaging material, resulting in robot defects.
- When relocating the robot, consider the weight of the robot's link or base and carry the robot with sufficient personnel at the same time. Especially for H-series, refer to the "Handling Guide" and make sure to carry it in accordance with the safety regulations of the country.
- The controller is moved by grasping the bottom handle.
- When transporting the robot or controller, make sure to maintain the proper posture. Failure to do so may result in back injury or other physical injuries.
- When transporting the robot using lifting equipment, make sure to observe all related national and regional regulations.
- Doosan Robotics does not assume responsibility for any damages or losses that occur during transportation, so make sure to transport the robot safely according to the user manual.

4.4.2 Package Specitications

The box specifications for transport are as follows:

Model	Length	Width	Height	Note
M0609	742 mm	500 mm	400 mm	
	755 mm	452 mm	545 mm	Since December '22
M0617	1206 mm	452 mm	545 mm	
M1013	968 mm	500 mm	435 mm	
	986 mm	452 mm	545 mm	Since October '22
M1509	742 mm	500 mm	400 mm	
	755 mm	452 mm	545 mm	Since December '22
H2017	1040 mm	1040 mm	1585 mm	
	1426 mm	736 mm	626 mm	Since July '22
H2515	1040 mm	1040 mm	1500 mm	
	1426 mm	736	626 mm	Since July '22

4.4.3 Pose for Robot Transportation

Set the following poses to transport the robot:

Model	J1	J2	J3	J4	J5	J6
M0607	0°	0°	150°	0°	25°	0°

Model	J1	J2	J3	J4	J5	J6
M0617	0°	0°	165°	0°	15°	0°
M1013	0°	0°	160°	0°	20°	0°
M1509	0°	0°	150°	0°	25°	0°
H2017	0°	0°	160°	0°	15°	0°
H2515	0°	0°	160°	0°	15°	0°

4.5 Maintenance

System maintenance must be performed by Doosan Robotics or a company designated by Doosan Robotics. Maintenance is intended to keep the system operable or to return the system to an operable state in the event of a problem, and it includes repair work as well as system diagnosis of potential issues.

When maintenance work is completed, risk assessment must be performed to confirm whether the system satisfies required safety levels. Corresponding national and regional regulations must be observed during inspection, and all possibilities related to safety must be tested.

When performing work on the manipulator or controller, the following safety procedures and warnings must be observed.

- Maintain the safety settings of the software during maintenance work.
- If a particular part is defective, replace it with a new identical part or part approved by Doosan Robotics.
- The replaced part must be returned to Doosan Robotics.
- After completing the work, resume the safety function.
- Document the repair history of the robot system and manage related technical documents.
- Disconnect the power cable and make sure other power sources connected to the manipulator or controller do not supply power.
- Do not connect the system to a power source during maintenance.
- Check the ground connection before supplying power to the system.
- When disassembling the manipulator or controller parts, observe ESD regulations.
- Do not disassemble areas that supply power within the controller. Power supply areas may still be charged with high voltage (up to 600V) even after the controller is turned off.
- Take caution to prevent water or dust from entering the system during maintenance.

4.6 Disposal and Environment

Doosan Robotics products comply with the Restriction of Hazardous Substances of Directive 2011/65/EU & Directive (EU)2015/863.

Since the products contain industrial waste materials, improper disposal can cause environmental pollution. Therefore, do not dispose of the product along with general industrial or household waste.

When disposing of all or part of the product, you must comply with the laws and regulations of the country, and contact the seller or Doosan Robotics for detailed information related to the disposal.

Sellers in Europe must register data applicable to the country of sale to EWRN (https://www.ewrn.org/national-registers) in accordance with Directive 2012/19/EU – Waste Electrical and Electronic Equipment.

4.7 Annex. System Specification

4.7.1 Manipulator

M0609

Classification	Item	Specification
Performance	Axis Structure	6
	Payload	6 kg
	Max. Radius	900 mm
	TCP Speed	1 m/s
	Repeatability	± 0.03 mm
Joint Movement	J1 Range / Speed	±360° / 150°/s
	J2 Range / Speed	±360° / 150°/s
	J3 Range / Speed	±150° / 180°/s
	J4 Range / Speed	±360°/ 225°/s
	J5 Range / Speed	±360° / 225°/s
	J6 Range / Speed	±360° / 225°/s
Operating Environment	Operating Temperature	0 - 45 °C (273K-318K)
	Storage Temperature	-5 - 50 °C (268K-323K)

Classification	Item	Specification
	Humidity	20-80%
Tool Flange & Connector	Digital I/O - X1	IN-3ch / Out-3ch
	Digital I/O – X2	IN-3ch / Out-3ch
	Power Supply	DC 24V/ Max. 3A
	Connector	1424229, female (PHOENIX)
Weight		27 kg
Mounting		Any orientation
IP Rating		IP 54
Noise		< 65 dB

M1509

Classification	Item	Specification
Performance	Axis Structure	6
	Payload	15 kg
	Max. Radius	900 mm
	TCP Speed	1 m/s
	Repeatability	± 0.03 mm
Joint Movement	J1 Range / Speed	±360° / 150°/s
	J2 Range / Speed	±360° / 150°/s
	J3 Range / Speed	±150° / 180°/s
	J4 Range / Speed	±360°/ 225°/s

Classification	Item	Specification
	J5 Range / Speed	±360° / 225°/s
	J6 Range / Speed	±360° / 225°/s
Operating Environment	Operating Temperature	0 - 45 °C (273K-318K)
	Storage Temperature	-5 - 50 °C (268K-323K)
	Humidity	20-80%
Tool Flange & Connector	Digital I/O - X1	IN-3ch / Out-3ch
	Digital I/O – X2	IN-3ch / Out-3ch
	Power Supply	DC 24V/ Max. 3A
	Connector	1424229, female (PHOENIX)
Weight		32 kg
Mounting		Any orientation
IP Rating		IP 54
Noise		< 65 dB

M1013

Classification	Item	Specification
Performance	Axis Structure	6
	Payload	10 kg
	Max. Radius	1300 mm
	TCP Speed	1 m/s
	Repeatability	± 0.05 mm

Classification	Item	Specification
Joint Movement	J1 Range / Speed	±360° / 120°/s
	J2 Range / Speed	±360° / 120°/s
	J3 Range / Speed	±160° / 180°/s
	J4 Range / Speed	±360°/ 225°/s
	J5 Range / Speed	±360° / 225°/s
	J6 Range / Speed	±360° / 225°/s
Operating Environment	Operating Temperature	0 - 45 °C (273K-318K)
	Storage Temperature	-5 - 50 °C (268K-323K)
	Humidity	20-80%
Tool Flange & Connector	Digital I/O - X1	IN-3ch / Out-3ch
	Digital I/O – X2	IN-3ch / Out-3ch
	Power Supply	DC 24V/ Max. 3A
	Connector	1424229, female (PHOENIX)
Weight		33 kg
Mounting		Any Orientation
IP Rating		IP 54
Noise		< 65 dB

M0617

Classification	Item	Specification
Performance	Axis Structure	6

Classification	Item	Specification
	Payload	6 kg
	Max. Radius	1700 mm
	TCP Speed	1 m/s
	Repeatability	± 0.1 mm
Joint Movement	J1 Range / Speed	±360° / 100°/s
	J2 Range / Speed	±360° / 100°/s
	J3 Range / Speed	±165° / 150°/s
	J4 Range / Speed	±360°/ 225°/s
	J5 Range / Speed	±360° / 225°/s
	J6 Range / Speed	±360° / 225°/s
Operating Environment	Operating Temperature	0 - 45 °C (273K-318K)
	Storage Temperature	-5 - 50 °C (268K-323K)
	Humidity	20-80%
Tool Flange & Connector	Digital I/O - X1	IN-3ch / Out-3ch
	Digital I/O – X2	IN-3ch / Out-3ch
	Power Supply	DC 24V/ Max. 3A
	Connector	1424229, female (PHOENIX)
Weight		34 kg
Mounting		Any Orientation
IP Rating		IP 54

Classification	Item	Specification
Noise		< 65 dB

H2017

Classification	Item	Specification
Performance	Axis Structure	6
	Payload	20 kg
	Max. Radius	1700 mm
	TCP Speed	1m/s
	Repeatability	± 0.1mm
Joint Movement	J1 Range / Speed	±360° / 100°/s
	J2 Range / Speed	±125° / 80°/s
	J3 Range / Speed	±160° / 100°/s
	J4 Range / Speed	±360°/ 180°/s
	J5 Range / Speed	±360° / 180°/s
	J6 Range / Speed	±360° / 180°/s
Operating Environment	Operating Temperature	0 °C to 45 °C (273 K to 318 K)
	Storage Temperature	-5 °C to 50 °C (268 K to 323 K)
	Humidity	20 % to 80 %
Tool Flange & Connector	Digital I/O - X1	IN-3ch / Out-3ch
	Digital I/O – X2	IN-3ch / Out-3ch
	Power Supply	DC 24V/ Max. 3A

Classification	Item	Specification
	Connector	1424229, female (PHOENIX)
Weight		79 kg
Mounting		Only Floor
IP Rating		IP 54
Noise		< 65 dB

H2515

Classification	Item	Specification
Performance	Axis Structure	6
	Payload	25 kg
	Max. Radius	1500 mm
	TCP Speed	1m/s
	Repeatability	± 0.1mm
Joint Movement	J1 Range / Speed	±360° / 100°/s
	J2 Range / Speed	±125° / 80°/s
	J3 Range / Speed	±160° / 100°/s
	J4 Range / Speed	±360°/ 180°/s
	J5 Range / Speed	±360° / 180°/s
	J6 Range / Speed	±360° / 180°/s
Operating Environment	Operating Temperature	0 °C to 45 °C (273 K to 318 K)
	Storage Temperature	-5 °C to 50 °C (268 K to 323 K)

Classification	Item	Specification
	Humidity	20 % to 80 %
Tool Flange & Connector	Digital I/O - X1	IN-3ch / Out-3ch
	Digital I/O – X2	IN-3ch / Out-3ch
	Power Supply	DC 24V/ Max. 3A
	Connector	1424229, female (PHOENIX)
Weight		77 kg
Mounting		Only Floor
IP Rating		IP 54
Noise		< 65 dB

4.7.2 Controller

CS-11P (AC Controller)

Item	Specifications
Weight	21.7 kg
Dimensions	606 X 306.9 X 446 mm
Material	Zinc Plated Steel
Protection Rating	IP54
Interfaces	RS232/RS422/RS485, TCP/IP (*RS232/RS422/RS485: USB to Serial converter not included)
Industrial Network	ModbusTCP (Master/Slave), ModbusRTU (Master), PROFINET IO (Device), EtherNet/IP (Adapter) (*In case of using a gateway, other communication types can be supported)

Item	Specifications
NC Interface	FANUC - FOCAS
I/O Port – Digital I/O	16/16
I/O Port – Analog I/O	2/2
I/O Port – OSSD I/O	2/2
I/O power supply	DC 24V
Rated supply voltage	100-240 VAC 47-63 Hz
Cable Length	6 m (Option: 3 m)

CS-12P (DC Controller)

Item	Specifications
Weight	21.5 kg
Dimensions	606 X 306.9 X 446 mm
Material	Zinc Plated Steel
Protection Rating	IP54
Interfaces	RS232/RS422/RS485, TCP/IP (*RS232/RS422/RS485: USB to Serial converter not included)
Industrial Network	ModbusTCP (Master/Slave), ModbusRTU (Master), PROFINET IO (Device), EtherNet/IP (Adapter) (*In case of using a gateway, other communication types can be supported)
NC Interface	FANUC - FOCAS
I/O Port – Digital I/O	16/16

Item	Specifications
I/O Port – Analog I/O	2/2
I/O Port – OSSD I/O	2/2
I/O power supply	DC 24V
Rated supply voltage	22 – 60 VDC
Cable Length	3 m (Option: 6 m)

4.7.3 Teach pendant

TP-02

Item	Specification
Weight	0.8 kg
Dimensions	264 x 218 x 69 mm
Protection Rating	IP40
Screen Size	10.1 inch
Cable Length	CS-11/CS-11P : 4.5 m (Option : 2.5 m) CS-12/CS-12P : 2.5 m (Option : 4.5 m)

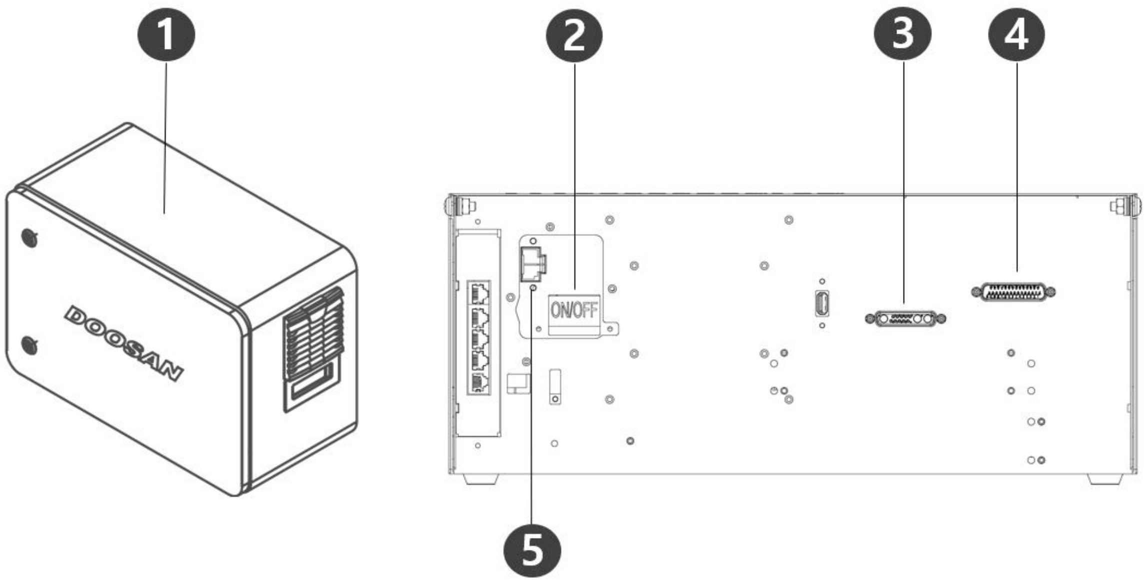
4.8 Annex. DC Controller

4.8.1 DC Controller (CS-12P)

Product Introduction (CS-12P)

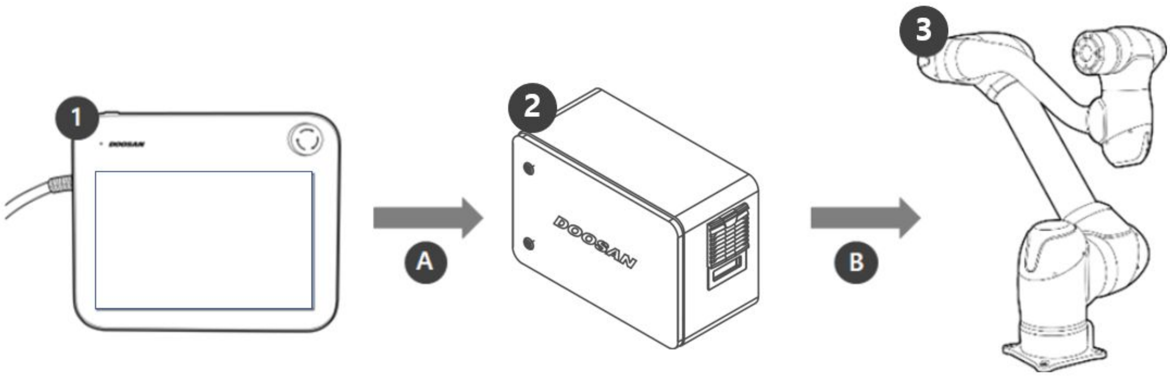
Names and Functions

DC Controller (CS-12P)



No.	Item	Description
1	I/O connection terminal (internal)	Used to connect the controller or peripherals.
2	Power switch	Used to turn ON/OFF the main power of the controller .
3	Teach pendant cable connection terminal	Used to connect the teach pendant cable to the controller .
4	robot cable connection terminal	Used to connect the robot cable to the controller .
5	Power connection terminal	Used to connect the controller power supply.

System Configuration



1	**Teach pendant**	It is a device that manages the overall system, and it is capable of teaching the robot specific poses and setting manipulator and controller related settings.
2	**Controller**	It controls the robot's movement according to the pose or movement set by the teach pendant. It features various I/O ports that allow the connection and use of various equipment and devices.
3	**Manipulator**	It is an industrial collaborative robot that can perform transport or assembly tasks with various tools.
A	Command/ Monitoring	
B	Power Supply/ Network	

Nameplate and Label

Installation (CS-12P)

Cautions during Installation

Caution

- Secure sufficient space before installing the controller. If not enough space is secured, the controller may be damaged or the manipulator or teach pendant cable may have a shortage.
- Check the input power supply when connecting power to the product. If the connected input power supply is different from the rated power input (22-60VDC), the product many not operate properly or the controller may be damaged.

Installation Environment

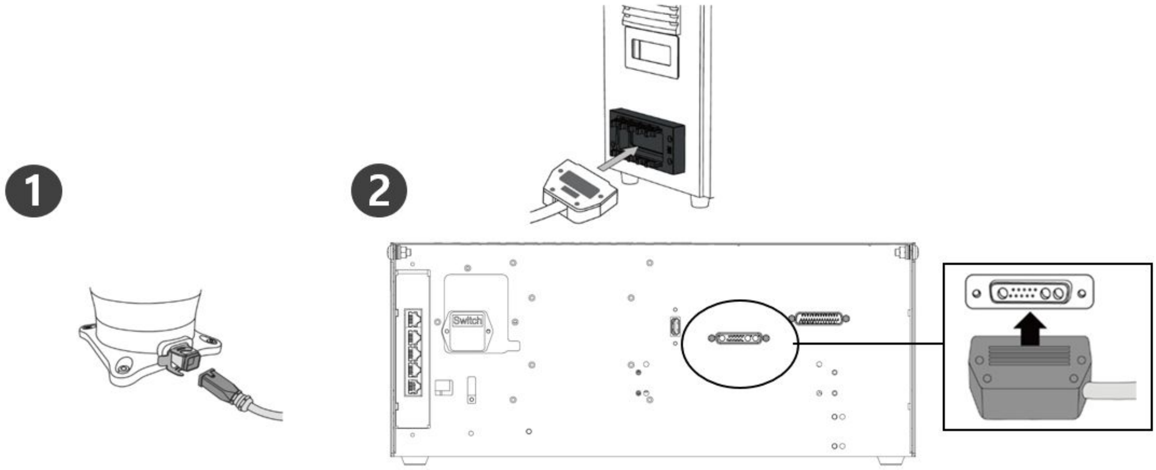
When installing the controller, consider the following.

- Secure sufficient space before installing the controller.
- The controller must be fixed.
- Make sure no component is not fixed in the mobile vehicle.

Hardware Installation

Install the robot, controller and teach pendant, the key components of the system, and supply power to them before operating the manipulator. Installation of each component is as follows:

Connecting the Manipulator and Controller



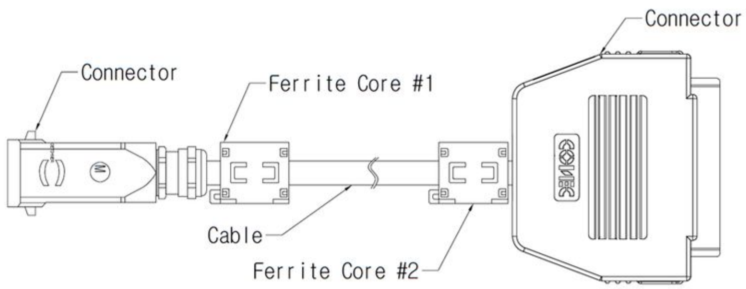
1	**Connect the manipulator cable to the controller, place a securing ring** • Connect the manipulator cable to the corresponding controller connector and place a securing ring on it to prevent the cable from becoming loose.
2	**Connect the manipulator cable's opposite end to the controller connector** • Push the manipulator cable's opposite end into the corresponding controller connector until a click is heard to prevent the cable from becoming loose.

Caution

- Do not disconnect the robot cable while the robot is turned on. This can cause damage to the robot.
- Do not modify or extend the robot cable.
- When installing the controller in the mobile vehicle, secure at least 50 mm of space on each side of the controller to enable ventilation.
- Make sure that connectors are properly connected before turning on the controller.

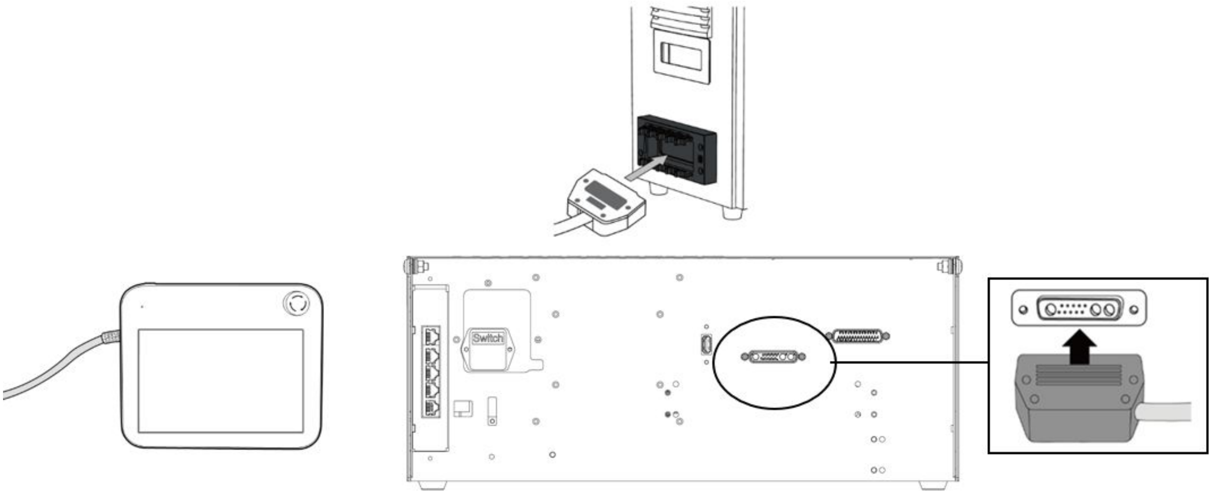
Note

- When configuring the system, it is recommended that a noise reducer be installed to prevent noise effects and malfunction of the system.
- If the controller is influenced by noise generated by electromagnetic waves, it is necessary to install a ferrite core to ensure normal operation. The installation location is as follows:



Connecting the Controller and Teach Pendant

Push the teach pendant cable into the corresponding controller connector until a click is heard to prevent the cable from becoming loose.



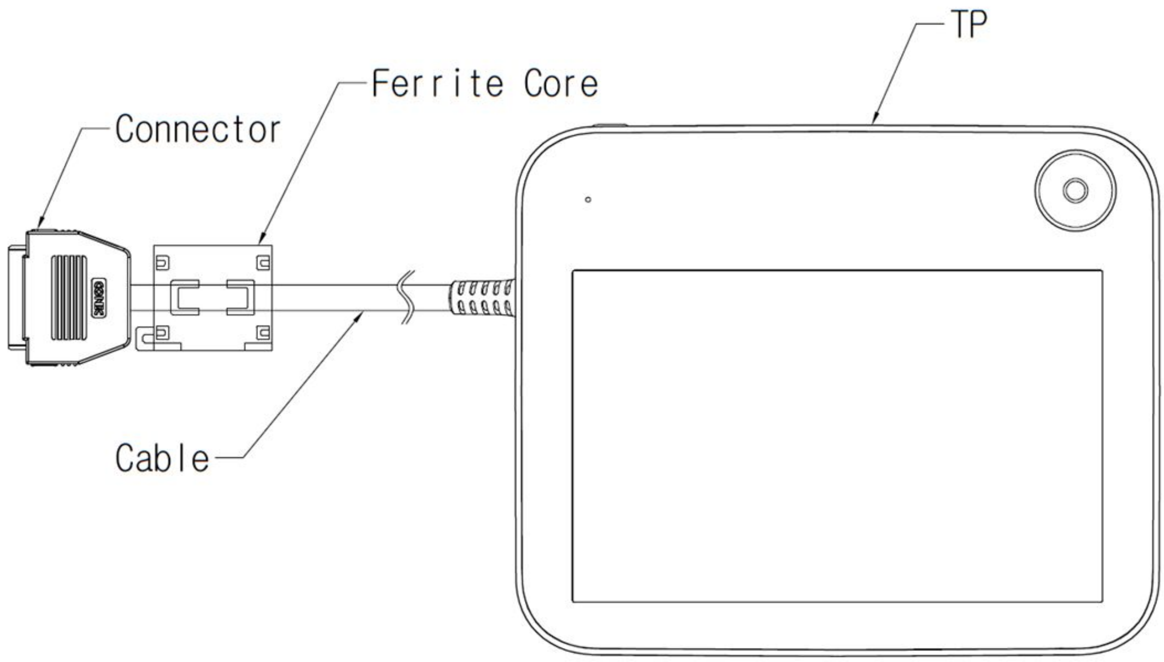
Caution

- Make sure that the pins of the cable end are not damaged or bent before connecting the cable.
- If the teach pendant is used by hanging on the mobile vehicle or on the controller, be careful not to trip on the connecting cables.
- Be careful not to allow the controller, teach pendant and cable come in contact with water.
- Do not install the controller and teach pendant in a dusty or wet environment.
- The controller and teach pendant must not be exposed to a dusty environment. Be especially careful in environments with conductive dust.

Note

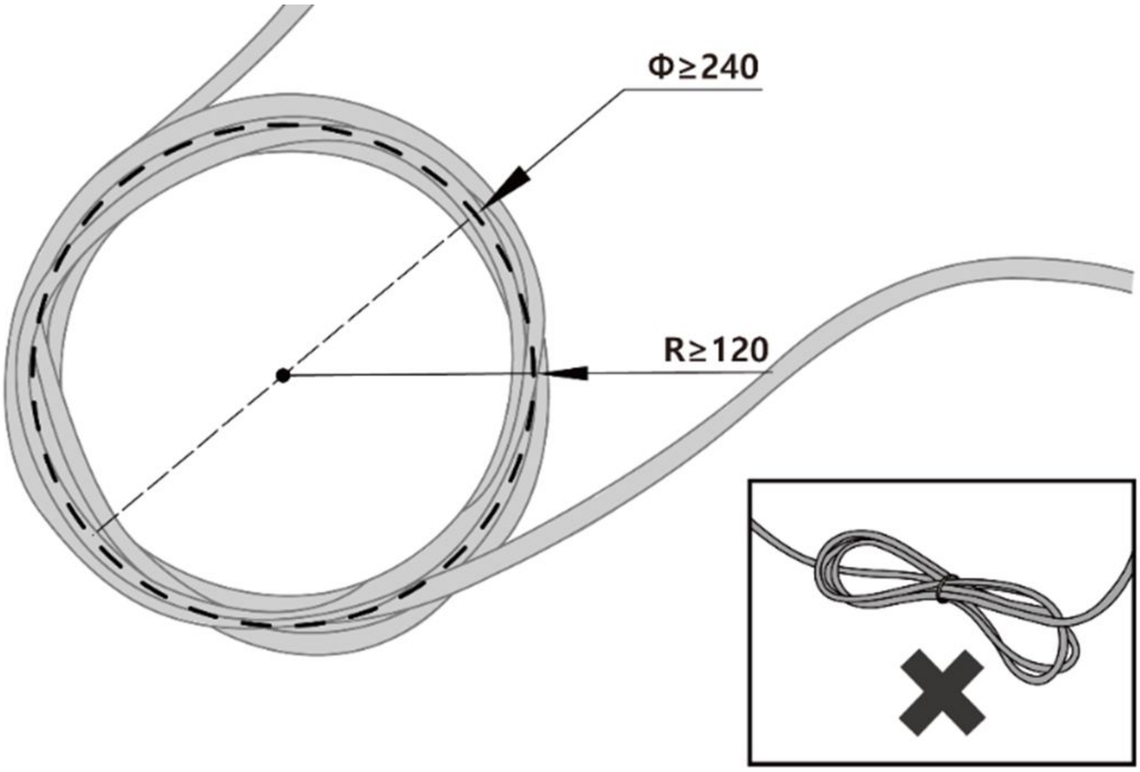
- When configuring the system, it is recommended that a noise reducer be installed to prevent noise effects and malfunction of the system.

- If the teach pendant is influenced by noise generated by electromagnetic waves, it is necessary to install a ferrite core to ensure normal operation. The installation location is as follows:



Routing of Manipulator Cable and Teach Pendant Cable

Ensure that the manipulator and teach pendant cable curvature radius is greater than the minimum curvature radius (120 mm).

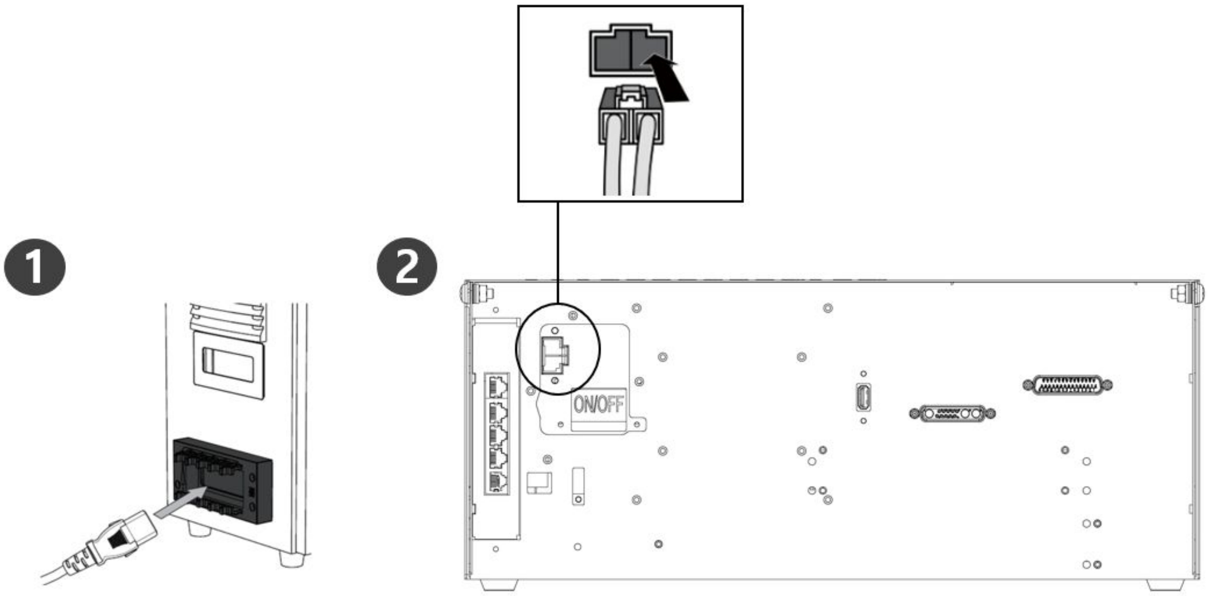


Caution

- Ensure that the curvature radius between the teach pendant cable and teach pendant connector is greater than the minimum curvature radius (120 mm).
- If the curvature radius is smaller than the minimum curvature radius (120 mm), cable disconnection or product damage may occur.
- In environments where electromagnetic noise can occur, proper cable installation must be taken to prevent malfunctions.

Supplying Power to the Controller

Push the power cable into the corresponding controller connector until a click is heard to prevent the cable from becoming loose.



Warning

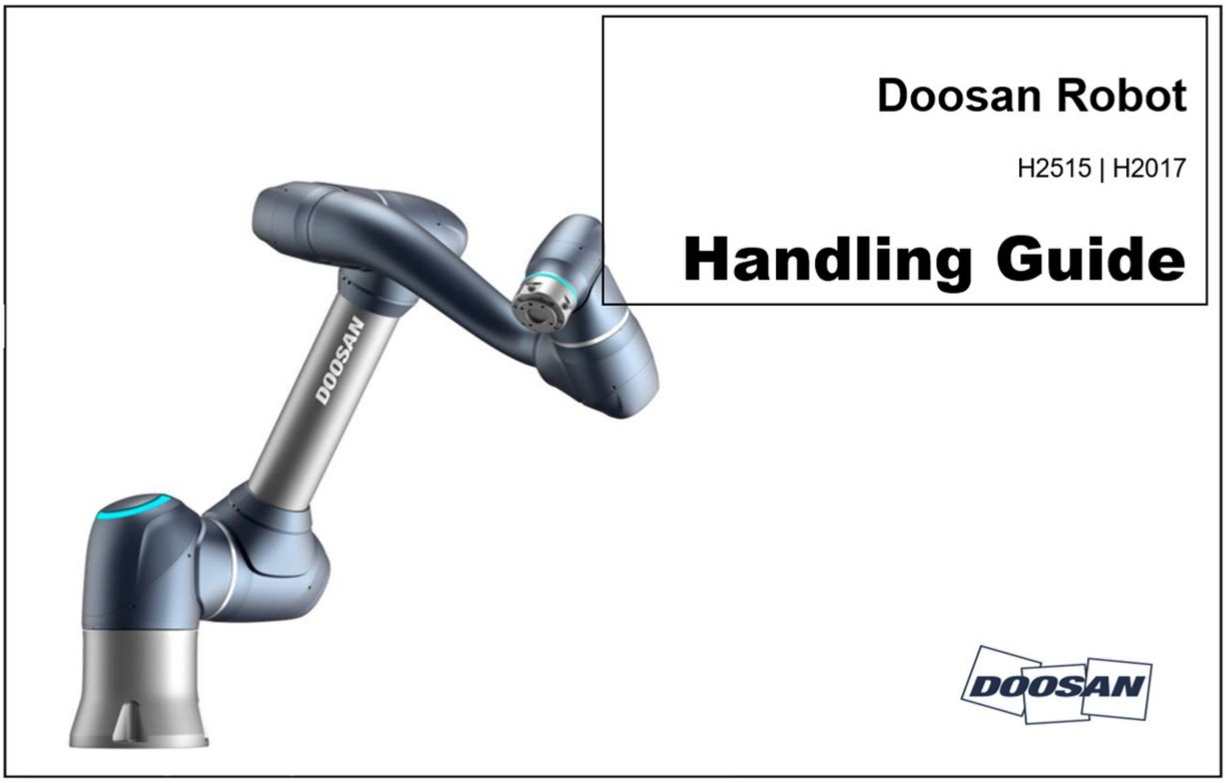
- After connecting the power cable, make sure that the robot has established a proper ground (electronic ground connection). Establish a common ground for all equipment in the system with an unused bolt related to the ground symbol inside the controller. The ground conductor must satisfy the maximum current rating of the system.
- Protect the input power of the controller using devices such as a circuit breaker.
- Do not modify or extend the robot cable. It can cause fire or controller breakdown.
- Make sure that all cables are properly connected before supplying power to the controller. Always use the original cable included in the product package.
- Be careful not to connect the polarity of the input voltage incorrectly.

Note

- When configuring the system, it is recommended to install a power switch that can turn off power to all devices in the system at once.
- If a controller for the AGV is used, the robot’s movement may be limited according to the load and motion.
- If the input voltage is less than 48V, the robot’s movement may be limited according to the load and motion.
- The power supply must satisfy minimum requirements such as ground and circuit breakers. The electrical specifications are as follows:

Parameter	Specification
Input Voltage	22 – 60 VDC
Rated Input Current	30 A

4.9 Annex. H-Series Handling Guide



> ⚠ **Caution**
>
> 1. Doosan Robotics does not assume responsibility for any damages that occurs during the use of lifting equipment.
> 2. If the robot is transported by packaging it with packaging materials, store the robot in a dry location. If the robot is stored in a location with high humidity, condensation may occur, resulting in robot
> 3. When relocating the robot, carefully consider the weight and have a suitable number of people hold the link and base of the robot.
> 4. When relocating the controller, hold the handle on the side of the box.
> 5. When transporting the robot or controller, make sure to maintain the proper posture. Failure to do so may result in back injury or other physical injuries.

6. When transporting the robot using lifting equipment, make sure to observe all related national and regional regulations.
7. Doosan Robotics does not assume responsibility for any damages or losses that occur during transportation, so make sure to transport the robot safely according to the user manual.

4.9.1 Quick Guide

Thank you for choosing this Doosan Robotics product.

This guide provides the minimum amount of information required for three handling methods for relocation and installation of the H-Series robot safely. Make sure to follow the instructions in this guide when handling the robot.

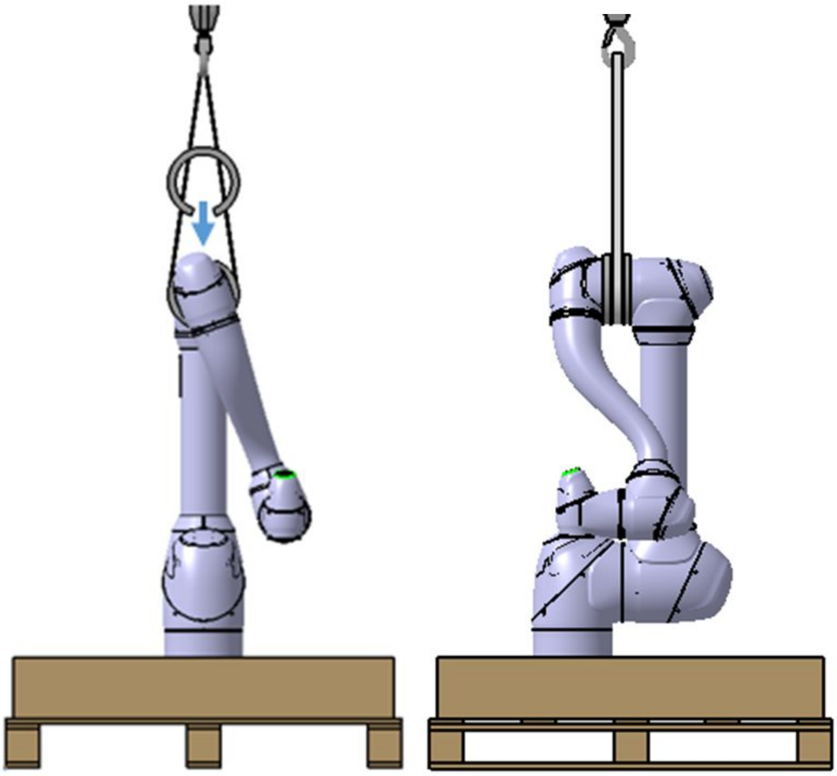
- If the robot needs to be relocated, be sure to use the packaging materials provided with the initial delivery. For this purpose, store the packaging materials and fillings in a dry, cool location.
- Industrial robot's must be installed with careful consideration given to the inspection standards defined by the Regulations and Safety Inspection of the Occupational Safety and Health Standard Announcement (if the robot is subject to inspection).
- The robot can be transported using a crane, lift or hand lift, and when using a crane to lift the robot, be sure to comply with regulations of the area or country of jurisdiction.
- Utilize the packing posture for robot installation and relocation.
- Make sure whether all standard and additional (optional) components are included, and contact the sales agent if there are any problems.
- The packaging materials and bolts are designed specifically for the relocation of the robot. Do not use them for any purposes other than relocating the robot.
- When relocating the robot, do not apply force to the exterior of the robot. Failure to comply with these instructions may result in injuries.
- Remove the packaging materials and bolts after installation. Make sure to store the packaging materials and bolts in case the robot needs to be relocated.
- Before relocation, make sure that the bolts and packaging materials are secure.

1. **When a crane (hoist) is used**
    - Use a spin-resistant cable capable of handling the weight of the robot.
    - The wire rope must be at least 1500 mm long.

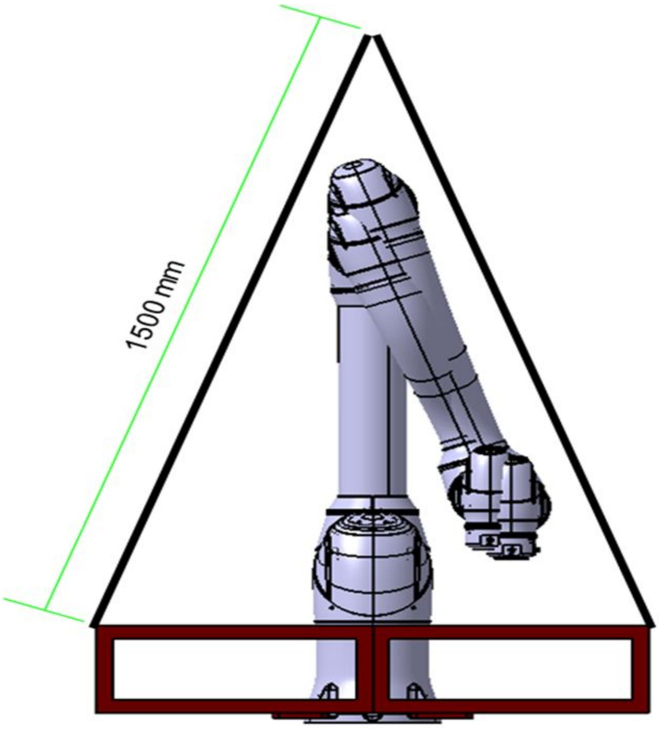
Item	Minimum Capacity
Crane	**1,000 kg**
Wire Rope (EA)	**1,000 kg**

1.1 Once the rope is secured to the robot frame,

- attach the rubber jig provided between axes 3 and 4 before the operation. (Refer to Figure below)

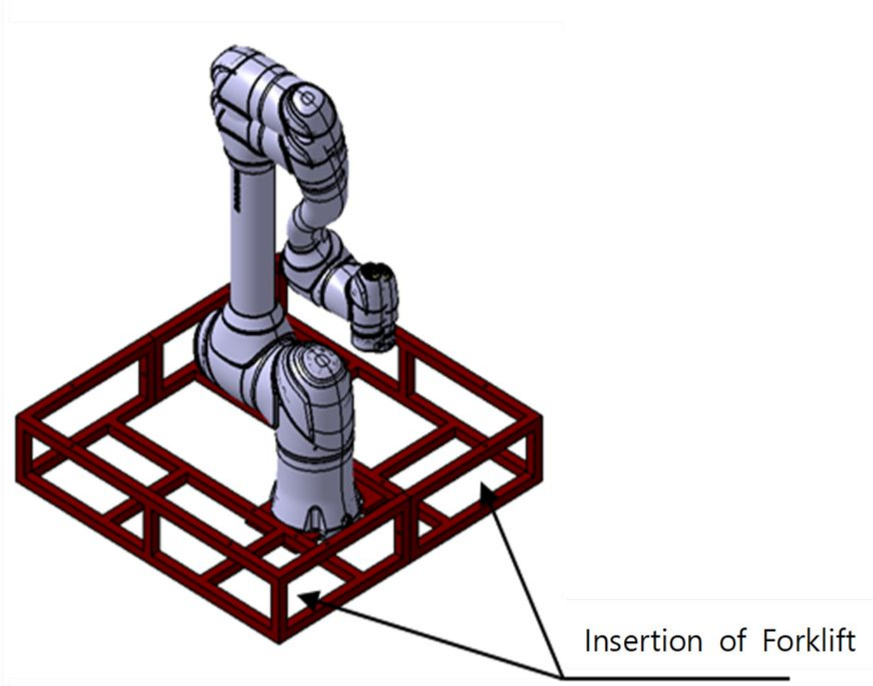


1.2 If the rope is secured on the bottom packaging material



> **Warning**
>
> - When the robot is lifted, it may tilt depending on its pose and optional attachments
> - During lifting, do not pass under the robot.

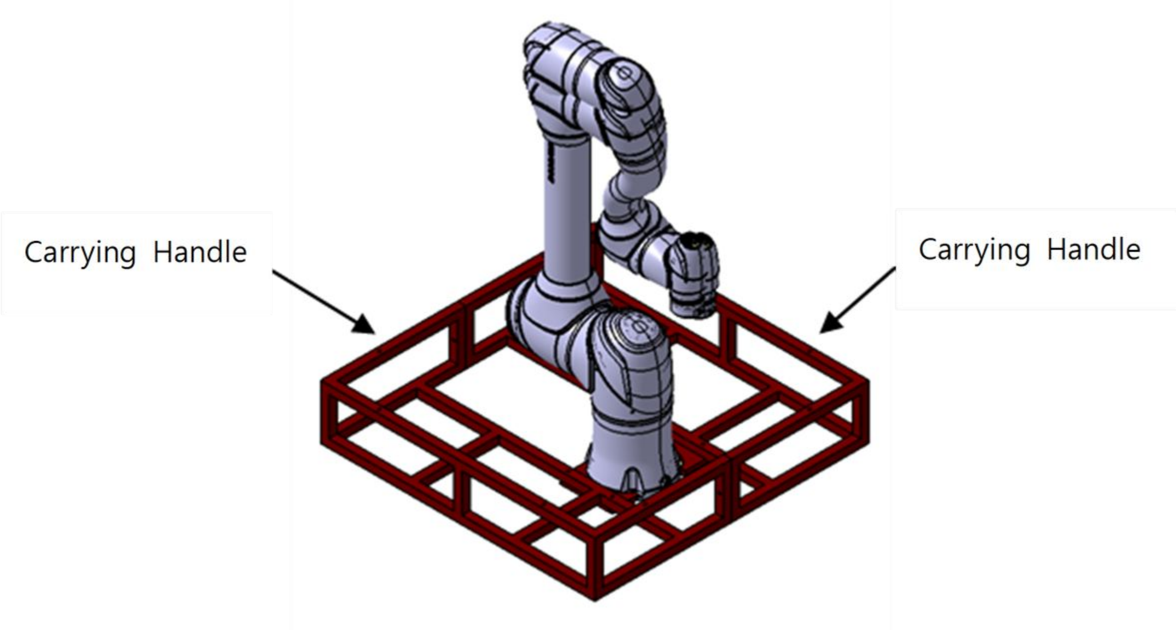
2. **When Using Forklifts**
   - If the robot needs to be relocated in its packaged state, lift it from the bottom of the package using a forklift.
   - During installation, relocate the robot using the lower packaging materials while taking caution to avoid damage to the robot.



3. When Lifting Equipment is Unavailable

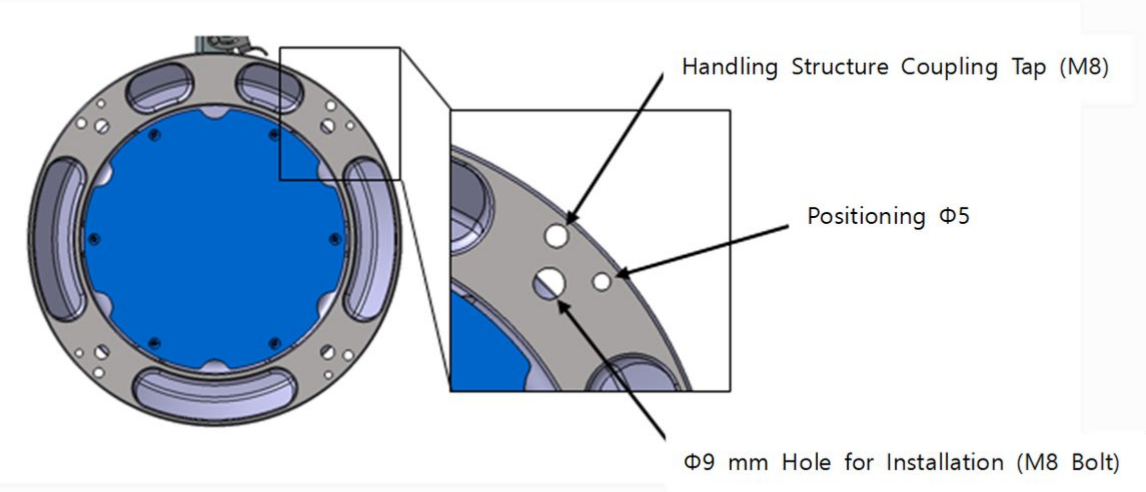
- If you need to relocate the robot due to the unavailability of lifting equipment, relocate the robot complying with the regional and national transport work standards.

- It is recommended to use the lower packaging materials as handles as below.



Note

- For H-Series, four M8 Taps are applied to the base to facilitate handling.



4.10 Annex. Doosan Robot Allowable Torque

4.10.1 Doosan Robot Allowable Torque

Caution

- The values below are the maximum allowable torque values for each joint and should not be used in excess of that value.
- It is recommended to operate within a range smaller than the values below when operating a robot.
- When a collision exceeding the allowable torque is detected while using the E-Series, slight misalignment may occur. If misalignment occurs, please perform Mastering based on the Home imprint for each axis.

Allowable Max. Torque[Nm]

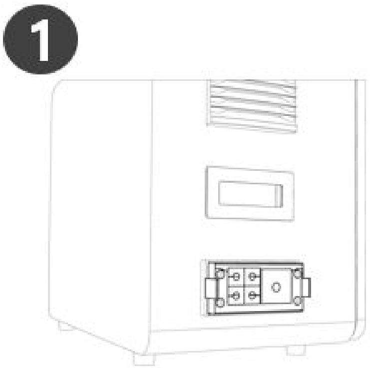
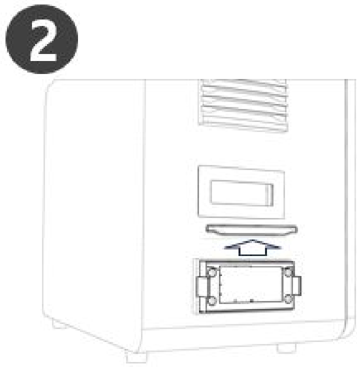
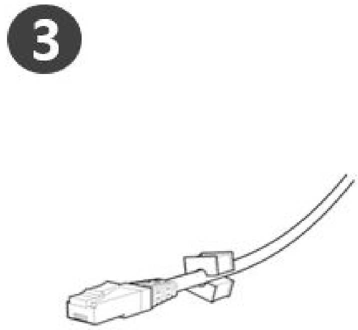
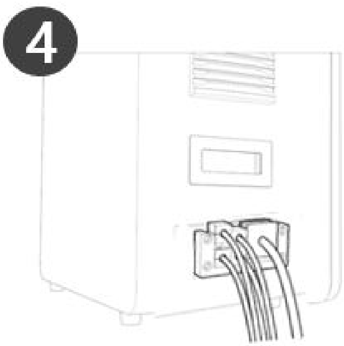
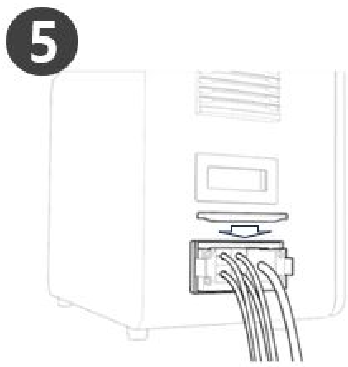
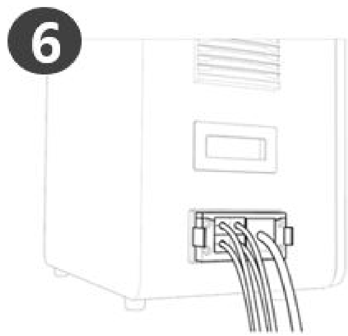
M-Series

Axis	1	2	3	4	5	6
M0609	160	160	90	45	45	45
M0617	340	340	160			
M1013						
M1509						

H-Series

Axis	1	2	3	4	5	6
H2017	430	430	340	160	90	45
H2515						

4.11 Annex. IP Protection Cube module Installation

		
Initial State	**Disassembling the frame cover**	**Assembling grommets on cables**
		
Assembling cables into cube module	**Assembling frame cover**	**Installation complete**

5 PART 4. Overview of User Manual

5.1 Power on/off the system

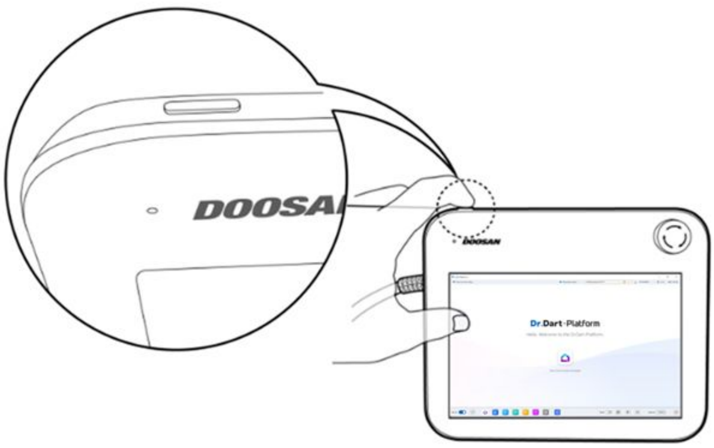
5.1.1 When using the teach pendant

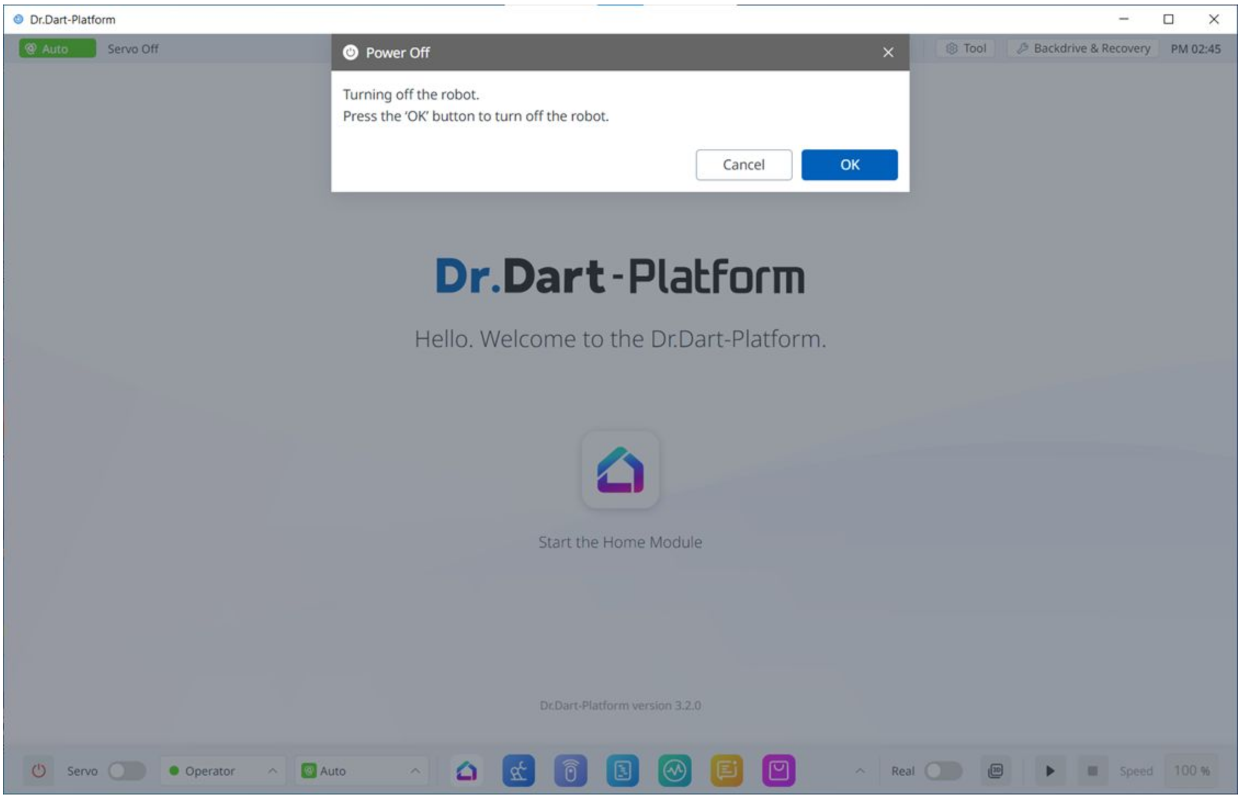
Press and hold the power button on the upper left of the teach pendant.

Note

If the system does not power up, check the power switch at the bottom of the controller. For more information, refer to Power On/Off Controller Switch(p. 157).

- The power for systems such as the robot, controller and teach pendant is turned on.
- Once the system is powered on, the LED indicator for the robot lights up.
- Press the shutdown button on the teach pendant or press and hold the power button on the upper left of the teach pendant for 2 seconds.
    a. The shutdown popup is displayed on the screen.
    b. Press the OK button on the shutdown popup to properly shutdown the system.

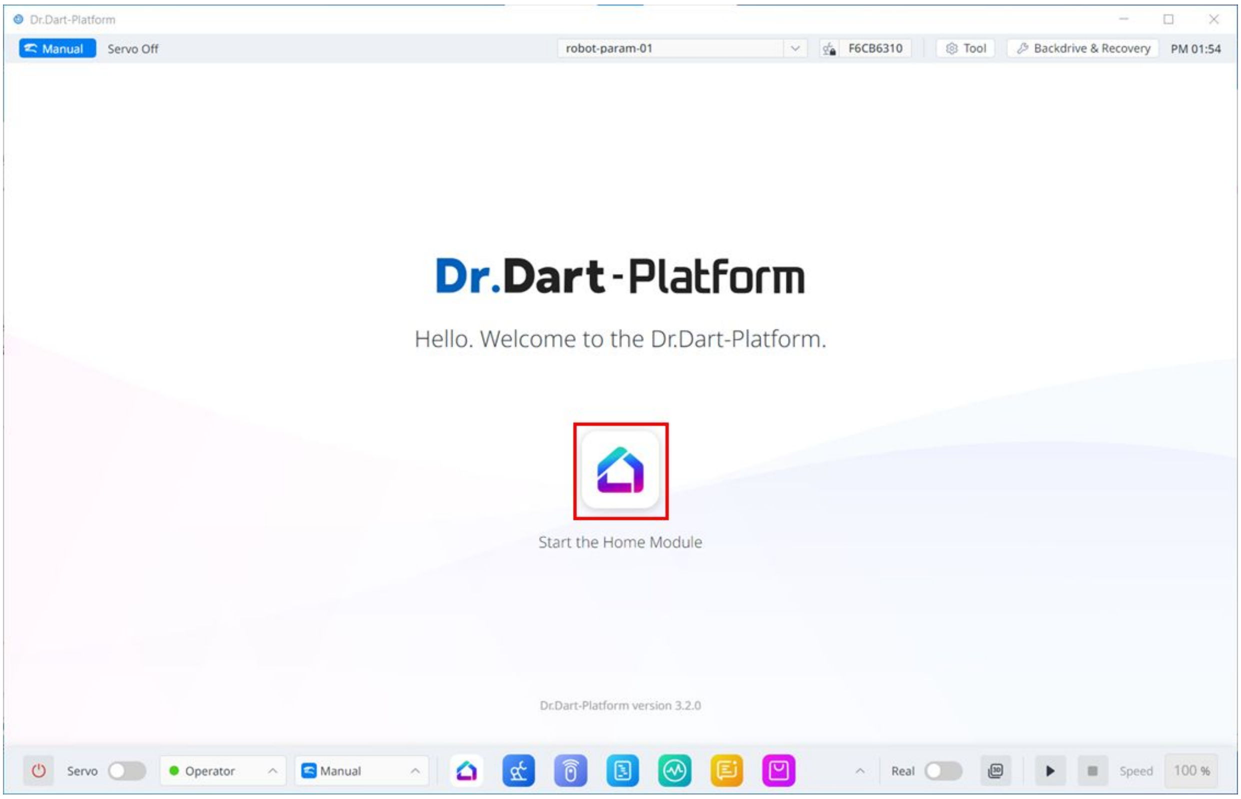




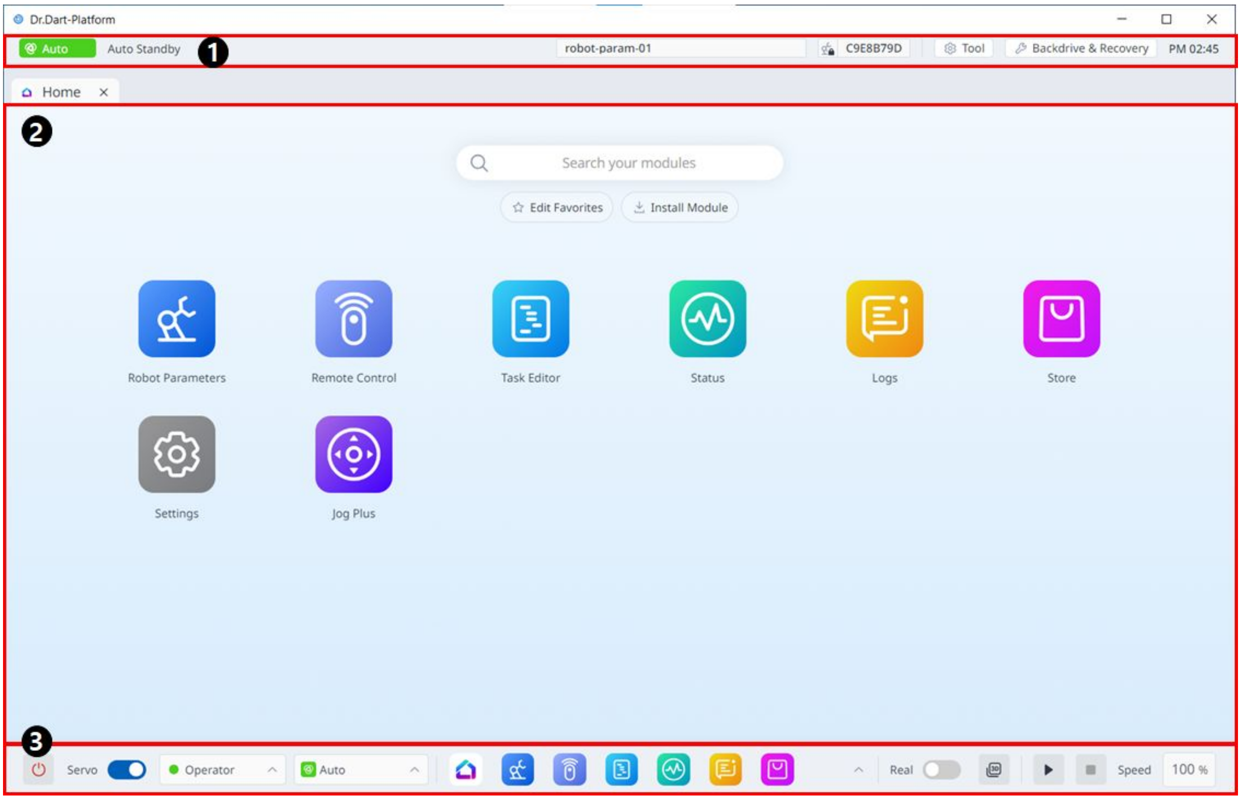
Caution

- Press and hold the power button for more than 4 seconds to force system shutdown.
- Forced shutdown may cause robot and controller failure.

5.2 Overview of Program's Screen Layout

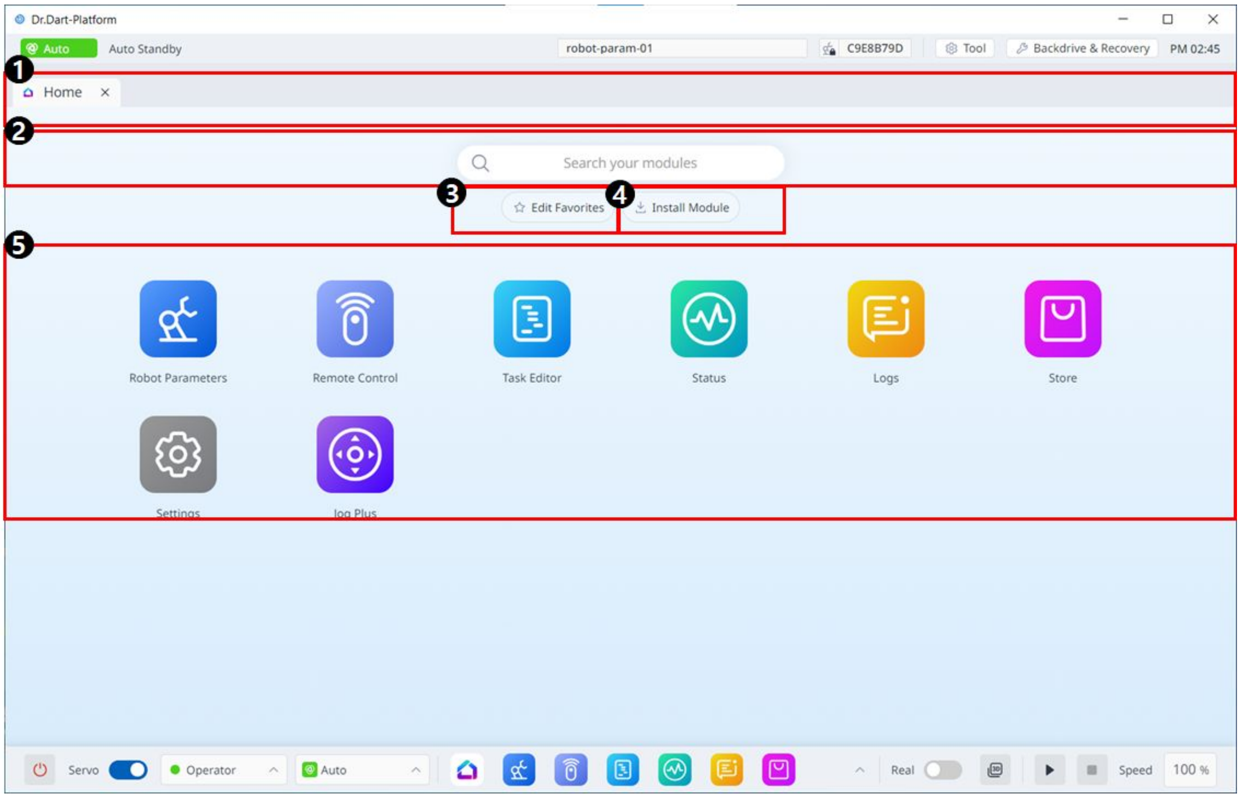


	Item	Description
1	Home module launch icon	Clicking this icon will redirect you to the Dart-Platform Home screen.



	Item	Description
1	Header	This screen shows the robot's status, the administrator's level, and the current time.
2	Body	This screen shows the modules you have and is where you can edit your favorites or search for modules.
3	Footer	This is the main menu, where you can manage servos, robots, automatic modes, etc. and view the list of modules.

5.2.1 Overview of Home Screen



Menu Layout

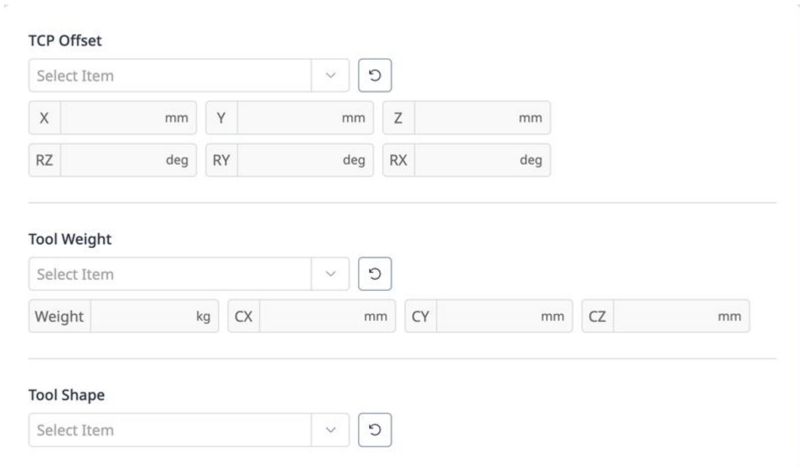
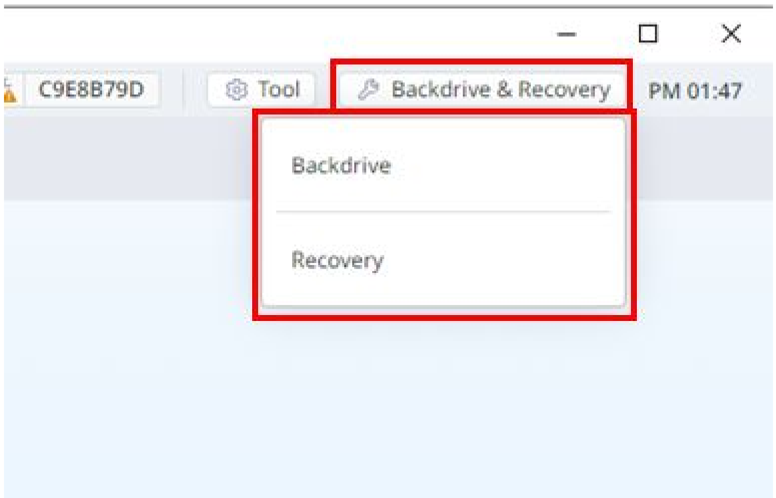
	Item	Description
1	Tab	Clicking the Run Module icon creates a tab for running modules.
2	Search	This is where you can search for installed modules.

	Item	Description
3	Selecting a favorite	In the Home module, you can select modules to set as favorites. Tap this button to select modules to set as favorites directly from the modules currently installed on the Home screen. Once you have selected a module, tap the same button changed to Save Favorites to finish the favorite setting. Deletion is performed in the same way. 
4	Install from Local	Used to load the module file to be installed on the running device.
5	Tab Panel	This is where the UI of the Screen component of the executed module is seen.

5.2.2 Getting to know the header

Setting up the menu layout

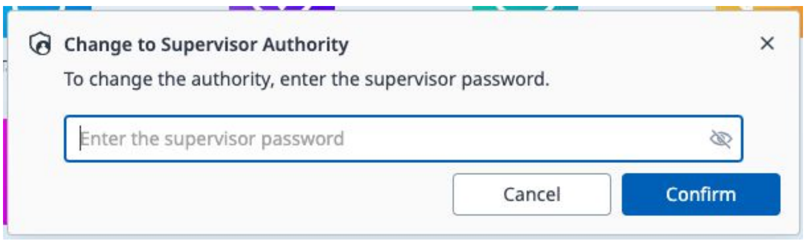
	Item	Description
1	Indication of robot's modes	This can be changed to Auto/Manual.
2	Indication of robot's detailed status	See the link

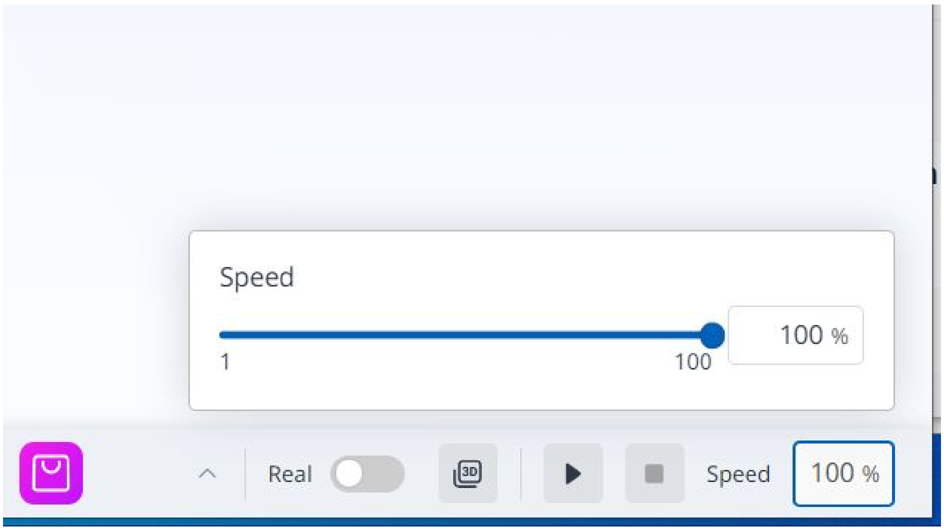
	Item	Description
3	Robot Parameter file information	This is where the selected file name of the Robot Parameters module is seen. If there is any information that does not match between the current robot setting and the information stored on the platform, a red dot mark will appear. 
4	Safety Checksum	This is where the current Robot Parameter Checksum information of the Controller is seen.
5	Tool Setting	This is where the current TCP, Tool Weight, and Tool Shape can be set. 
6	Backdrive & Recovery	This is the area where you can use the Backdrive & Recovery function. 

	Item	Description
7	Current Time Information	The current time can be seen.

5.2.3 Overview of Footer

Menu Layout

	Item	Description
1	Turn off button	This button turns off the platform. Press and hold the button for about 1-2 seconds.
2	Servo on/off switch	This is the section where you can turn on/off the servo.
3	Operator/ Supervisor	This button can change Operator/Supervisor level. When changing the administrator level, the administrator password must be entered. 
4	Auto switch	This button changes the state of the robot to Auto or Manual. The changed value can be seen in the upper left corner of the screen. 
5	Home	You can go to the Dart-Platform home screen.
6	Favorite Modules	This is a list of favorite modules.

	Item	Description
7	Virtual&Real switch	• This is where you can choose whether to operate a virtual or real robot. • This switch is only enabled when the servo is turned on.
8	3D Simulator button	This is a button that makes it easy to view the 3D Simulator while running the module.
9	Play/Pause/ Resume/Stop	This button allows you to run, pause, resume, or stop the robot.
10	Speed Slider	• This button allows you to set the robot's operation speed. • Clicking on this area will bring up a popup where you can set the speed, which can be changed using a slider or by entering text. 

5.3 What is a robot?

5.3.1 Functional Limits of each Robot Series

The respective robot series (A, As, M/H, E Series) limit the use of functions as follows:

- Current-based: Current of motor located on each joint is used.
- FTS-based: An FTS (force torque sensor) located on the end of the robot is used.
- JTS-based: JTS (joint torque sensors) located on each joint is used.

Features	A / E series (current-based)	A Series S (Current-based and FTS-based)	M Series (JTS-based)	H Series (JTS-based)
Direct Teaching - Free Motion	O	O (Current-based)	O	O
Direct Teaching - Restrained Motion	X	O (FTS-based)	O	O
Collision Detection	O	O (Current-based)	O	O
Installation Pose Measurement	X	O (FTS-based)	O	X (can only be installed on the floor)
Tool Weight Measurement	X	O (FTS-based)	O	O
Workpiece Weight Measurement	X	O (FTS-based)	O	O
Nudge Function	X	X	O	O
Force control	O (setting available only in three translation directions, excluding rotation)	O (FTS-based)	O	O
Compliance control	O (setting available only in three translation directions, excluding rotation)	O (FTS-based)	O	O

Functional Limits of force monitoring for each Robot Series

The teach pendant and DART-Studio can be used to monitor force data. The DRL command (Check_force_condition()) can also be used to externally monitor force data.

- **When the palletizing mode is set to “ON”**: The same control/monitoring functions provided in the OFF state are available, except for H Series robots.

Features	A / E series (current-based)	A Series S (Current-based and FTS-based)	M Series (JTS-based)	H Series (JTS-based)
Force control	O (setting available only in three translation directions, excluding rotation)	O (FTS-based)	O	O
				O (If the palletizing mode is set to “ON”: Force control output limit (Base Rx, Ry orientation))
Compliance control	O (setting available only in three translation directions, excluding rotation)	O (FTS-based)	O	O
				O (If the palletizing mode is set to “ON”: Compliance control output limited (Base Rx, Ry orientation))
Force monitoring (Teach Pendant)	X	O (FTS-based)	O (Force value of “0” shown for the singularity section)	O (Force value of “0” shown for the singularity section)
				O (If the palletizing mode is set to “ON”: 4-Degree of Freedom provided for the base (x, y, z, Rz))
Force monitoring (DART-Studio)	O (Force value of “0” shown for the singularity section)	O (FTS-based)	O (Force value of “0” shown for the singularity section)	O (Force value of “0” shown for the singularity section)

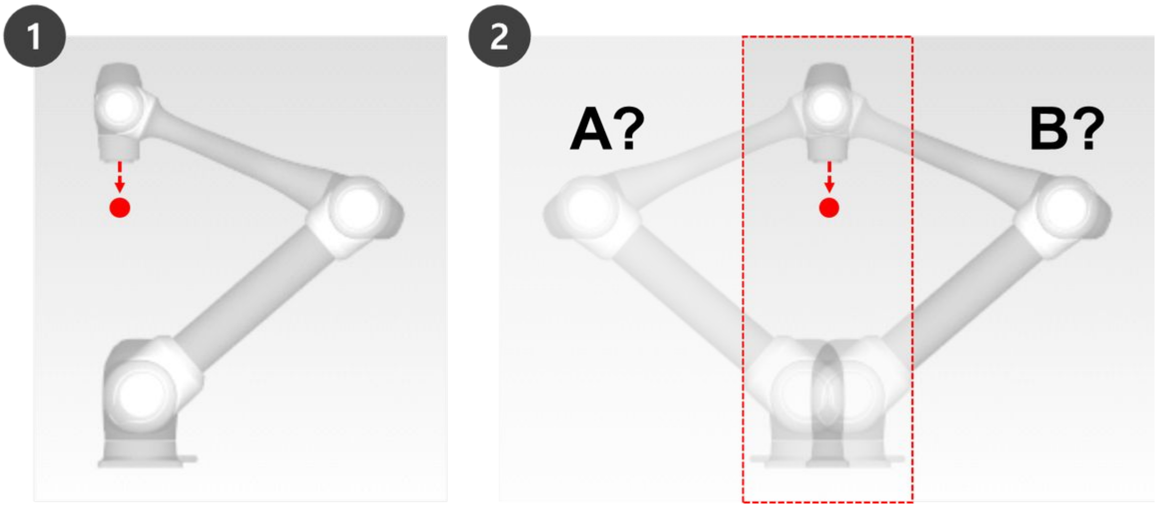
Features	A / E series (current-based)	A Series S (Current-based and FTS-based)	M Series (JTS-based)	H Series (JTS-based)
				O (If the palletizing mode is set to “ON”: 4-Degree of Freedom provided for the base (x, y, z, Rz))
Force monitoring (When using the DRL command: Check_force_ condition())	O (Force value of “0” shown for the singularity section)	O (FTS-based)	O (Force value of “0” shown for the singularity section)	O (Force value of “0” shown for the singularity section) O (If the palletizing mode is set to “ON”: 4-Degree of Freedom provided for the base (x, y, z, Rz))

Control output limit (Base Rx, Ry orientation): The force or compliance control values corresponding to the Base Rx, Ry orientation are not output. Entering the force or compliance control value of the relevant axis (Base Rx, Ry) will be ignored as “0”.

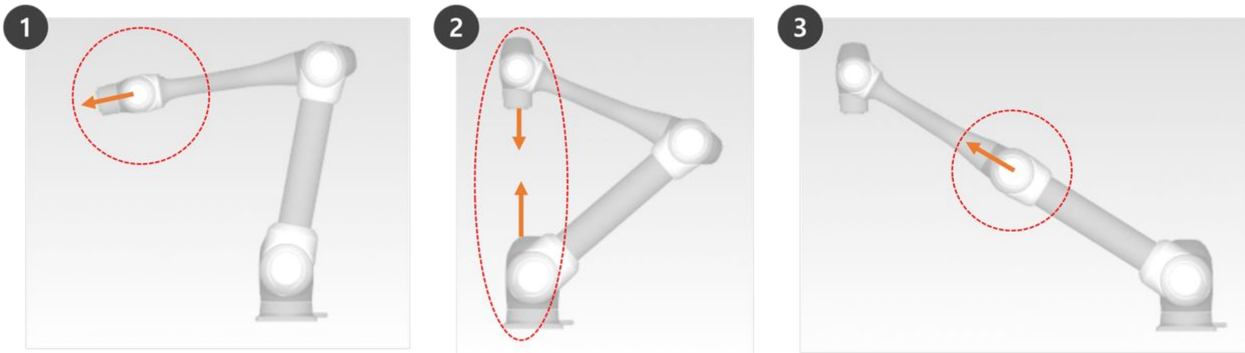
5.3.2 Overview of Singularity

Singularity in a multi-joint robot refers to a position (or point) where the robot has difficulty in calculating its next pose during moving. Multi-joint robots calculate each joint angle during movement based on the robot end.

For example, in Fig. 1 below, when the robot is moving to the red dot, the robot will not be able to determine whether to move its joints to set pose A or pose B as shown in Fig. 2. This position (or point) is called the singularity.



Near a singularity, robot movement is not fluid in terms of plane, point and line, robot end linear movement may not be maintained, and position error during control may increase. Singularity occurs in three cases as shown in the following figure, including when the robot joints form a line.



1. Wrist Singularity: When the robot wrist forms a line as Axis 5 approaches 0°
    - When compared to a human arm, Axes 4, 5 and 6 correspond to the wrist joint.
2. Shoulder Singularity: When Axes 1 and 6 are on the same line
    - When compared to a human arm, Axes 1 and 2 correspond to the shoulder joint.
3. Elbow Singularity: When the robot forms a line as Axis 3 approaches 0°
    - When compared to a human arm, Axis 3 corresponds to the elbow.

Caution

- Manual and automatic operations moving with joint rotation are not influenced by singularity.
    - Task movement, MoveL command, etc.
- Singularity only occurs during manual and automatic operation where the robot ends performing linear movement.
    - Joint movement, MoveJ commands, etc.

- In the singularity zone, force control or compliance control is unavailable.
- As the rotation speed of certain axes increase rapidly when a linear motion passes a singularity, it is possible for a Joint Speed Limit Violation or Joint Angle Limit Violation to occur.

How to avoid Singularity

Doosan Robotics robots offer options to avoid singularities during motion control. However, it is recommended to configure a task that does not create exceptions using joint movement commands such as MoveJ in singularity zones.

Here are the singularity avoidance options provided by Doosan Robot:

- Automatic avoidance: Performs motion by avoiding singularities. However, the robot motion may differ from the expected path.
- Path priority: Maintains path and speed, but may stop due to an error near a singularity.
- Variable speed: Maintains path, but decelerates near a singularity.

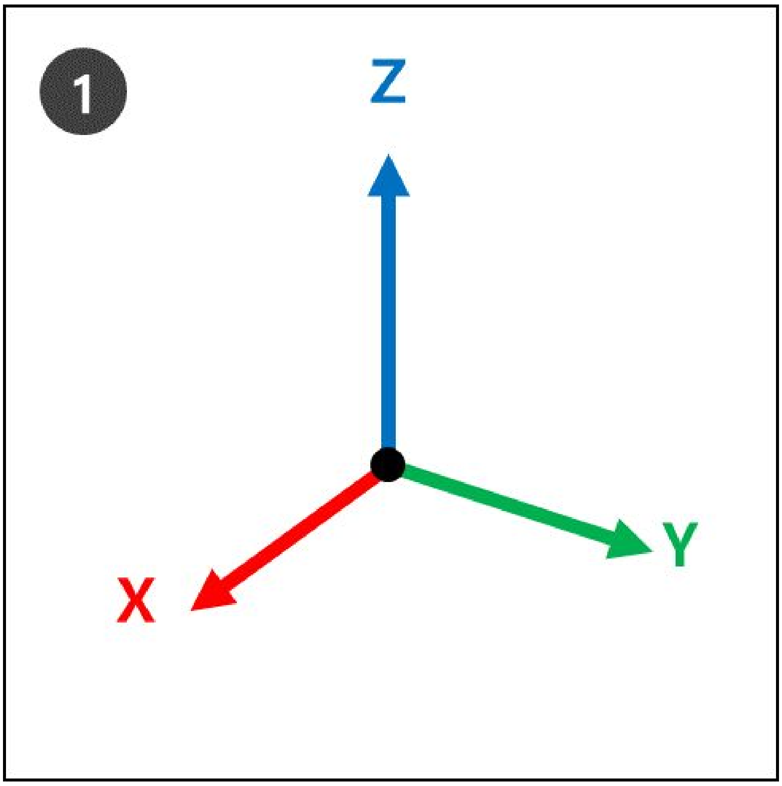
5.3.3 Overview of Euler Angle

Euler Angle is a way to express the angles of X, Y and Z axes, which are perpendicular among themselves in the object direction. A, B and C refer to the sequential rotation angles. Each robot manufacturer defines this A, B and C rotation order differently, such as **Rz-Ry-Rz, Rz-Ry-Rx** or **Rx-Ry-Rz**.

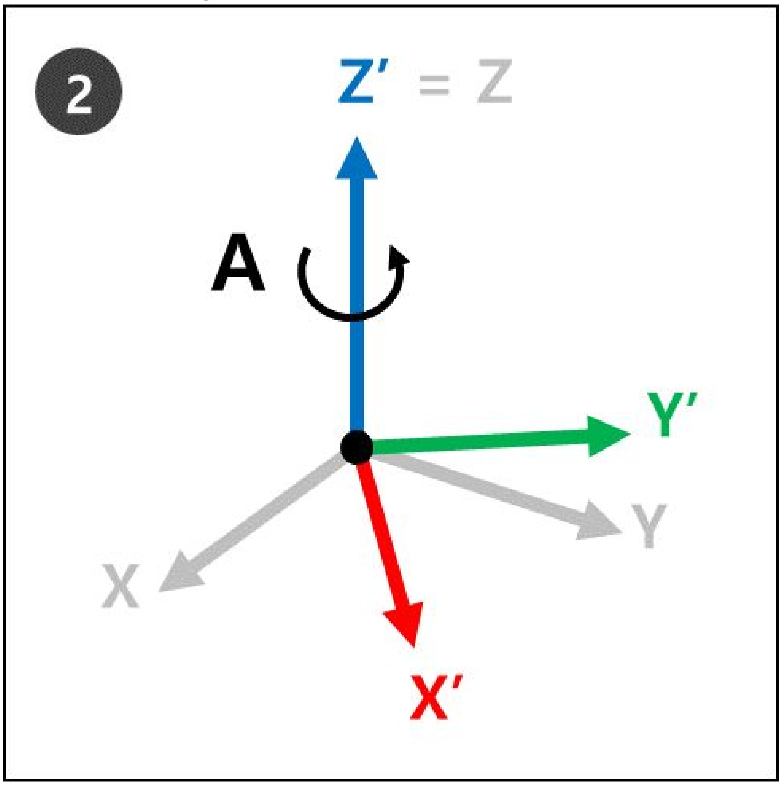
For example, **Rz-Ry-Rx**. Here, **Rz** means the rotation in Z-axis, **Ry** means the rotation in Y-axis and **Rx** means the rotation in X-axis. Rz can be expressed as angle A, Ry as angle B, and Rx as angle C to indicate the current rotating direction of an object. Note that once rotation is made in Z-axis direction from the coordinates, rotations will be made based on new coordinates.

This can be visualized with steps 1 to 4.

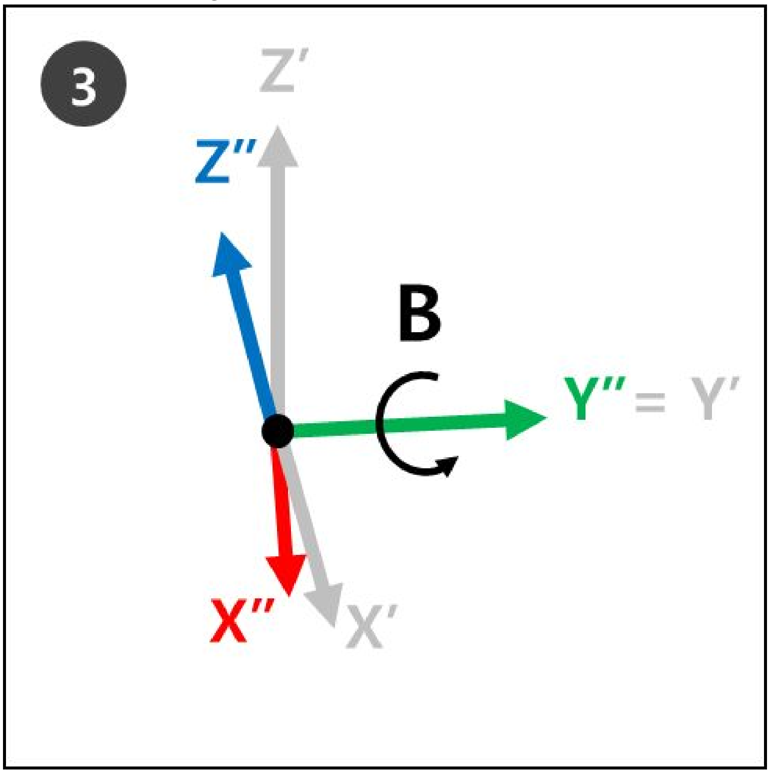
1. Assume there are coordinates (X, Y, Z).



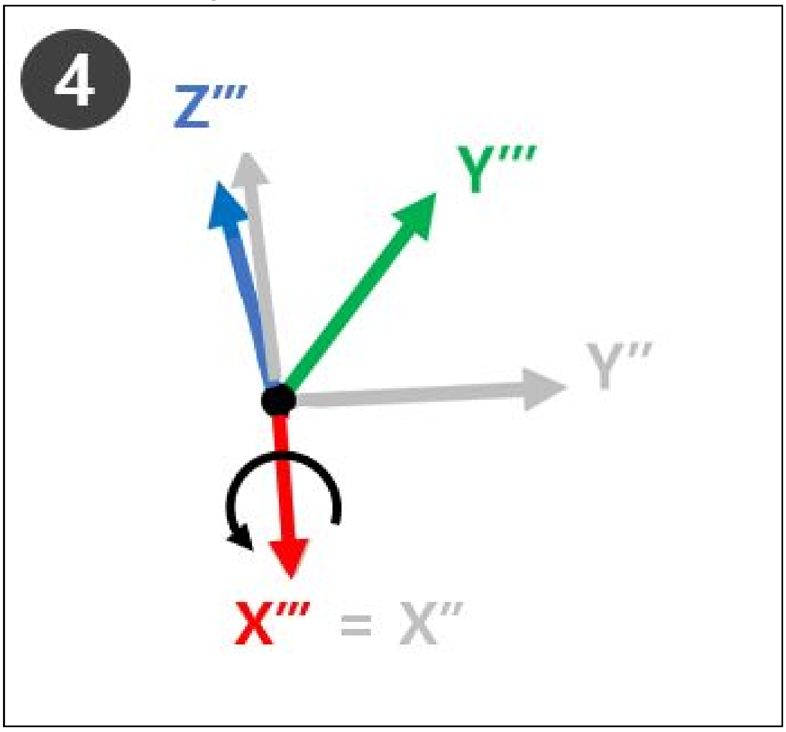
2. **Rz**: Rotate by A degrees from the Z-axis.



3. **Ry** : Rotate by B degrees from the new Y-axis (Y') of the new coordinates (X', Y', Z') in step 2.

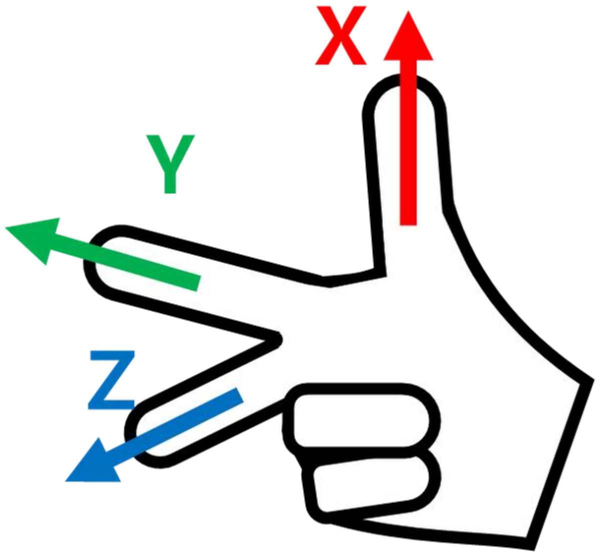


4. **Rx** : Rotate by C degrees from the new X-axis (X'') of the new coordinates (X'', Y'', Z'') in step 3.



5. The new coordinates (Z’’’, Y’’’, X’’’ of step 4 refers to the current robot rotation when Euler Angles A, B and C are applied.

This can be easily visualized with one’s right hand. Make the following pose with your right hand. This is called the Right-Hand Rule, and making the thumb (X-axis), index finger (Y-axis) and middle finger (Z-axis) to be perpendicular to each other will create coordinates consisting of X, Y and Z axes.

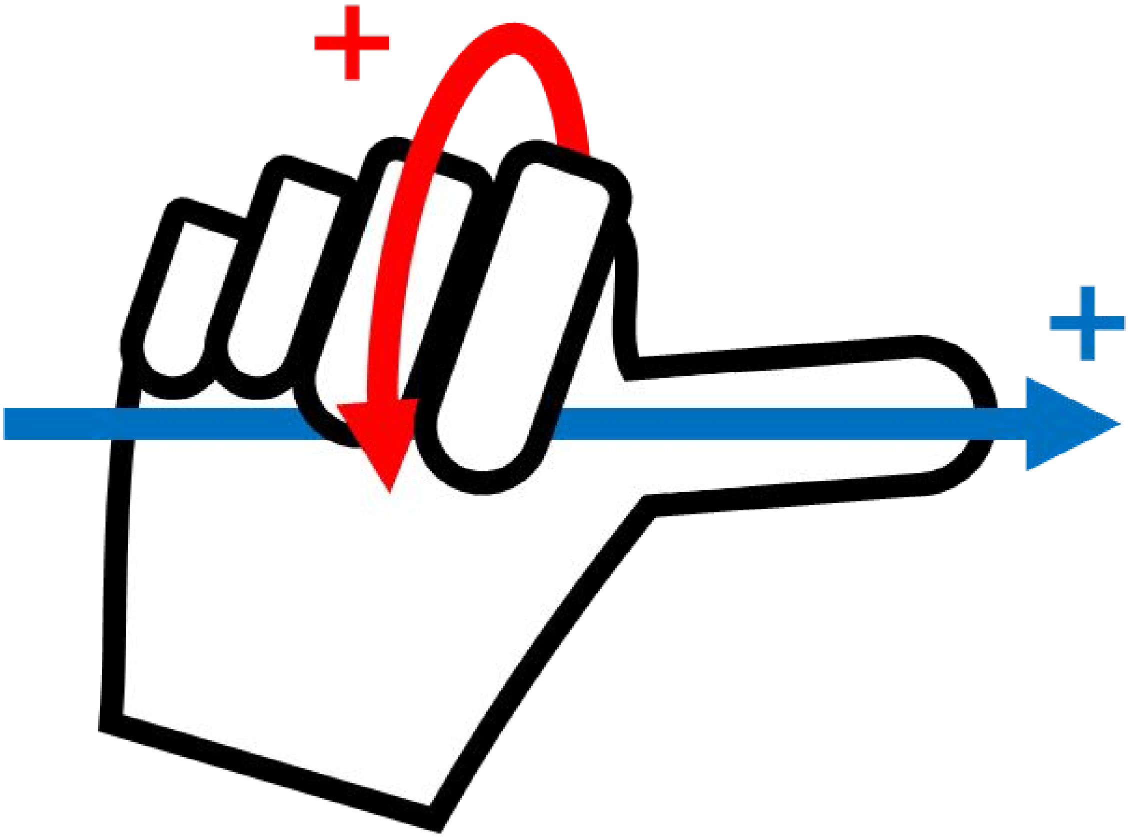


Then make the Right-Hand Rule Cartesian pose and make rotations Rz, Ry and Rx in sequential order.

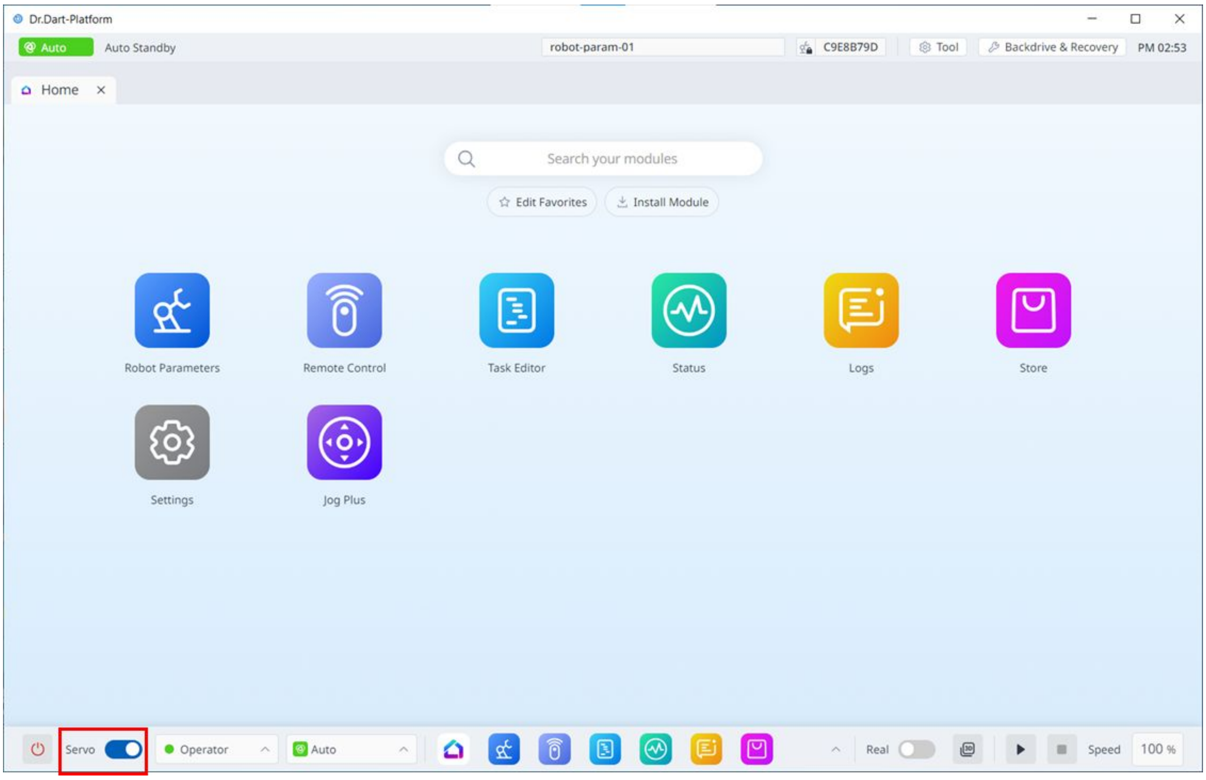
1. Rz: Rotate the middle finger (Z-axis) by A degrees.
2. Ry: Rotate the index finger (Y-axis) by B degrees.
3. Rx: Rotate the middle finger (X-axis) by C degrees.

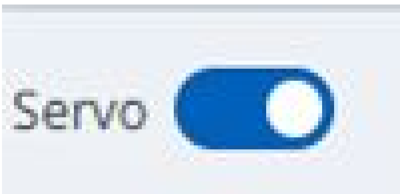
Note

The + rotating direction of A, B and C is the direction of four fingers except the thumb, when the thumb is pointing at the + direction and the four fingers are clenched. This is called the Law of Clockwise Screw.



5.4 Overview of Servo On



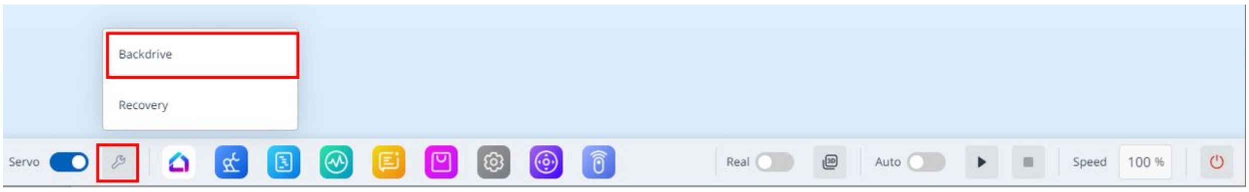


Servo On refers to the standby status where the robot arm can be operated by supplying power to joints. Pressing the emergency stop button or violating critical safety limits sets the Servo Off status. During servo off status, the power to joints is cut off, which results in the robot arm being unable to be operated, and **Task Editor and Jog Plus**, which are related to robot arm operation, are disabled in the main menu.

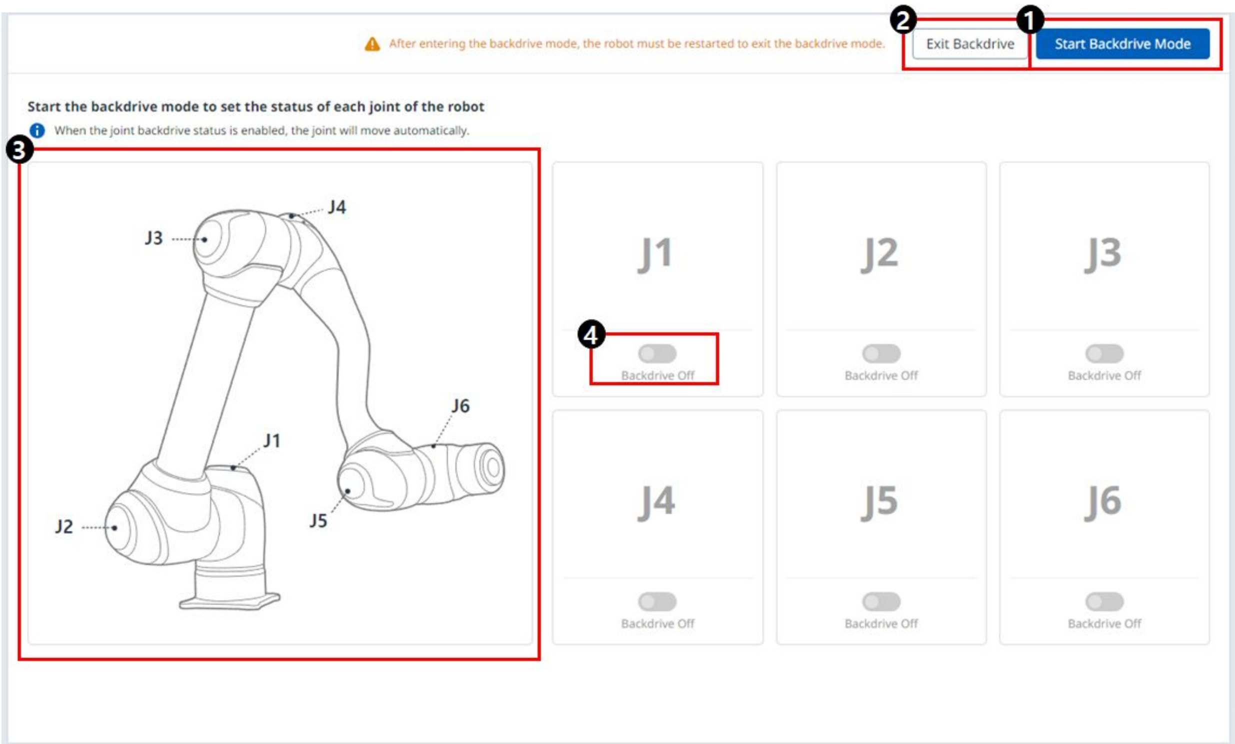
To switch from servo off to servo on, tap the Servo button on the left-hand side of the main menu at the bottom.

5.5 Backdrive Module

Backdrive cuts off power supplied to the motors, releasing only the brakes to allow the robot's joints to move under external force. **This** function is used when the robot cannot return to normal status with Recovery mode or Handguiding. **With** Backdrive mode, the user can engage or disengage the brake of each joint.



To enter the Backdrive module, tap the Backdrive&Recovery module at the bottom.



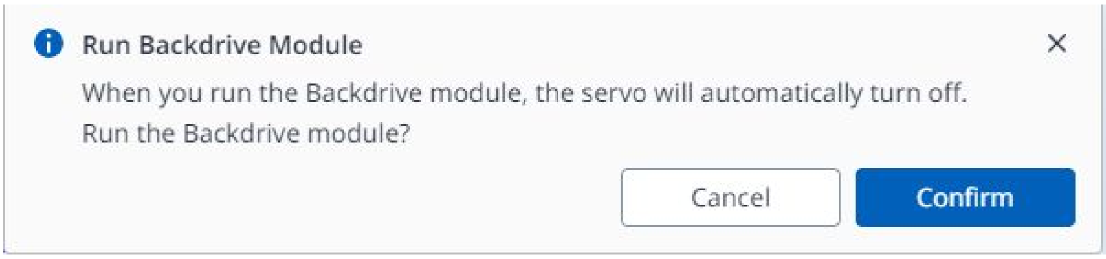
Menu Items

	Item	Description
1	Start Backdrive Mode	This button allows you to run the Backdrive mode.
2	Exit Backdrive	This button allows you to exit the Backdrive module.
3	Joint Image	This is an image that describes the position of each joint.
4	On/Off toggle button	You can choose whether to enable it for each joint.

The process of setting **Backdrive** mode is as follows:

1. Tap the **Status** button on the main menu **Backdrive** button.

- **If the Backdrive** button is not enabled, pressing and releasing the Emergency Stop button or pressing the **Servo Off** button will enable it.
- **If the servo** is turned on, the following pop-up window appears and the servo is automatically disabled.



2. **The** Start Backdrive Mode **button on the Backdrive** screen.
   - OFF/ON buttons to release the brakes of each joint are enabled.

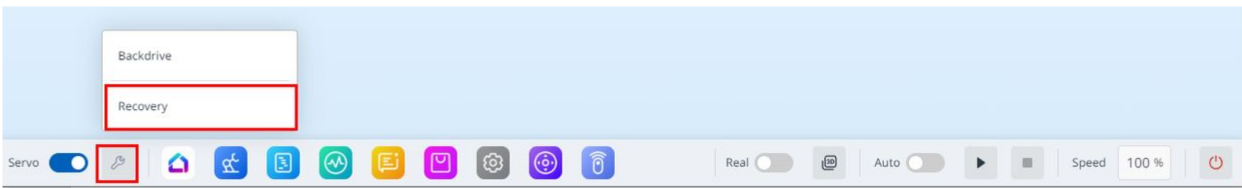
3. Set the brake of the joint to move as OFF (Release) and move the robot by applying force.
   - Due to the deceleration ratio of the decelerator inside the joint, the joint sagging speed due to the manipulator weight is not high, and movement speed when force is applied is also not high.
   - If the decelerator malfunctions or if joints move at a speed faster than a certain speed during zero-gravity motion, the brakes of all joints are applied automatically to ensure safety.
4. Set the brake ON (Hold) when the position change is complete.
5. Tap the **Power** on the main menu to shut down the operating program, tap and hold the power button on the top of the teach pendant to shut down the system, and press it again to turn on the system.
   - **Backdrive** status is released and work can resume normally.

Note

- Move each joint back to the normal work range individually in sequential order.
- If **Backdrive** mode is executed, the system must be rebooted to resume normal work again.
- **Use** caution as temporary sagging may occur depending on the axis location in Backdrive mode.

5.6 Recovery Module

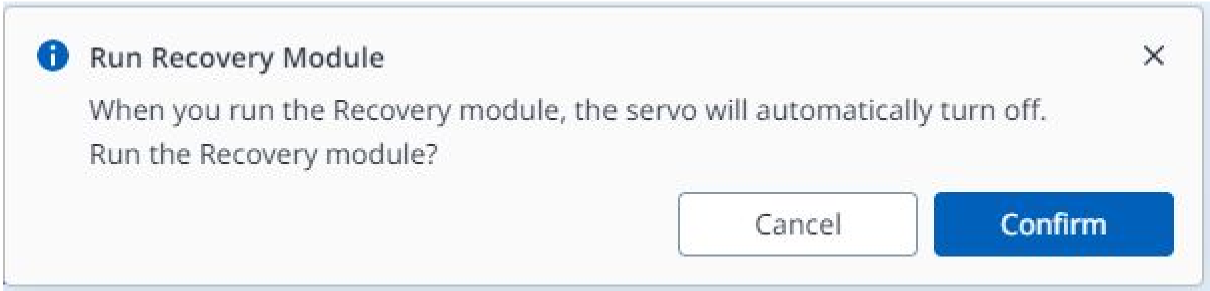
Recovery Module: If there is an error with a continuing safety violation or if a robot needs to be packed for transportation, **the user** can use the Safety Recovery Mode to configure the position and angle of the robot.



You can enter the Recovery module by tapping the Backdrive & Recovery module at the bottom.

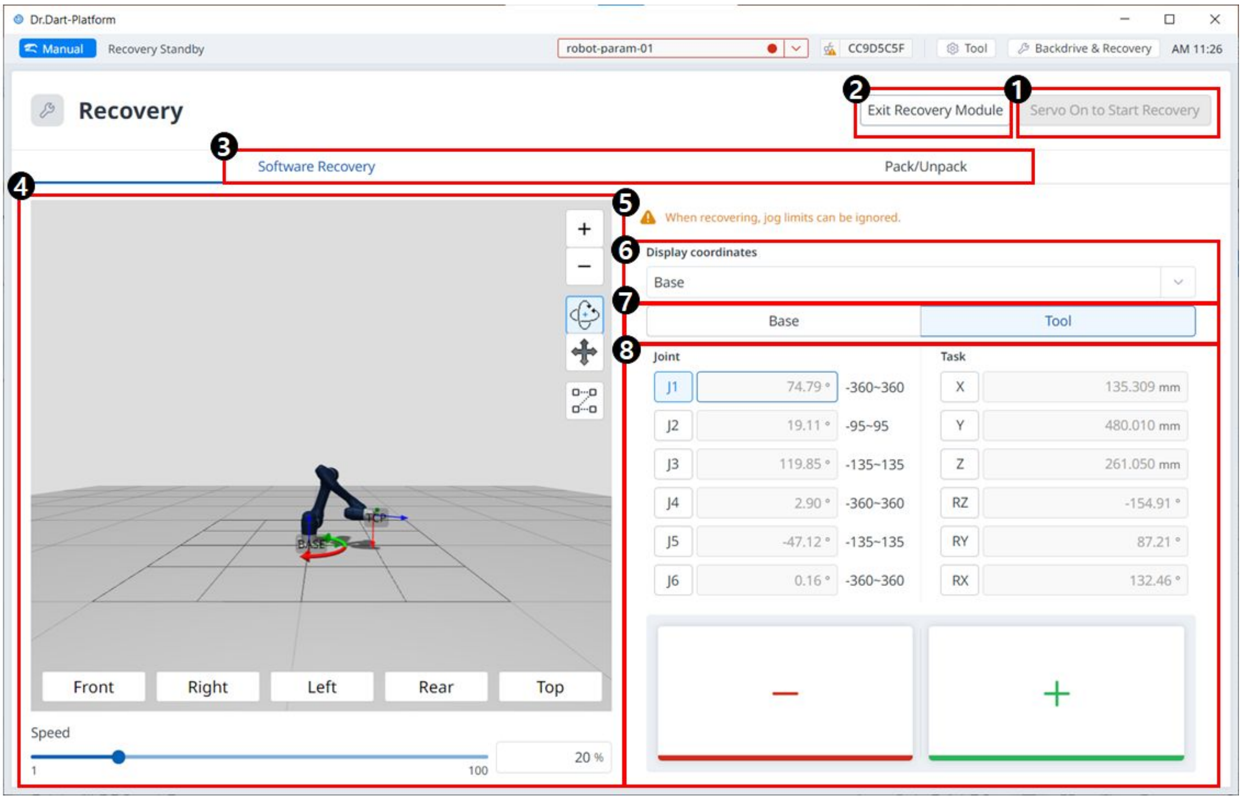
- **Software Recovery:** In Servo Off status, if a safety violation error situation caused by position-related safety violations, such as the robot exiting the operation area or violating prohibited areas, **occurs** or force is continuously applied when the robot is stopped due to colliding with a fixed object, **Servo On** or **Jog** cannot be set even when attempting to reset the robot to a normal state using the Jog or program. In such cases, **Software Recovery** mode is used to reset the robot to normal.
- **Packaging Mode**: For packaging and transporting the robot, the robot can be set to predefined values (which go beyond the normal operation angle limit) for transporting.

If the servo is enabled when the Recovery module is launched, the following pop-up appears and the servo is automatically turned off.



5.6.1 Using Software Recovery Mode

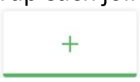
Software Recovery Mode



Menu Items

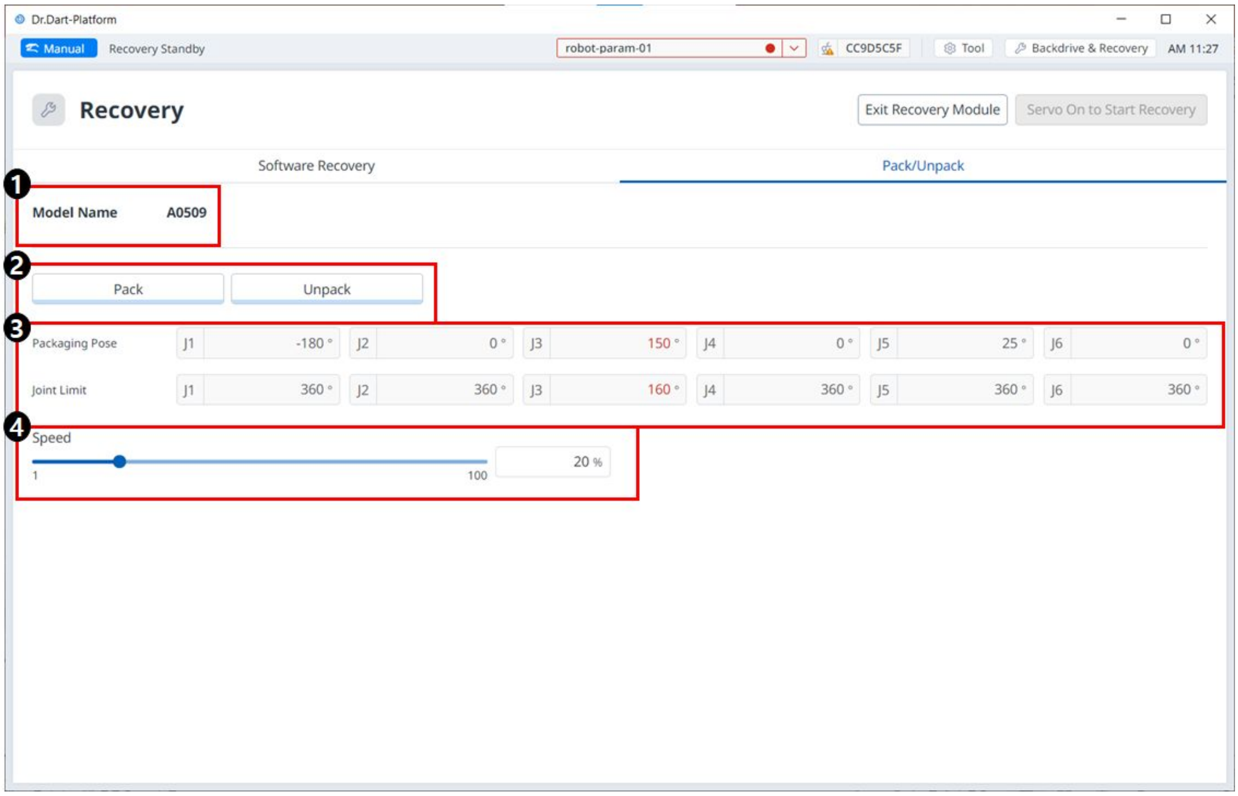
	Item	Description
1	Servo On to Start Recovery	This is a button to enable the servo before entering Recovery mode.
2	Exit Recovery	This button allows you to exit the Recovery module.
3	Header	This section allows you to select either Software Recovery mode or pack/unpack mode.
4	3D Simulation	This area allows you to preview a 3D simulation of the set values.
5	Warning Message	This explains the precautions.
6	Display Coordinates	This is where you can set the coordinate based on Base or World.
7	Base/Tool Button	This is where you can set the value based on Base or Tool.
8	Joint/Task	This section allows you to enter the desired values to make the robot move.

To use the software recovery mode, follow these steps:

1. **Tap** the **Recovery** menu in the Main Menu window. **The** Software Recovery screen appears automatically in the Recovery window.
2. Tap each joint button on the right side of the Software Recovery screen, and use  ,  buttons to set the position. Or press buttons of the cockpit to adjust the joint angle by direct teaching.
    - For definitions of the buttons in the cockpit, see Cockpit(p. 254)
    - Changes made to the setting are reflected on the simulation window on the left in real time.
3. When the setting is complete, tap the X button on the top left to close the window.

> **Caution**
>
> Software repair mode is not available when the joint angle limit is exceeded by 3 degrees.

5.6.2 Using Pack/Unpack

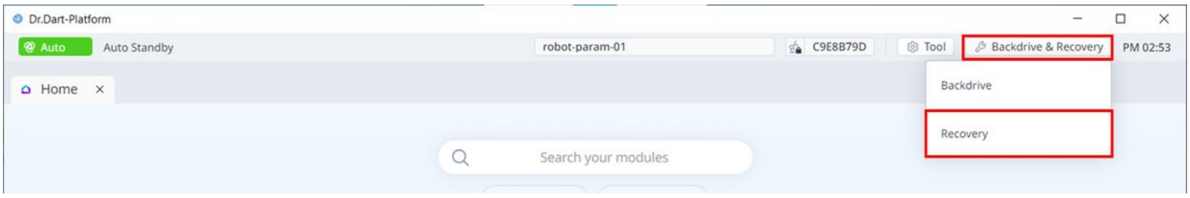


Menu Items

	Item	Description
1	Model Name	The name of the connected robot model appears.
2	Pack/Unpack	Either Pack or Unpack can be selected.
3	Packaging Pose/Joint Limit	The pose and joint limit values appear.
4	Speed Ratio	The speed of the pack or unpack mode can be adjusted via a slider or input.

To configure the packaging mode, follow these steps:

1. **Tap** the **Recovery** menu in the header pane.

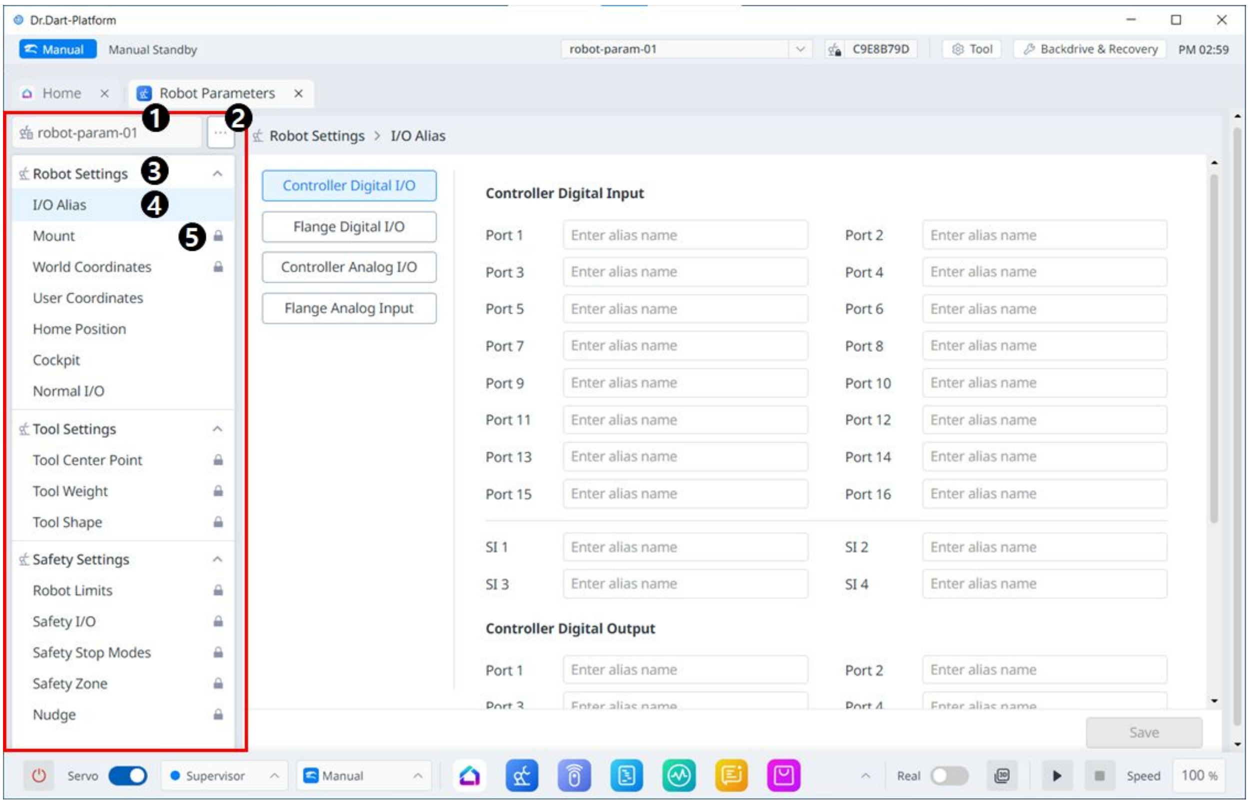


2. Select the **Packaging Mode** tab.

3. To enable packaging mode, tap the **Servo On to Start Recovery** button.

4. The robot automatically moves to the set packaging pose.
   - The **Pack** button allows you to put the robot in the Pack position and the **Unpack** button allows you to put the robot in the Default Home Position.

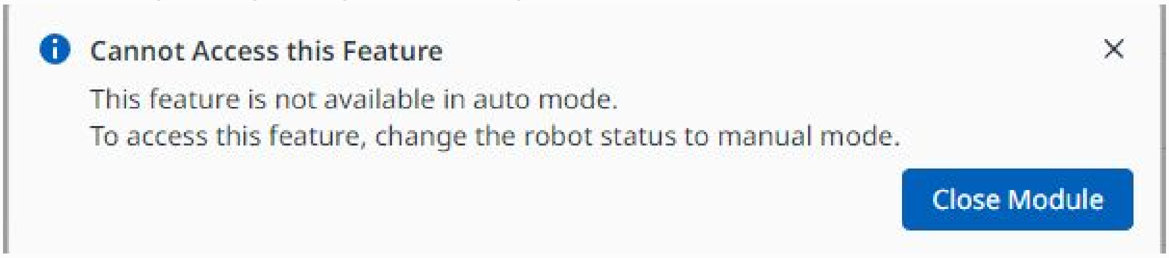
5.7 Robot Parameters Module



Menu Layout

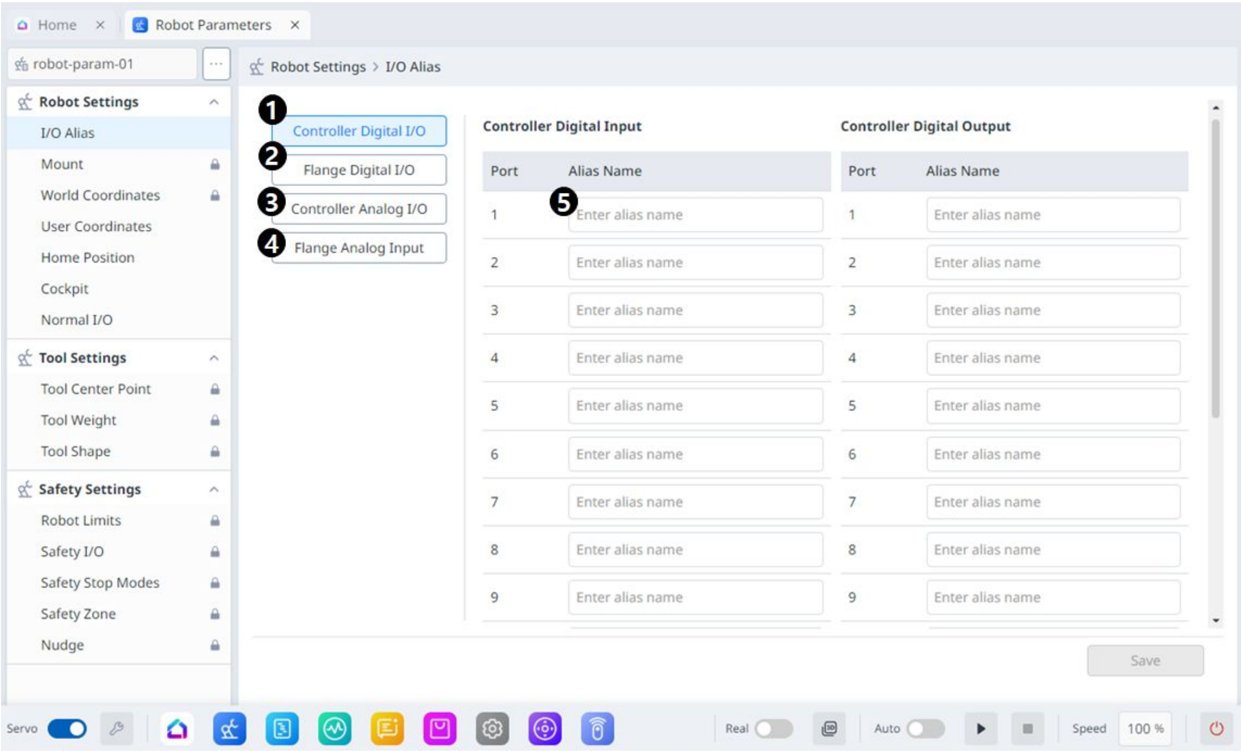
	Item	Description
1	Project name	This is where the project name is entered.
2	View More	Clicking this button will create a new file or import, save, or export an existing file.
3	Accordion menu	Clicking on an item will bring up a list of related menus.
4	Sub menu	You can enter each screen and function by clicking on the menus.
5	Lock icon	When the lock icon is seen, certain settings can be changed at the administrator level.

To use this module, the robot must be in Manual mode.
If the following warning message is seen, change the state of the robot to Manual mode.



5.7.1 Robot Settings

I/O Alias



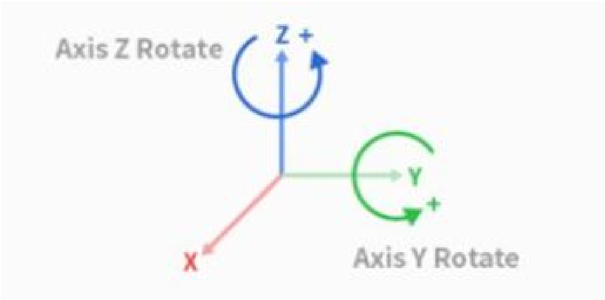
Menu Items

	Item	Description
1	Controller Digital I/O	The name of the controller digital I/O can be set individually.
2	Flange Digital I/O	The name of the flange digital I/O can be set individually.
3	Controller Analog I/O	The name of the controller analog I/O can be set individually.
4	Flange Analog Input	The name of the flange analog I/O can be set individually.
5	I/O Name	The name can be up to 40 characters long.

Mount

The robot installation pose can be set in the robot installation pose (mount) menu. If the robot is installed on a flat surface, this step can be skipped.

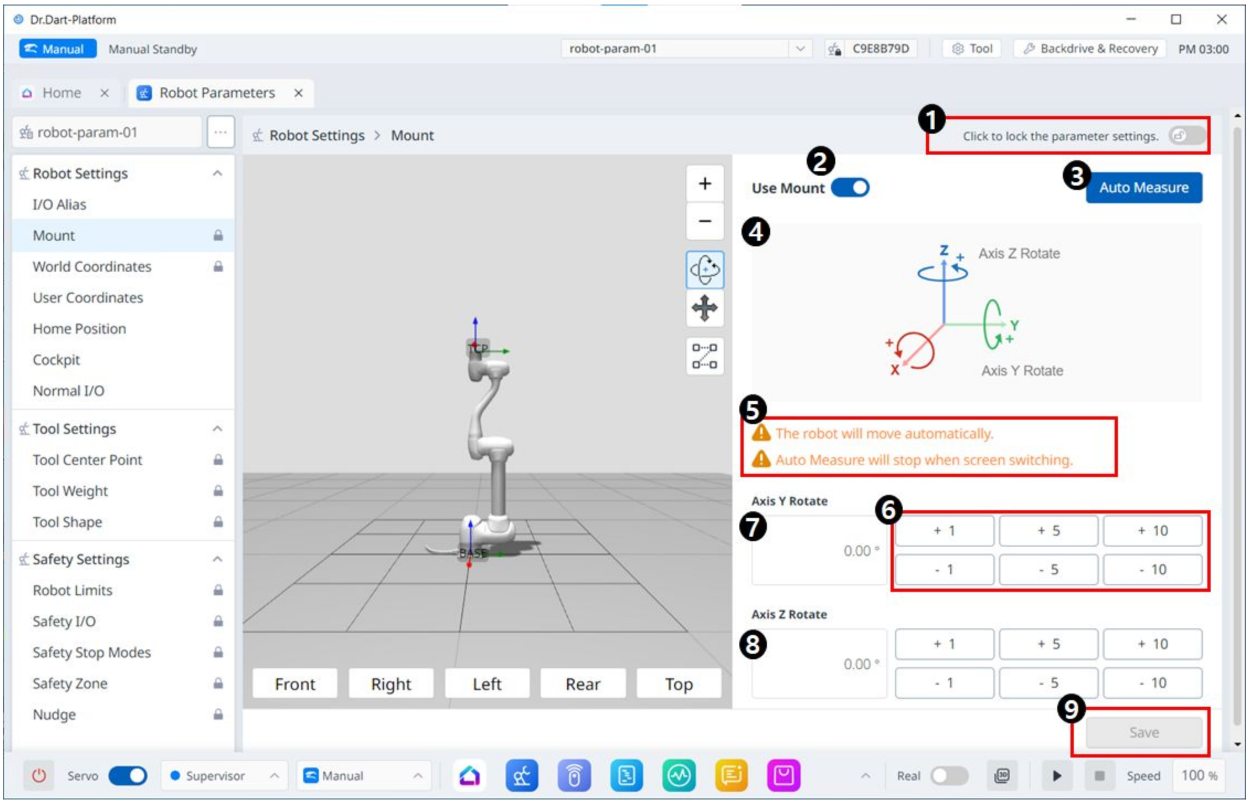
The robot installation pose can be set in **Robot Parameters > Robot Settings > Mount**.



- The installation angle can be measured using the auto measure function. However, if the angle is less than 5 degrees, auto measure is unavailable.
- If the robot is installed on the ceiling or wall, the robot installation angle can be set with Y-axis and Z-axis rotations.
- As auto tool weight calculation is performed based on gravity, it is recommended to reset the tool weight once mount setting is done.

Caution

- When setting the robot installation pose (mount) Workcell Item, it is recommended to change the world coordinates as well. If the world coordinates are not changed, the robot pose on the robot simulator screen of the teach pendant is displayed as the robot being installed on the flat surface (basic).



Menu Layout

	Item	Description
1	Lock Toggle Button	Used to lock the set value. The safety password is required for modifying the set value.
2	Use Mount	Button to enable the use of mount. Button is available after unlocking.
3	Auto Measure	This automates a commanded operation. The 3D Simulation next to it shows this movement.
4	Information Image	This is an image that tells you about the Mount.
5	Information Message	This is a message that tells you about the Auto Measure.
6	Increment/Decrement Button	This allows you to increment or decrement as much as desired.
7	Y-Axis Rotate Input Field	The Y-axis rotation angle can be entered directly.

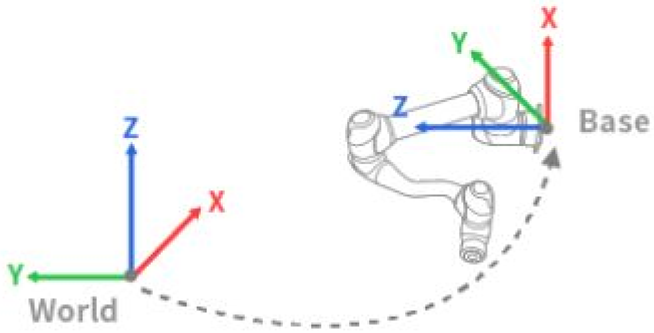
	Item	Description
8	Z-Axis Rotate Input Field	The Z-axis rotation angle can be entered directly.
9	Apply Button	This allows the set values to be applied.

World Coordinates

The world coordinates of the robot can be set from World Coordinates. In case the robot coordinate is the base coordinates, this step can be skipped.

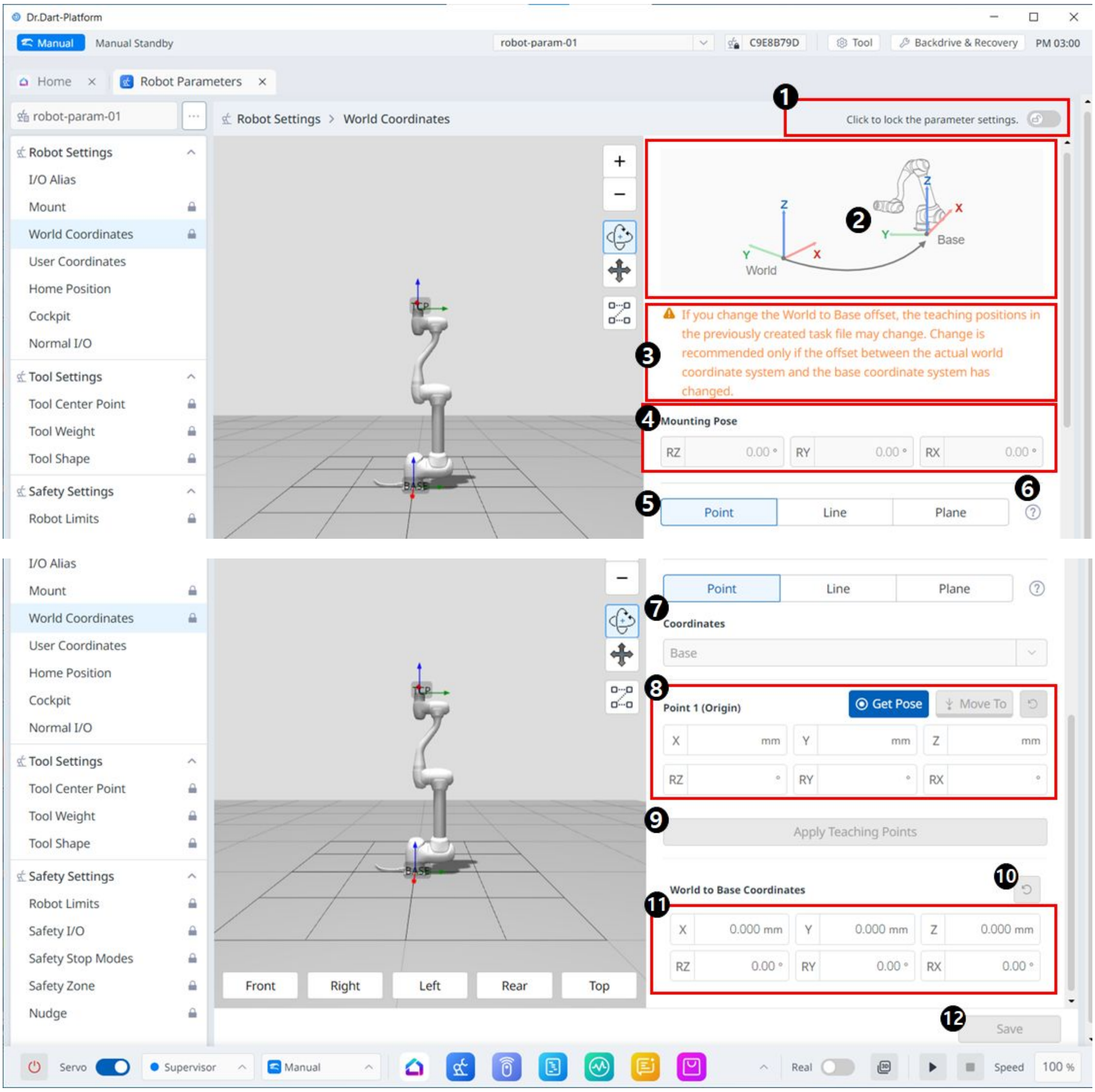
World coordinates can be set in **Robot Parameters > Robot Settings > World Coordinates**.

- World coordinates are used when the robot base installation location is physically moved/rotated.
- Changing the world coordinates will apply the same move/rotation to the robot simulator screen.



Note

World coordinates can also be used even after the base location and angle are changed after robot teaching. If the coordinates of tasks created through robot teaching in the past are changed from BASE to WORLD, an offset corresponding to the move/rotation of world coordinates is applied to all motion coordinates.

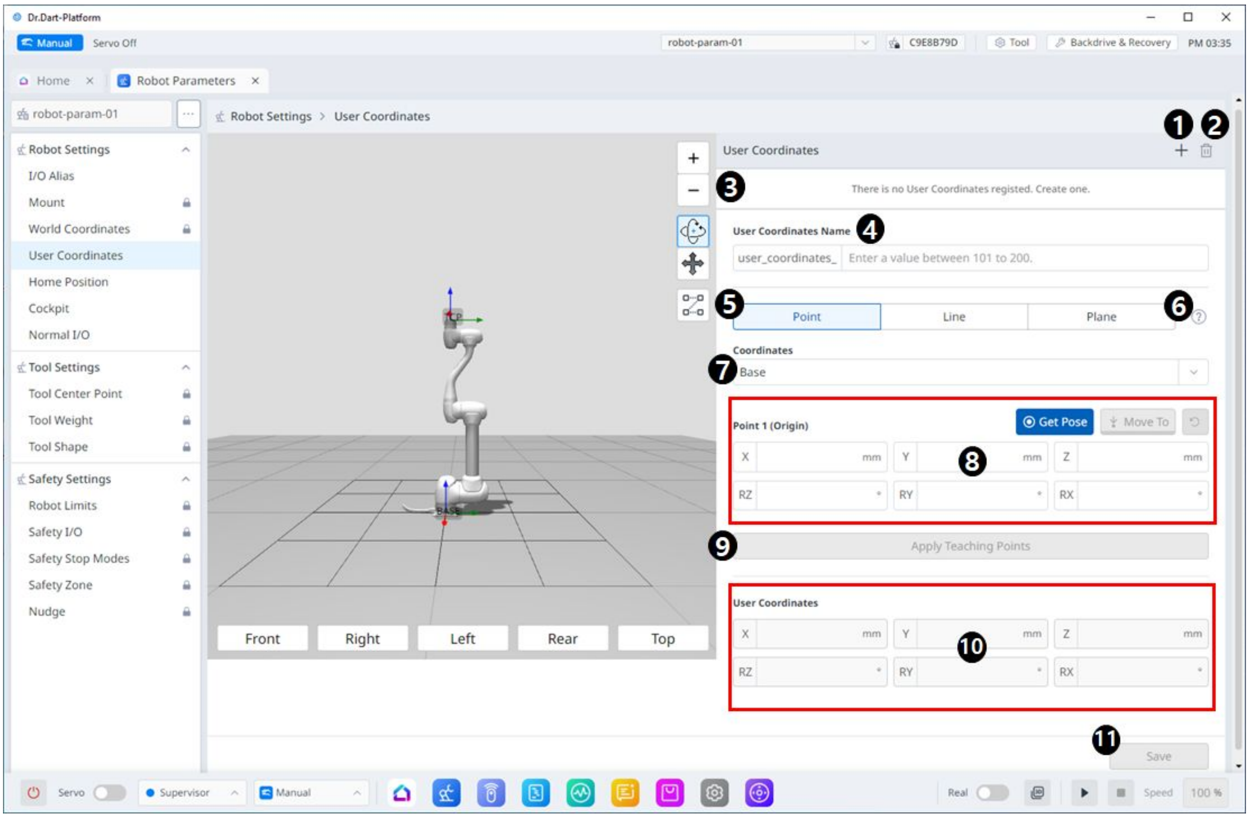


Menu Layout

	Item	Description
1	Lock Toggle Button	Used to lock the set value. The safety password is required for modifying the set value.
2	Information Image	This is an informative image required for the setting.
3	Information Message	This is an informative message required for the setting.

	Item	Description
4	Mounting Pose	This section includes Mounting Pose values for A, B, and C.
5	Point, Line and Plane settings	This is where you can select and set the desired items among point, line and plane.
6	Teaching Guide	This is a guide for setting up point, line and plane.
7	Coordinates	This is where you can select the desired coordinate between Base and World.
8	Point 1 setting	This is where you can set the settings for each of the 6 axes, as well as Get Pose and Move To.
9	Apply Teaching Points button	This button allows you to enter the desired settings and apply them.
10	World to Base Coordinates Reset	This button allows you to reset the World to Base Coordinates already entered.
11	World to Base Coordinates setting	This is where you can enter settings for the 6 axes.
12	Apply button	The setting value can be applied.

User Coordinates

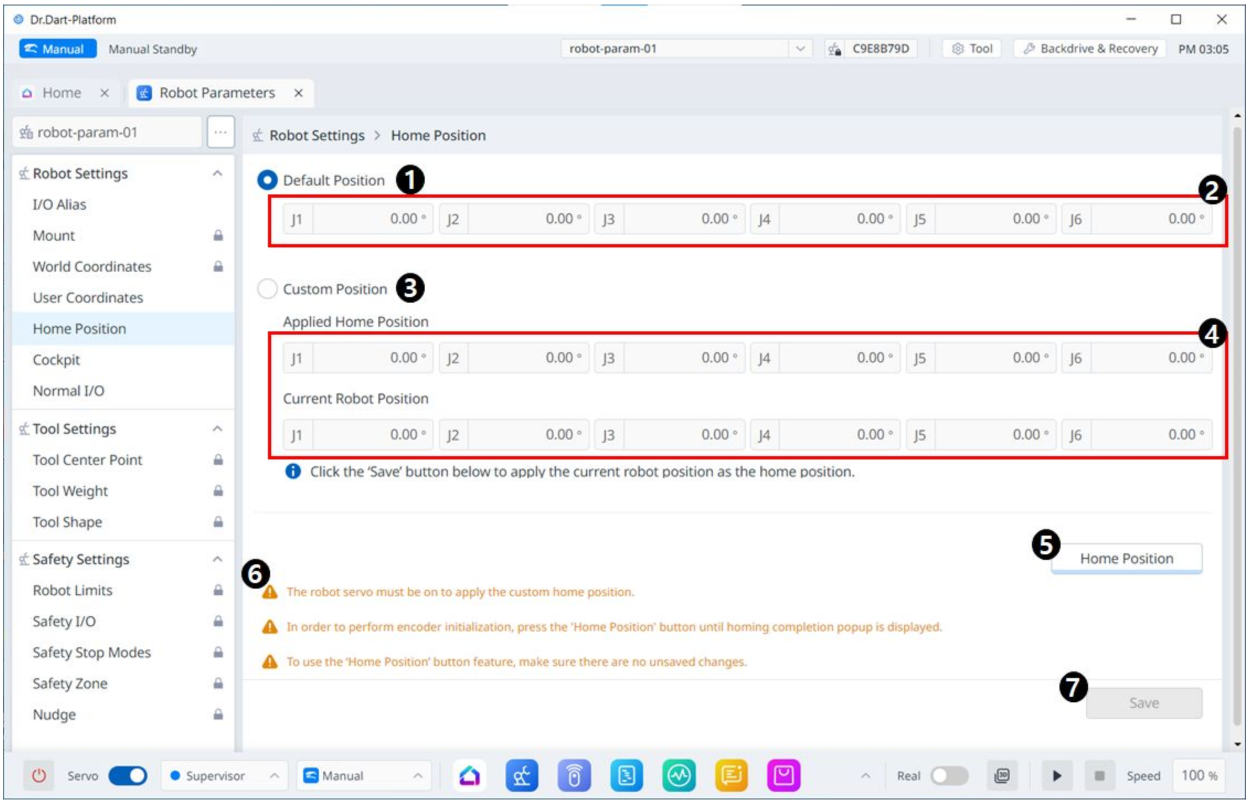


Menu Layout

	Item	Description
1	Add New	This button allows you to add User Coordinates. Up to 100 user coordinates can be added.
2	Delete	This button allows you to delete the selected User Coordinate.
3	Selected User Coordinates	This is a list of the User Coordinates added.
4	User Coordinates Name	This is where you can set the names of the User Coordinates. A number from 101 to 200, with a maximum length of 40 characters, can be entered.
5	Point, Line and Plane settings	This is where you can set each point, line, and plane.
6	Information icon	A guide to User Coordinates is provided.

	Item	Description
7	Coordinates	This is where you can select either Base or World as the basis for the desired value.
8	Point1 setting	This is where you can enter values for each of the 6 axes of Point 1 and run Get Pose or Move To.
9	Apply Teaching Points	This button allows the desired values to be applied after they are entered.
10	User Coordinates	In the User Coordinates section, you can enter each of the desired values.
11	Save	This button allows the setting values to be saved.

Home Position



Menu Items

	Item	Description
1	Default Position option	This is the section where you can select the Default Position option.
2	Default Position value	These are the values that correspond to the Default Position, all of which are 0.
3	Custom Position option	This allows you to select the Custom Position option.
4	Custom Position value input	This is the section where you can enter values for the 6 axes, apply Get Pose, and initialize them.
5	Home Position	This button allows you to set the Default Position or the Custom Position you set as the Home Position.
6	Warning Message	A note of caution when setting this up.
7	Save	This button allows the setting values to be saved.

Cockpit

MANDATORY **EASY** **5 MIN**

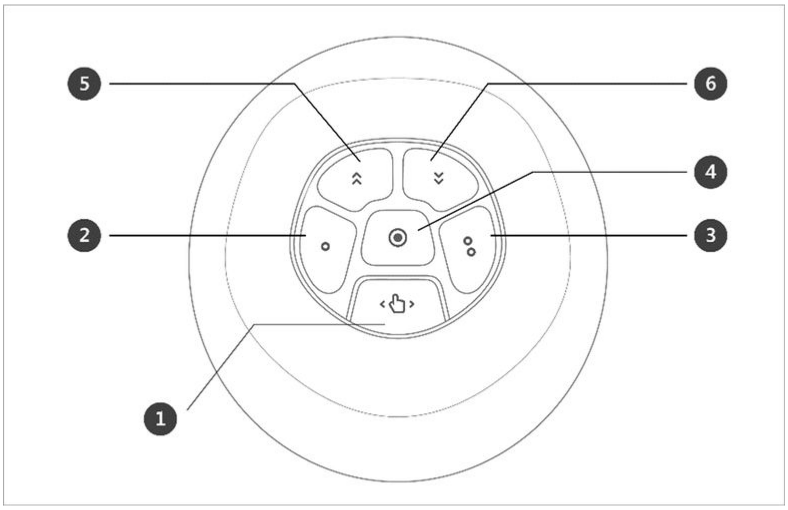
Direct teaching is used to hold the robot end with one's hands to push and pull the robot to the desired pose, and apply the pose to the currently selected motion. There are two direct teaching methods.

- Freedrive: Each joint moves in the direction the user applied force
- Constrained Motion: The robot end moves or rotates only in the direction set in the constrained motion even when force is applied from a random direction

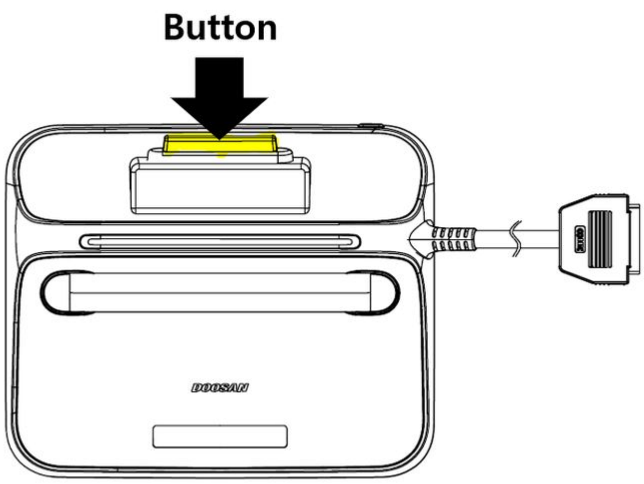
Freedrive

When Button 1 is pressed, the Freedrive mode is activated, allowing the robot to be moved freely. Each joint moves in the direction the user applied force. The robot cannot be moved by hand once the button is released.

- During direct teaching, the robot LED blinks cyan.

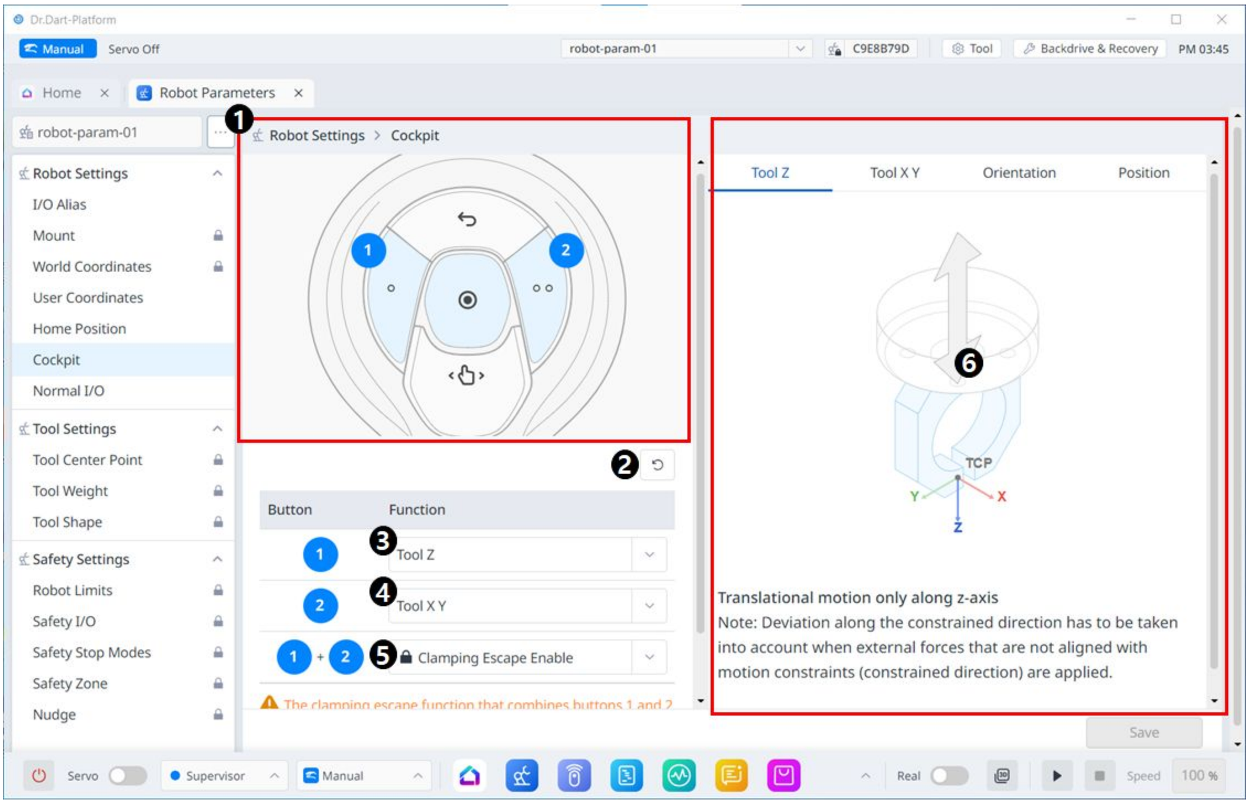


Pressing the hand guide button on the back of the teach pendant will activate the Freedrive mode, just like pressing Button 1, and the robot can be moved freely.



Constrained Motion

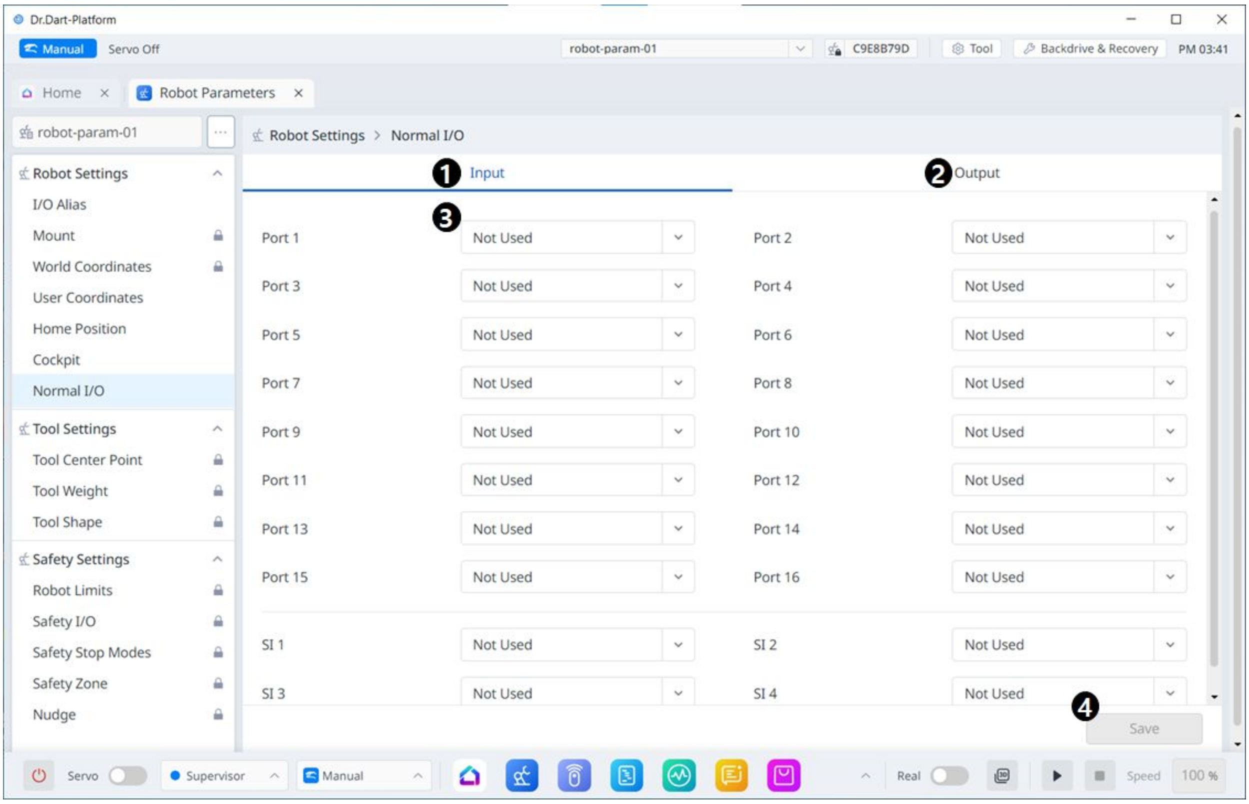
When Button 2 and Button 3 are pressed, the robot end moves only in the direction matching the constraint condition even when force is applied from a random direction. The constraint condition can be set with 2 of 4 of the conditions in the following figure: Z-axis constrained, plane fix constrained, surface constrained and direction constrained.



Menu Items

	Item	Description
1	Cockpit Image	This is an image for Cockpit settings.
2	Reset	This button allows you to initialize the set values.
3	1 Button Setting	This is the section where you can select the function to be set for the button 1.
4	2 Button Setting	This is the section where you can select the function to be set for the button 2.
5	1+2 Buttons Setting	This is the section where you can select whether to enable clamping for the buttons 1+2.
6	Guide Image	An guiding image for Cockpit setting items

Normal I/O



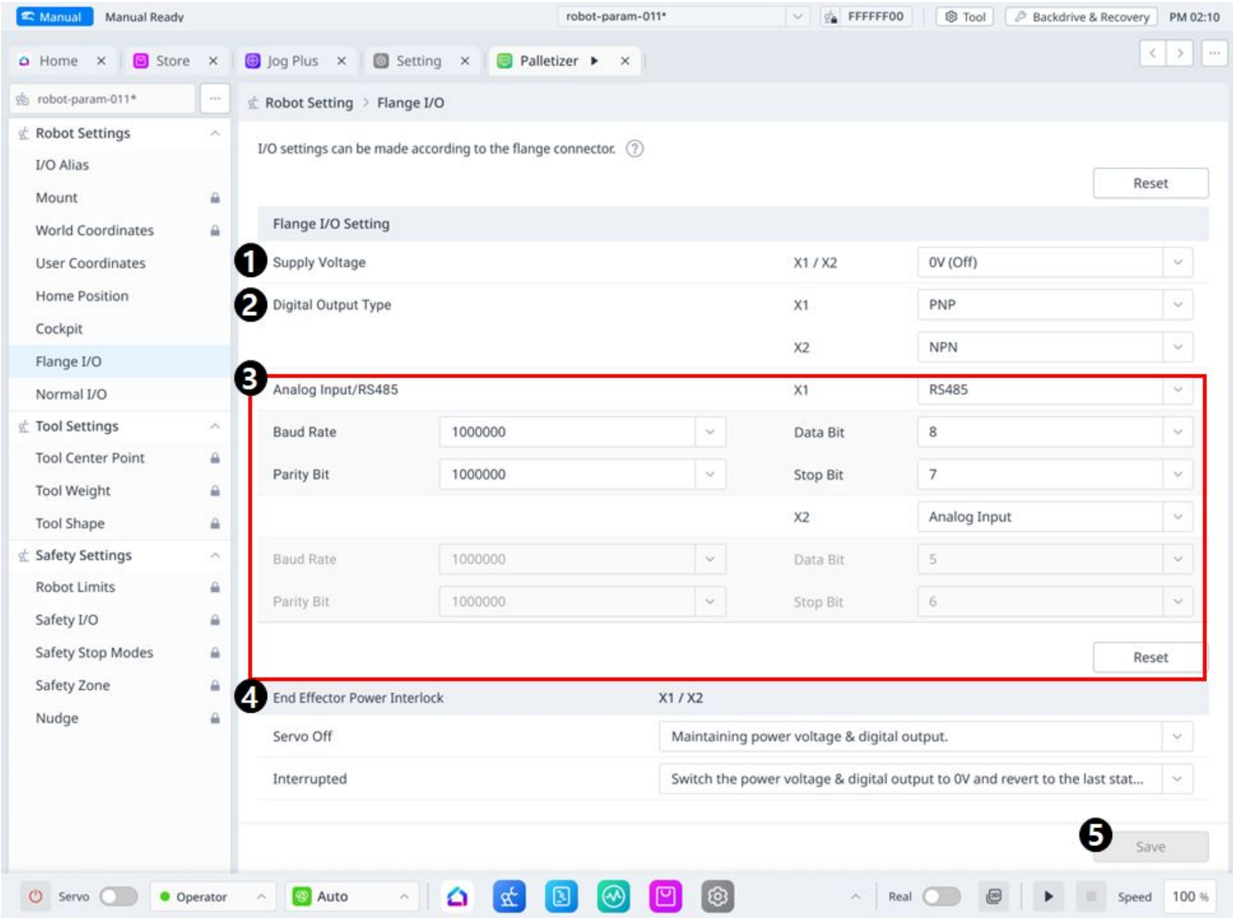
Menu Items

	Item	Description
1	Normal Input	This is the section where you can set what to be entered.
2	Normal Output	This is the section where you can set what to be output.

	Item	Description
3	Port Component	The options listed in the drop-down menu are different for Input and Output. For Input, the options in the drop-down menu for each port are: Not Used Power On (H) Power Off (H) For Output, the options in the drop-down menu for each port are: The options are: Not Used Safe Torque Off (L) Safe Operating Stop (L) Normal Speed (L) Reduced Speed (L) Auto Mode (L) Manual Mode (L) Remote Control Mode (L) Standalone Zone (L) Collaborative Zone (L) High Priority Zone (L) Tool Orientation Limit Zone (L) Designated Zone (L) Task Operating (L) Robot In Motion (L) Mastering Alarm (L) Home Position (L) Deceleration - SS1 SS2 (L)
4	Save	This allows the set values to be applied.

Flange I/O Setting

This menu can only be accessed when connecting to a robot installed new flange.



Menu Item

	Item	Description
1	Supply Voltage	• Provides the ability to set the supply voltage. • You can select the voltage(0V(=Off) or 12V or 24V)
2	Digital Output Type	Provides the function to set the digital output type for each X1 and X2 port. • In series A, only X1 port is supported in the digital output type item. • In series M/H , both X1 and X2 ports are supported in the digital output type item.

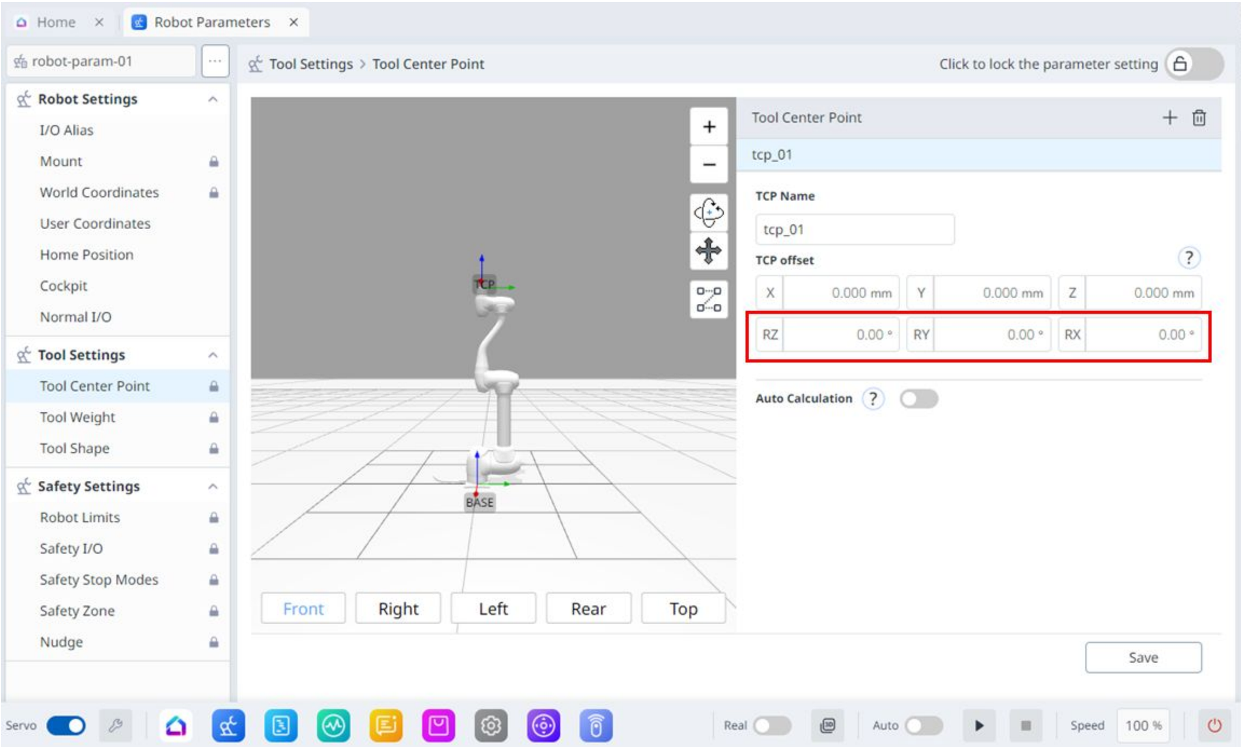
	Item	Description
3	Analog Input/RS485 Mode Setting	Provides the ability to select Analog Input or RS485. • In series A, only the X1 port is supported in the Analog Input/RS485 item. • In series M/H , both X1 and X2 ports are supported in the Analog Input/ RS485 item. **When selecting Analog Input,** ▪ Baud Rate, Data Bit, Parity Bit, Stop Bit items are disabled **When selecting RS485,** You can choose from the following options • Baud Rate : 19200, 38400, 57600, 115200(default), 1000000 bps • Data Bit : 5, 6, 7, 8(default), 9 Bit • Parity Bit : Odd, even, none(default) • Stop Bit : 1(default), 2
4	End Effector Power Interlock	Provides a function to set the operation when Servo Off or Interrupted. ▪ In series A, the Servo Off selection combo box is disabled.
5	Save	It can apply the set values.

5.7.2 Tool Settings

Tool Center Point

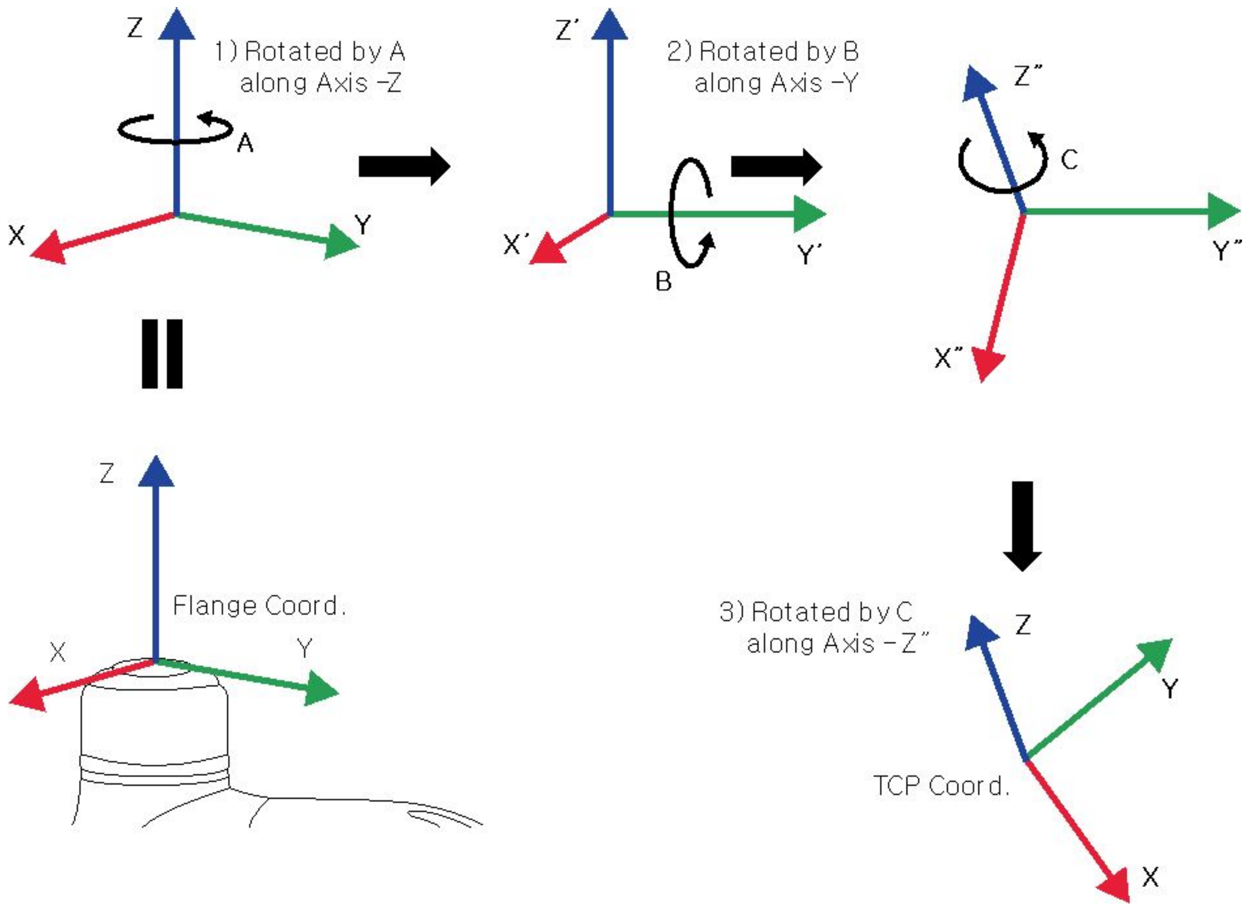
When configuring the tool center point (TCP), the position and rotation angle based on the flange coordinates must also be defined. At this time, The distance from the default starting point of the flange coordinate to the toolcenter point (TCP) inthe X, Y and Z directions cannot be set to be greater than 10000 mm. Also, note that Force Control, Compliance $L = \sqrt{X^2 + Y^2 + Z^2}$ Control, and Direct Teaching-Point Fixation are only available when the converted lengths of X, Y, and Z are 300 mm or shorter.

If the tool center point (TCP) is configured using Auto Calculate, the calculation is made based only on the X, Y and Z positions, so it is necessary to enter the rotation angle. The rotation angle can be defined with RZ, RY, and RX and it based on the “Euler Z-Y-Z” rotation method.



The definitions of the coordinate axis expressed with x, y, z and coordinate axis expressed with X, Y, Z are as follows:

- Coordinate axis of “Flange Coordinate” (x, y, z): The coordinate axis direction of the “flange coordinate ”defined at the end of the flange is identical to the robot coordinate when the robot joint angle of the robot is (0,0,0,0,0,0).
- Coordinate axis of the “TCP Coordinate” (X, Y, Z): This is set at the end or at the working point of the tool installed on the end of the flange. At this time, the rotation angle of the “TCP Coordinate” is defined based on the “Flange Coordinate”in the order of 1) to 3) of the following:

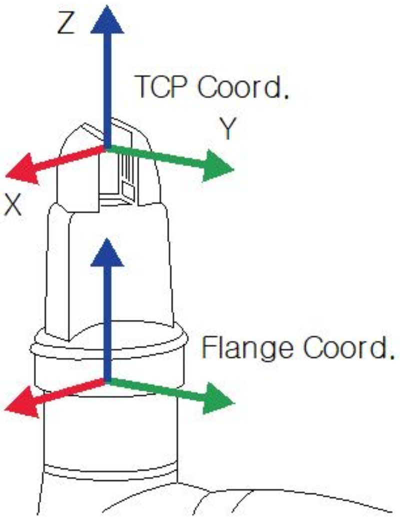


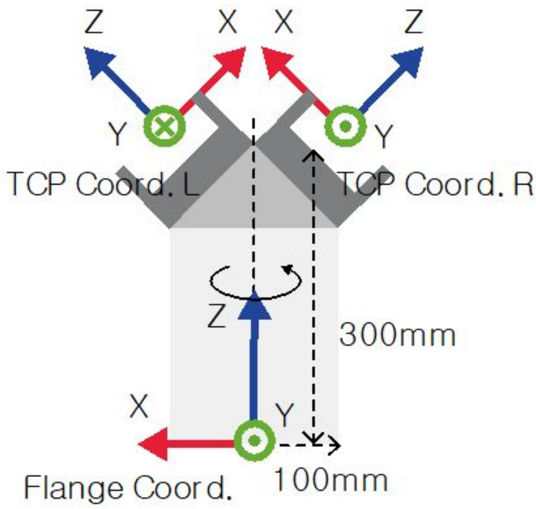
1) Rotate A degrees along the z axis of the flange coordinate.

2) Rotate B degrees along the y’ axis of the coordinate rotated according to 1).

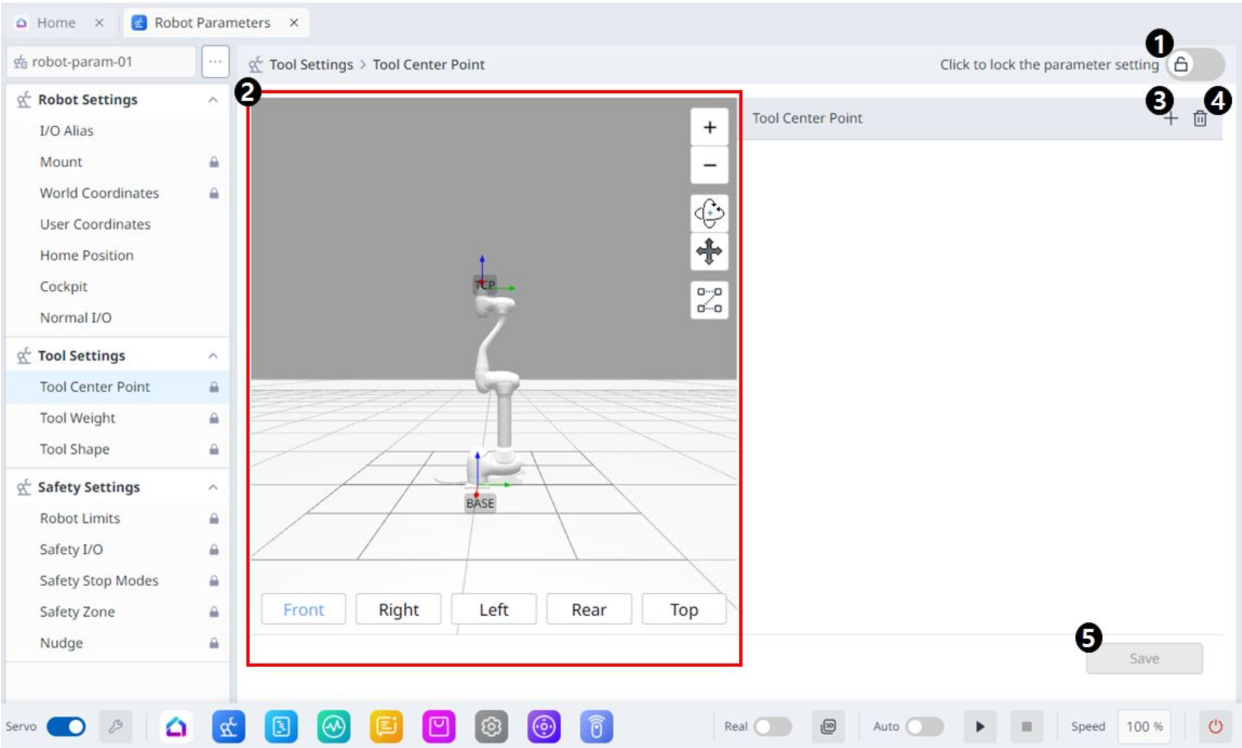
3) Rotate C degrees along the z’’axis of the coordinate rotated according to 2).

Here are a few examples of configuring the TCP according to the method described above:



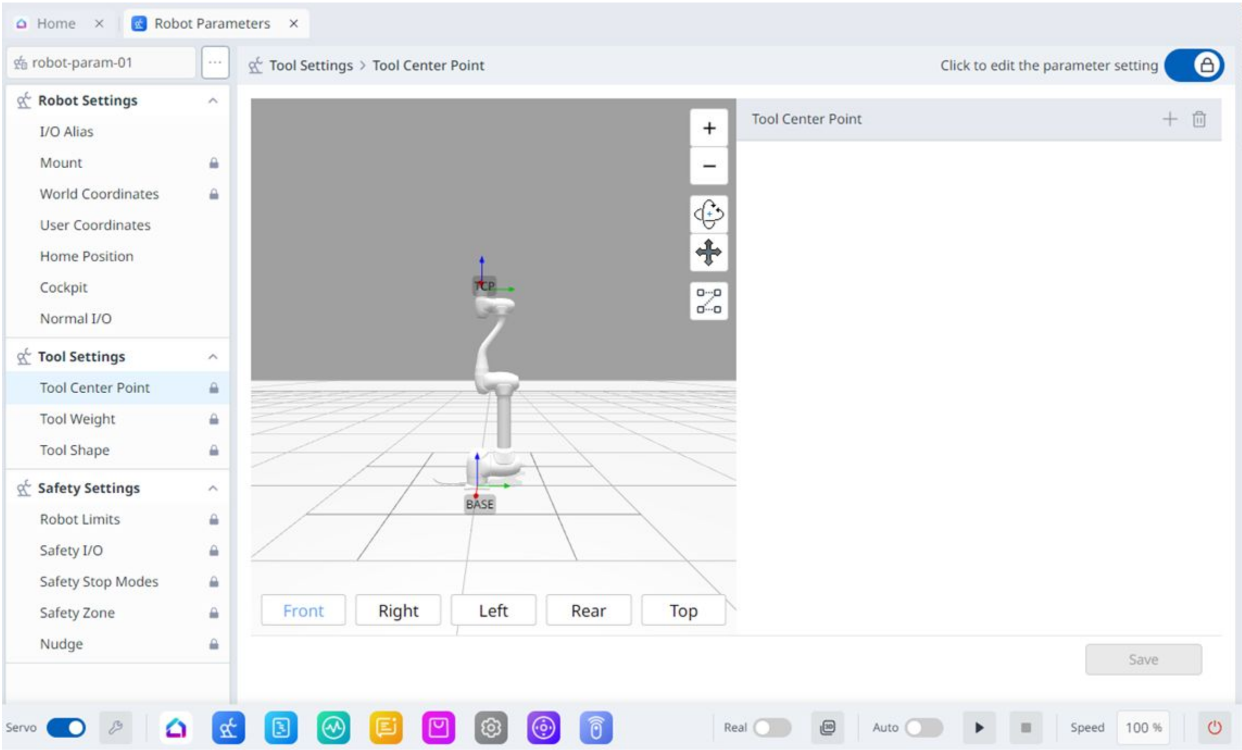


- [X, Y, Z, A, B, C] = [0, 0, 100, 0, 0, 0]: General Gripper with only a Z-direction offset (TCP Coord)
- [X, Y, Z, A, B, C] = [100, 0, 300, 180, -45, 0]: Left Gripper with 45-degree angle (TCP Coord. L)
- [X, Y, Z, A, B, C] = [-100, 0, 300, 0, -45, 0]: Right Gripper with 45-degree angle (TCP Coord. R)

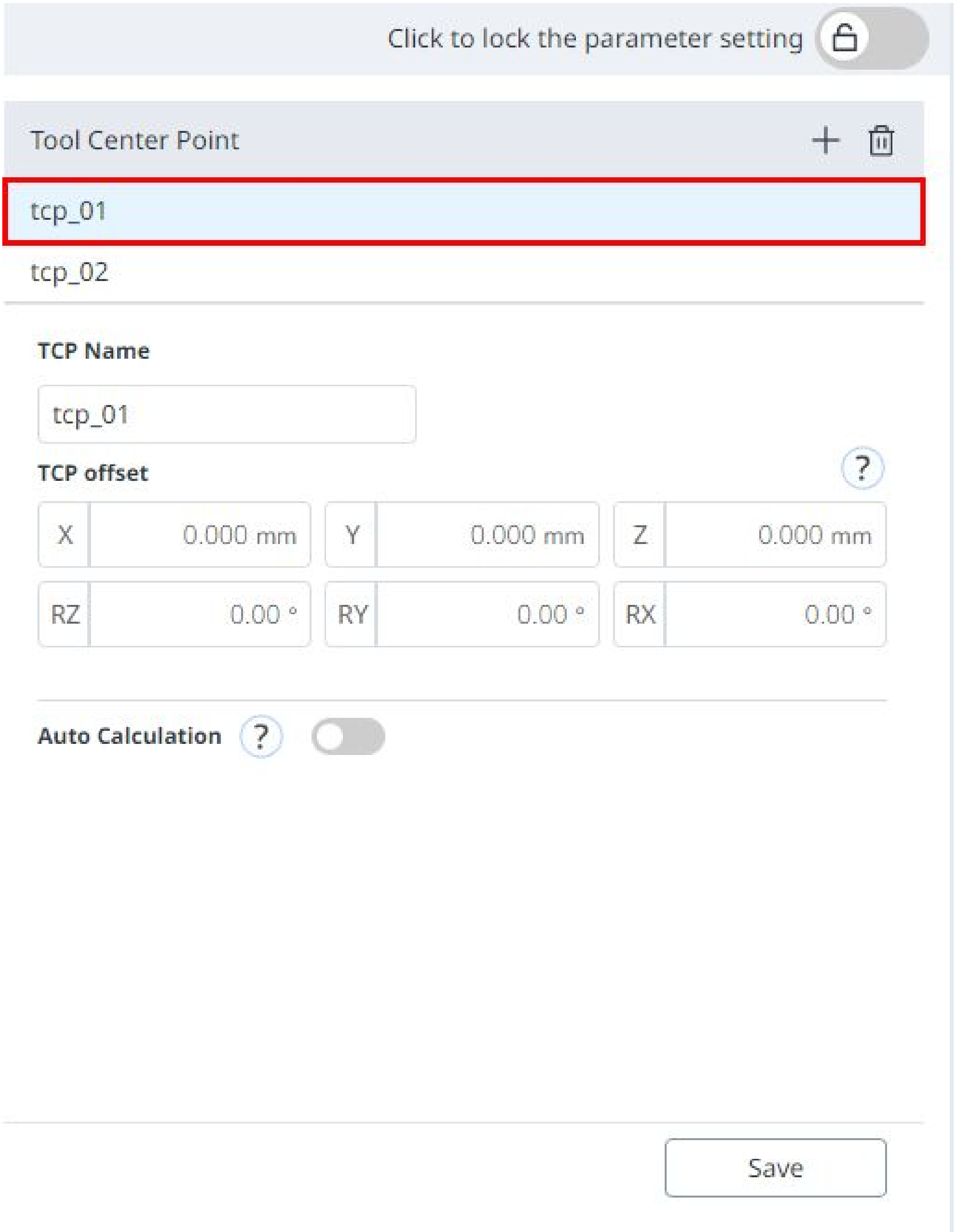


	Item	Description
1	Lock Toggle Button	Used to lock the set value. The safety password is required for modifying the value.
2	3D Simulation	This is where you can simulate the configured Tool Center Point.
3	Adding	This button allows you to add TCP.
4	Deleting	This button allows you to delete the selected TCP.
5	Save	This button allows the setting values to be saved.

When the settings are locked, the screen below is seen.



At this time, the selected TCP is seen in blue as shown below.


Click to lock the parameter setting
Tool Center Point
tcp_01
tcp_02
TCP Name
tcp_01
TCP offset
X
0.000 mm
Y
0.000 mm
Z
0.000 mm
RZ
0.00 °
RY
0.00 °
RX
0.00 °
Auto Calculation
Save

Tool Weight

The weight of the tool installed on the flange can be set by adding a tool weight Workcell Item. The Tool Weight can be set in **Robot Parameters > Tool Settings > Tool Weight**.

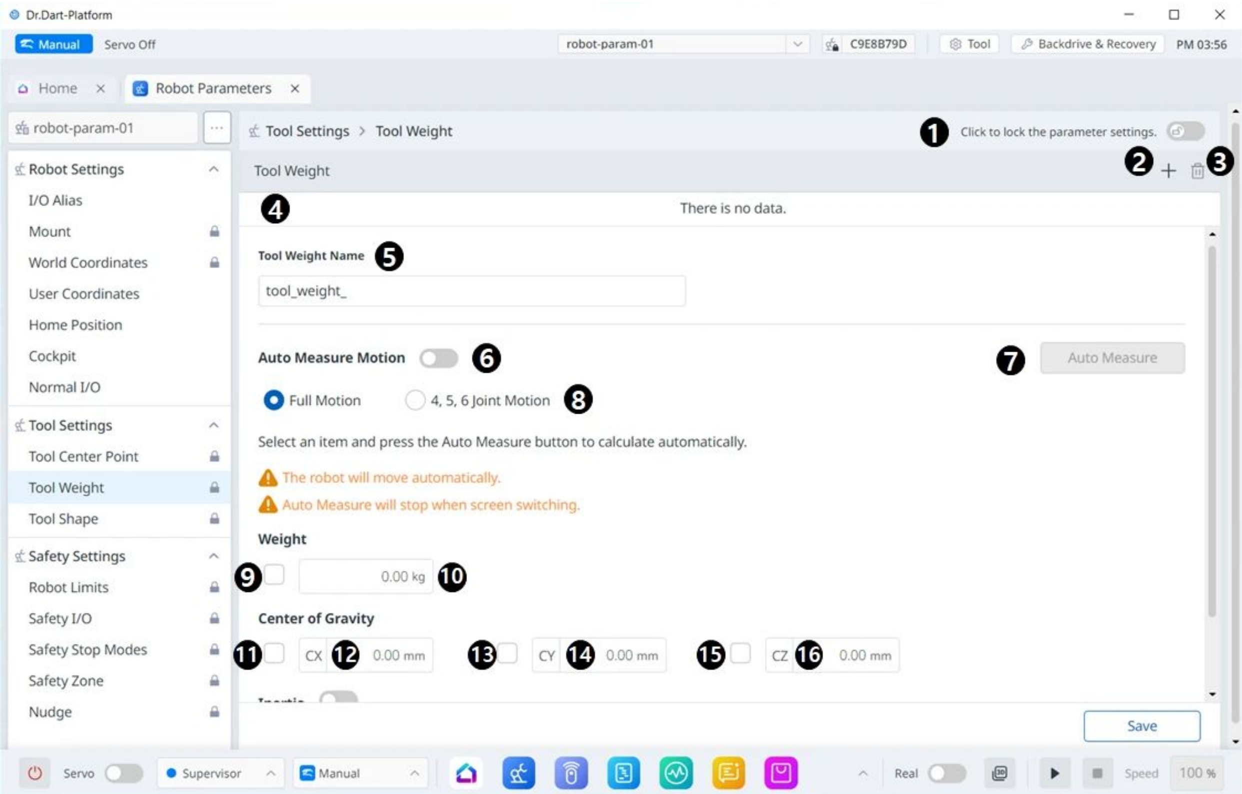
- The tool weight can be measured using the auto measure function.
- It is recommended to add tool weight as Workcell Items for each tool with a workpiece. If the workpiece weight is too heavy, the robot may recognize the weight of the workpiece as external force. It is because the robot determines this external force as a collision and stops.
- When creating a task, change the weight Workcell Item according to the process to change the tool weight. For example, it is possible to configure a task to select the standard tool weight Workcell Item before picking up a workpiece, and select the tool weight Workcell Item with the workpiece after picking up a workpiece.

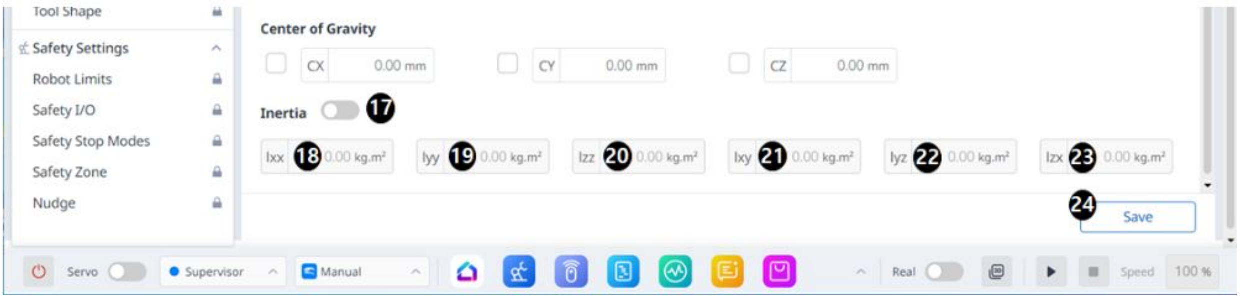
The activated tool weight Item can be set as the standard tool weight by pressing the set tool icon (

) on the top of the teach pendant.

- Set of the tool setting is the same as the **set** of Other Commands. **Set** command can be used when changing the Tool Weight while a task is being performed. For more information, refer to Task Editor Module(p. 319).

> **Note**
>
> - Up to fifty different tool weights can be registered.





	Item	Description
1	Lock Toggle Button	Used to lock the set value. The safety password is required for modifying the set value.
2	Adding	This button allows you to add a new Tool Weight.
3	Deleting	This button allows you to delete a Tool Weight.
4	Tool Weight List	A list of the configured Tool Weights

	Item	Description
5	Tool Weight Name	This is where you can enter a name for the Tool Weight.
6	Auto Measure Motion	This button allows you to run the automatic measurement.
7	Automatic Measurement	This button allows you to select an option and run an automatic measurement for it.
8	Motion Selection	You can select the desired Motion from the options.
9	Selection of the Use of Weight	You can choose whether to use weight. This selection box is disabled for E Series or A Series without FPT sensors.
10	Weight Input	This is where you can enter the desired weight.
11	Selection of the Use of Center of Gravity CX	The use of the center of gravity CX can be selected.
12	CX Input	CX can be entered.
13	Selection of the Use of Center of Gravity CY	The use of the center of gravity CY can be selected.
14	CY Input	CY can be entered.
15	Selection of the Use of Center of Gravity CZ	The use of the center of gravity CZ can be selected.
16	CZ Input	CZ can be entered.
17	Whether to Use Inertia	This checkbox allows you to choose whether to use inertia.
18	lxx Input	An LXX entry for inertia can be entered.
19	lyy Input	An lyy entry for inertia can be entered.
20	lzz Input	An lzz entry for inertia can be entered.
21	lxy Input	An lxy entry for inertia can be entered.

	Item	Description
22	Iyz Input	An Iyz entry for inertia can be entered.
23	Izx Input	An Izx entry for inertia can be entered.
24	Save	This button allows you to save the setting values.

Tool Shape

MANDATORY **EASY** **5 MIN**

The shape of the tool installed on the flange can be set by adding a tool shape Workcell Item.

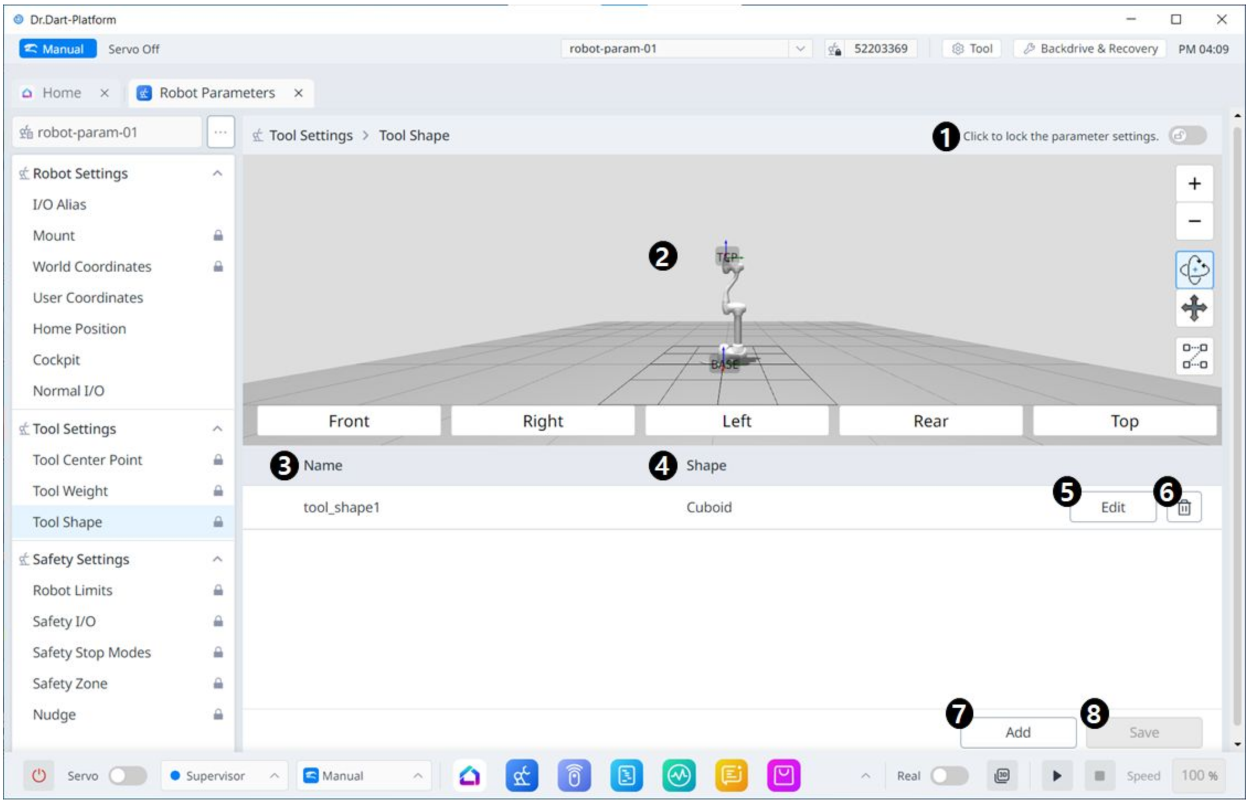
The Tool Shape can be set in **Robot Parameters module > Tool Settings > Tool Shape**. For more information, see Tool Shape setting(p. 269).

- The robot determines space limit violation status based on the TCP (Tool Center Point) of the robot end and the robot body. If the actual robot has a tool shape larger than the set TCP, a tool shape Workcell Item must be added to protect the workpiece and tool.
- Take caution as the zone the robot can maneuver will decrease if the tool shape is set too large.

The tool shape item is only available after it is registered (Confirmed) and the toggle switch is enabled. The activated tool shape Item can be set as the standard tool shape by pressing the set tool icon (Tool) on the top of the teach pendant.

- Set of the tool setting is the same as **set** of Other Commands. **Set** command can be used when changing the Tool Shape while a task is being performed. For more information, refer to Task Editor Module(p. 319) .

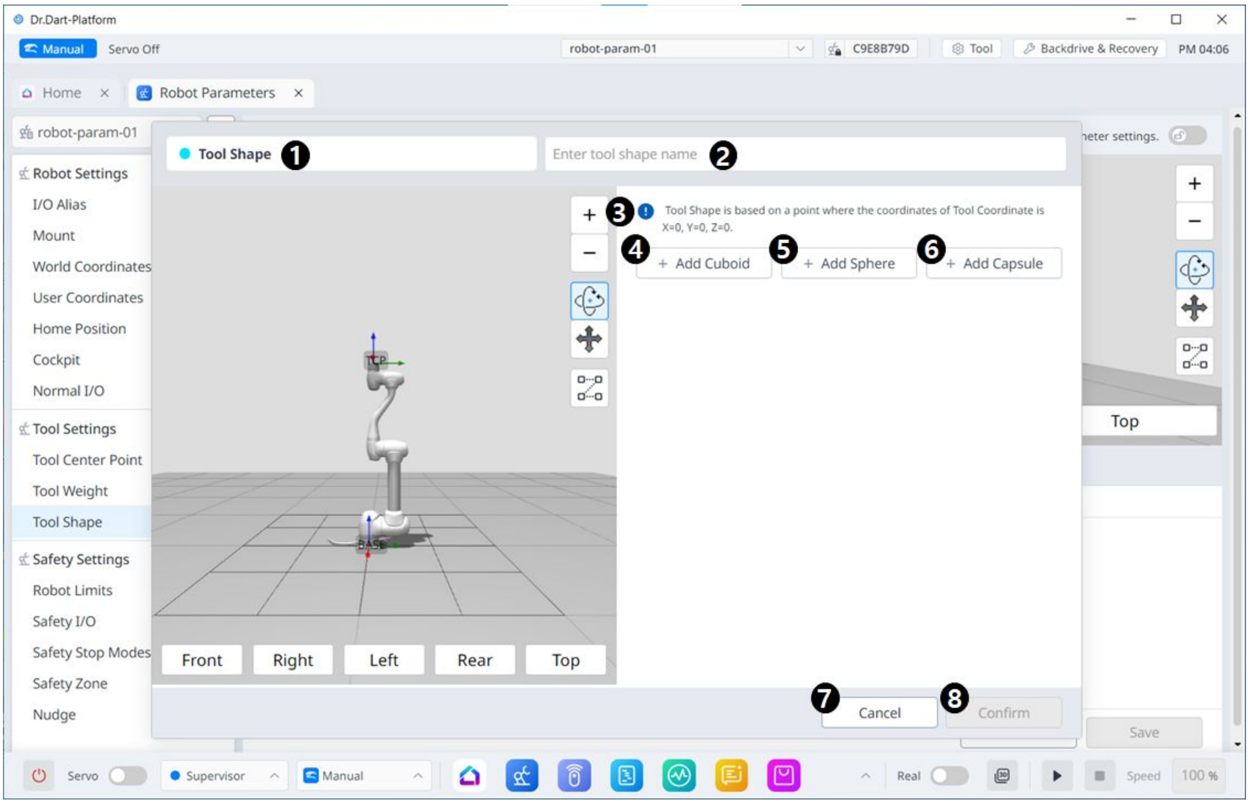
> **Note**
>
> - Up to fifty different tool shapes can be registered.



Menu Items

	Item	Description
1	Lock Toggle Button	Used to lock the set value. The safety password is required for modification.
2	3D Simulation	This is where you can 3D Simulate the result of the configured Tool Shape.
3	Whether to enable Tool Shape	This button allows you to select whether to enable each Tool Shape.
4	Tool Shape Name	The name of the configured Tool.
5	Tool Shape Form	The shape of the configured Tool.
6	Editing Tool Shape	This button allows you to edit the configured Tool Shape.
7	Deleting Tool Shape	This button allows you to delete the selected Tool Shape.

	Item	Description
8	Adding Tool Shape	A tool shape can be added.
9	Applying	This button allows you to apply the Tool Shape after setting it.

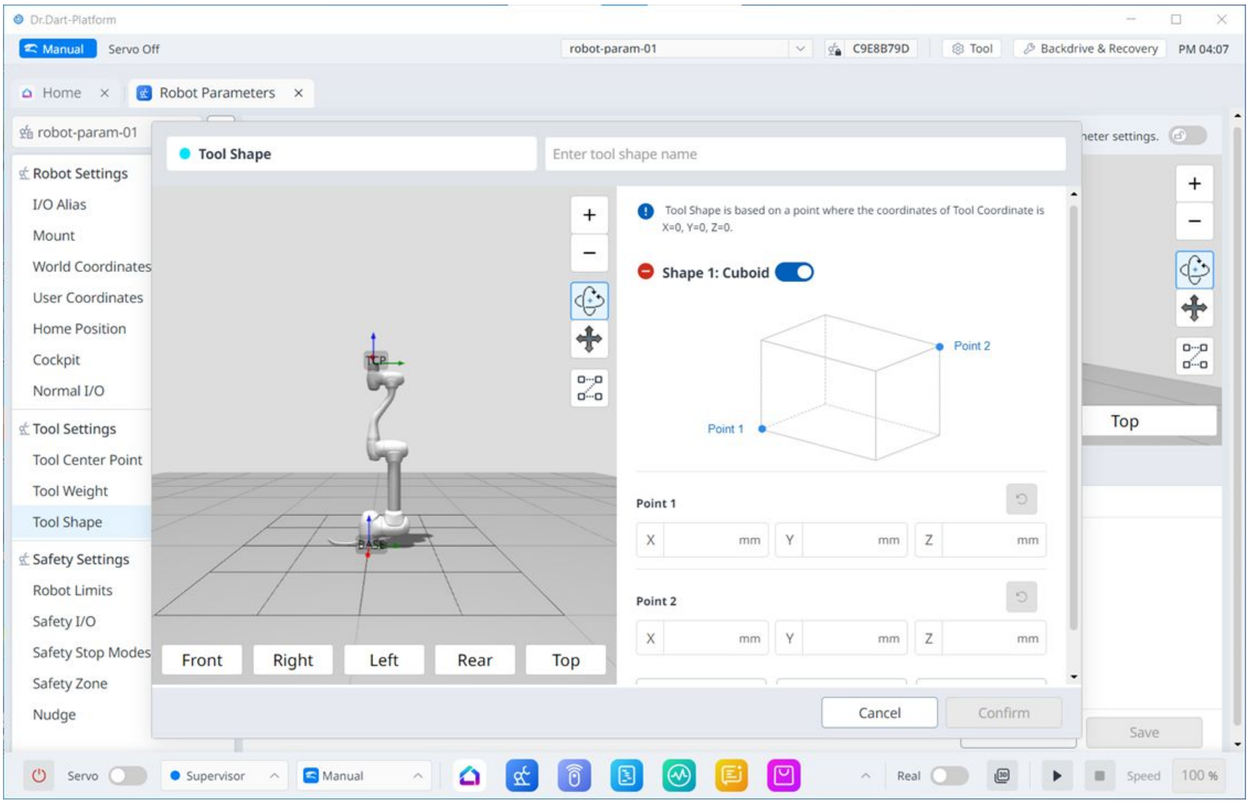


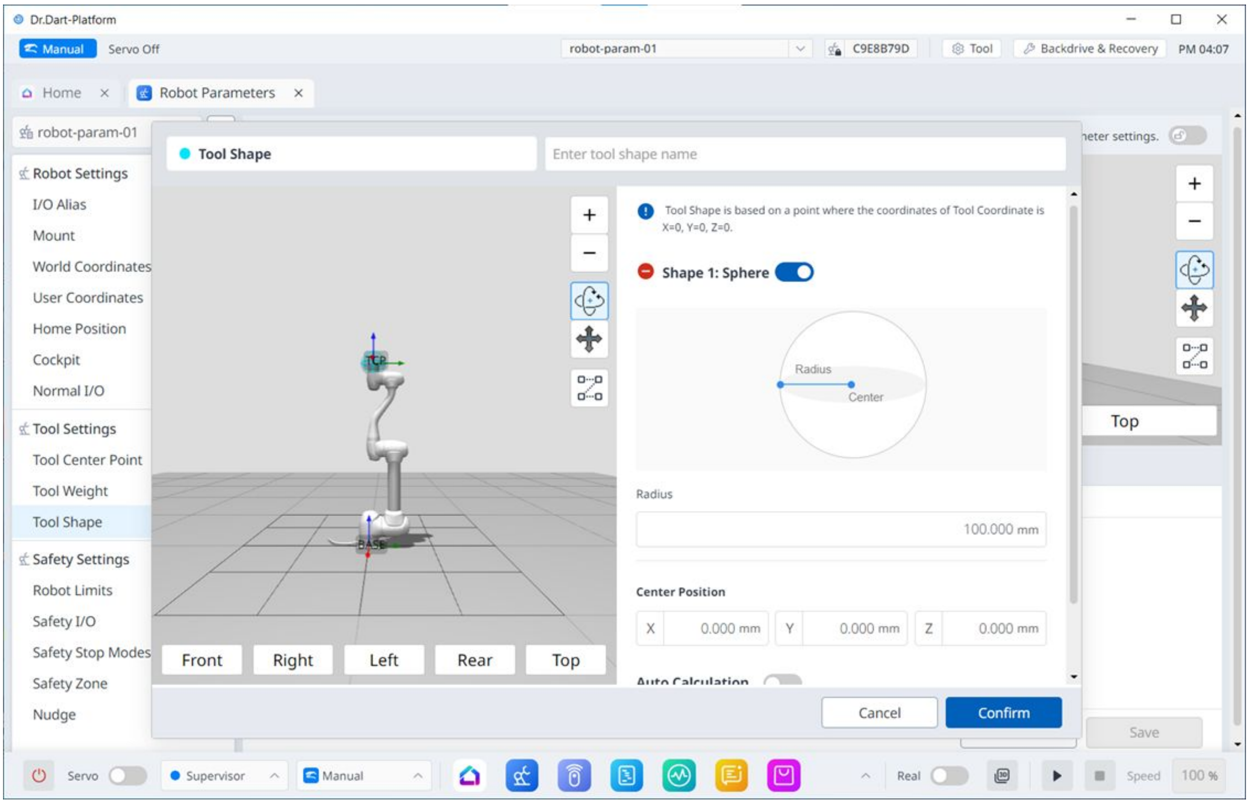
Menu Items

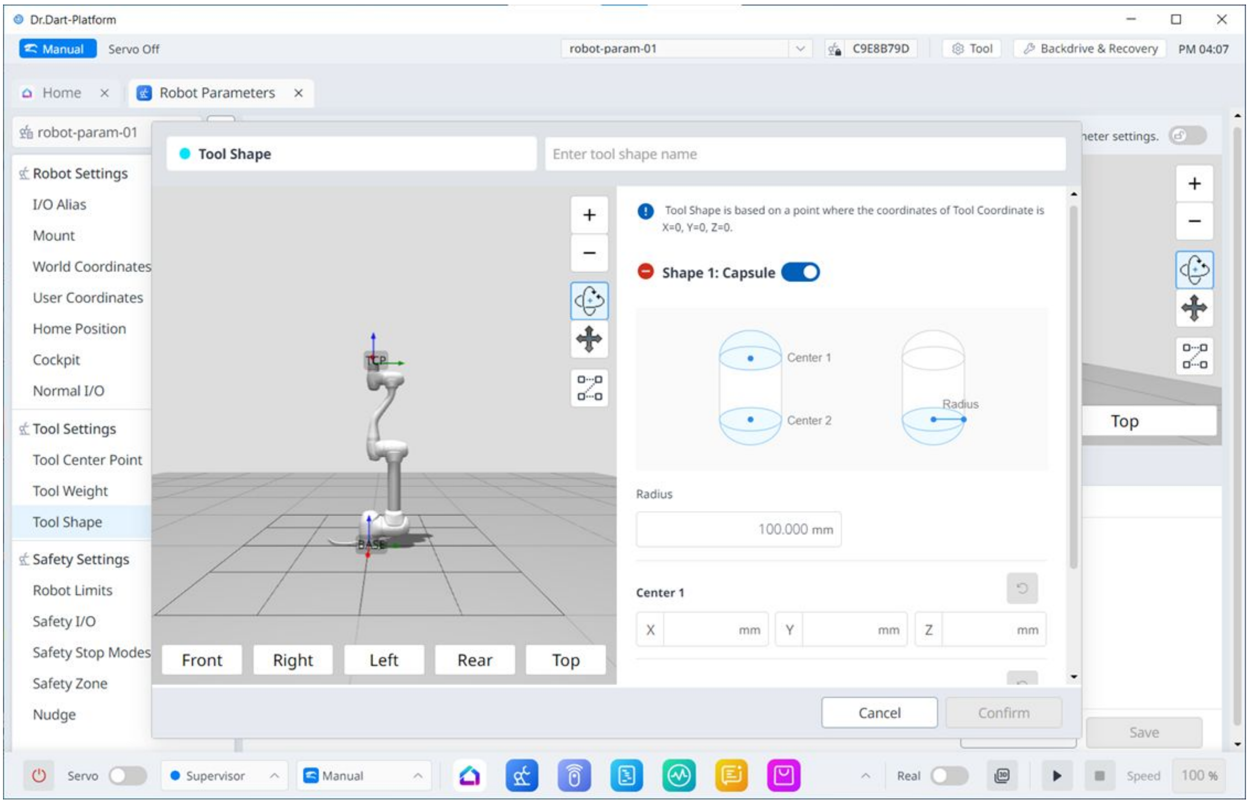
	Item	Description
1	Tool Shape	This indicates that this pane is a Tool Shape pop-up.
2	Entering a Name	This is a field where the name of the Tool Shape can be entered.
3	Cautionary Message	A note of caution when setting up
4	Add New Cuboid	This button allows you to add a cuboid.

	Item	Description
5	Add New Sphere	This button allows you to add a sphere.
6	Add New Capsule	This button allows you to add a capsule.
7	Cancel	This button allows you to cancel the setting.
8	Confirm	This button allows you to confirm the setting.

Once the cube/sphere/capsule is added, the display is seen as below.




Tool Shape
Tool Shape is based on a point where the coordinates of Tool Coordinate is X=0, Y=0, Z=0.
Shape 1: Sphere
Radius
Center
Radius
100.000 mm
Center Position
Cancel
Confirm


Tool Shape
Tool Shape is based on a point where the coordinates of Tool Coordinate is X=0, Y=0, Z=0.
Shape 1: Capsule
Center 1
Center 2
Radius
Radius
100.000 mm
Center 1
Cancel
Confirm

5.7.3 Safety Settings

This section walks you through the basic concepts for using Safety Settings.

The stop modes provided to ensure user safety are as follows:

- STO (Safe Torque Off): Stops Servo Off (motor power is immediately turned off)
- SS1 (Safe Stop 1): Servo Off after maximum deceleration stop
- SS2 (Safe Stop 2): Standby after maximum deceleration stop (pause)
- RS1: Upon collision, complies to the direction opposite of the collision and then enters standby (can only be set in Collision Detection/TCP Force Limit Violation)

Doosan Robotics robots have two types of safety stop functions. Emergency Stop is used for general emergency situations, and the robot can resume operation with Servo On after releasing the emergency stop. In case of Protective Stop, the robot can resume operation by resolving the cause of Protective Stop and releasing the stop.

- Emergency Stop: It sets the stop mode when the Emergency Stop button of the teach pendant or an additionally installed external device is activated
  - It activates when the Emergency Stop switch of the teach pendant or the one connected to the TBSFT EM terminal is pressed.
  - Only STO or SS1 can be selected.
- Protective Stop: It sets the stop mode when the externally connected protective equipment is activated
  - It activates when the protective equipment connected to the TBSFT PR terminal is activated.

For more information on the Safety Stop functions, refer to Safety Functions(p. 21).

Press the Emergency Stop button on the teach pendant or activate the safety device connected to the Safety I/O to activate emergency stop. Safety devices can be connected to Emergency Stop or Protective Stop through **Robot Parameters > Safety Settings > Safety I/O** functions of the teach pendant screen.

- For more information about connecting a safety device to Safety I/O, refer to Connect Controller I/O(p. 167).
- For information on how to set the safety stop function for this connection in the program, See Safety Signal I/O(p. 33).

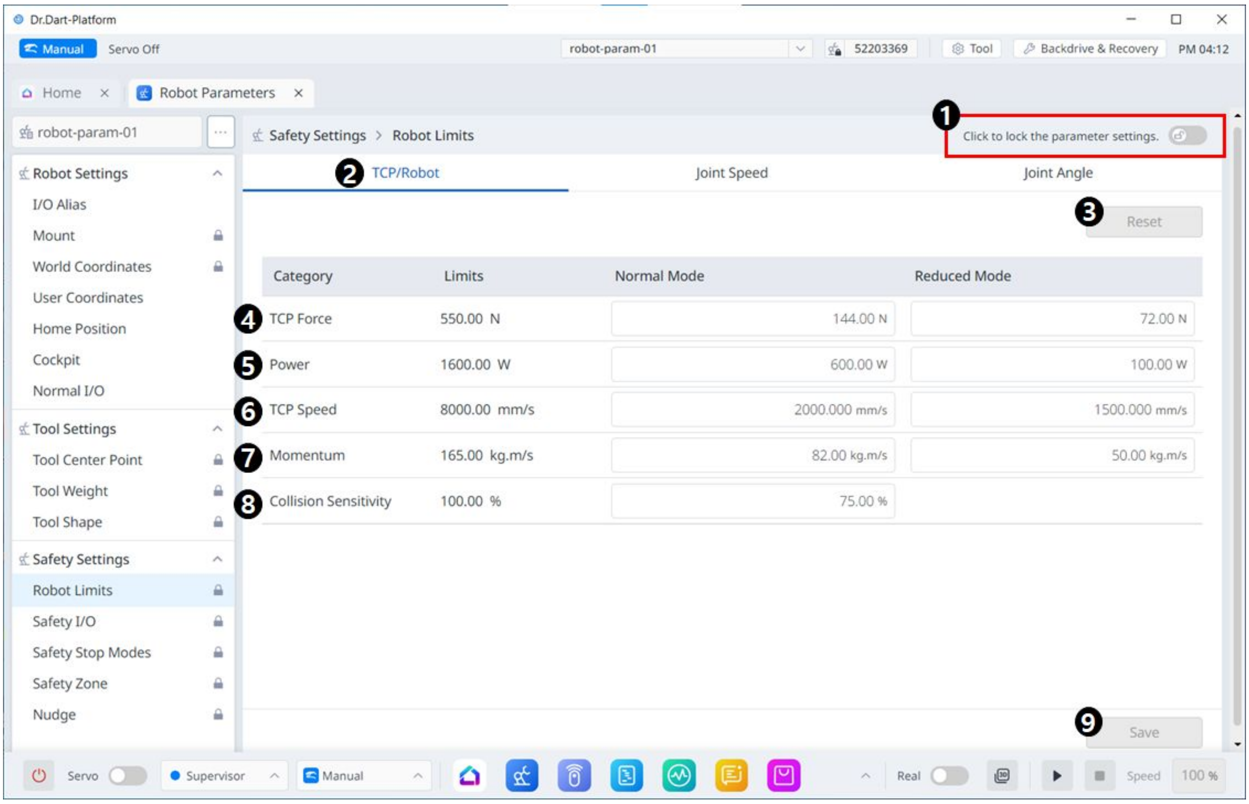
Robot Limits Setting

In Robot Limits, various limits related to the robot can be set. These limits are used to ensure the robot operates safely within the set limits.

Robot limits can be set in **Robot Parameter > Safety Settings > Robot Limits**.

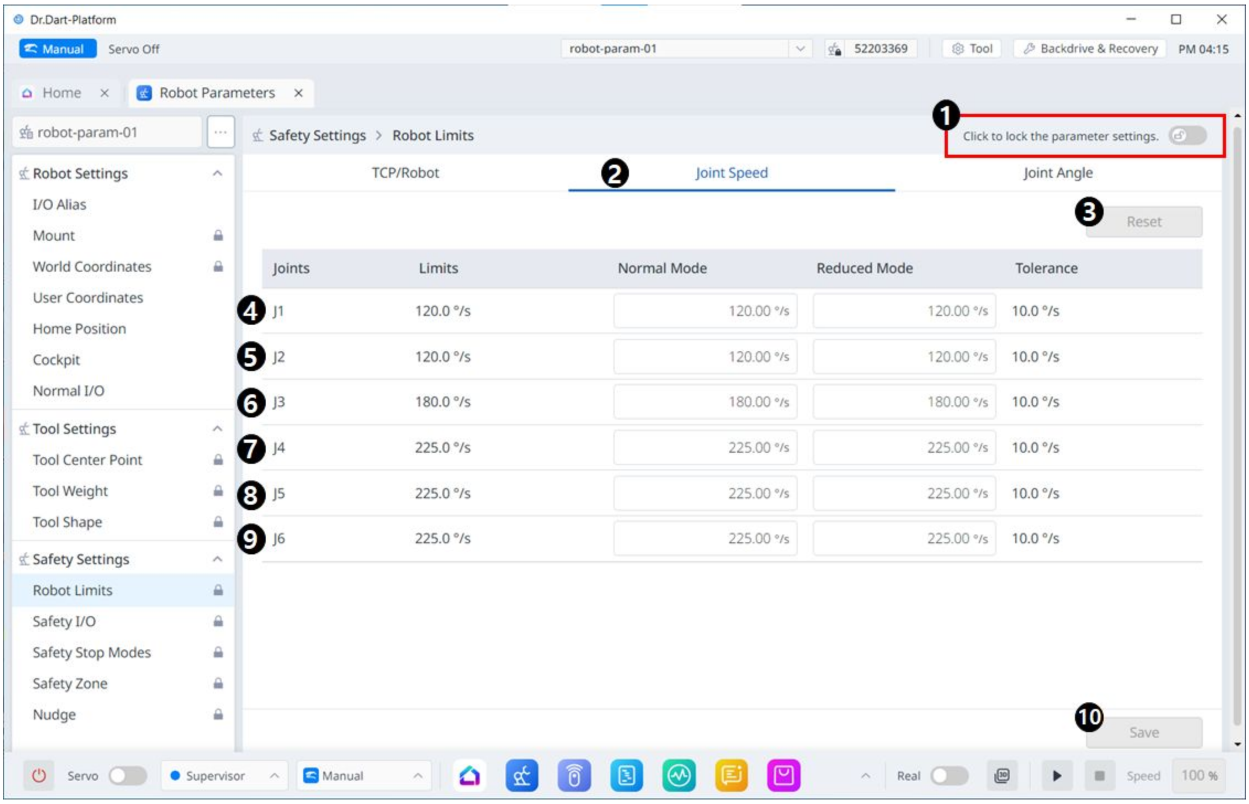
- For a detailed description of each limit, see Robot Limits(p. 31) .

Robot Limits are largely divided into 3 categories. Each category includes the following screens and functions.



Menu Items

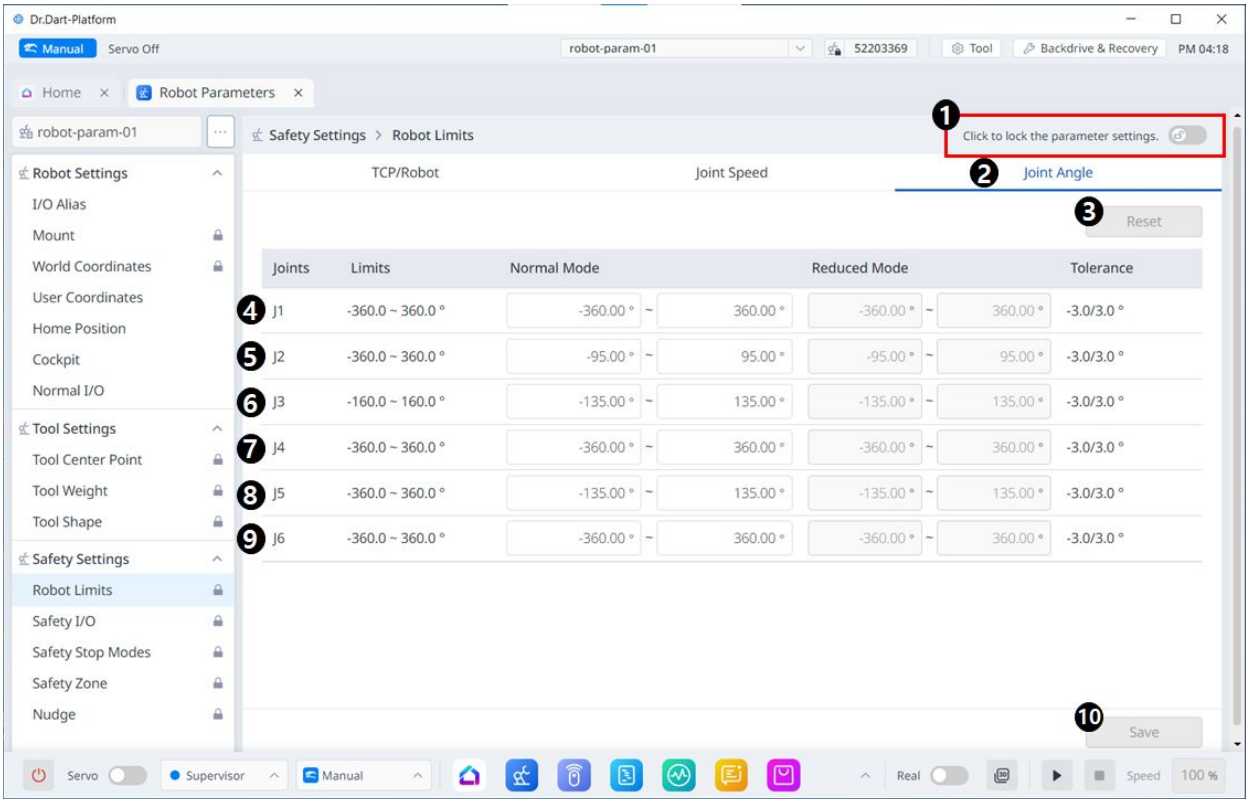
	Item	Description
1	Lock Toggle Button	Used to lock the set value. The safety password is required for modifying the set value.
2	TCP/Robot	Large classification of robot limits.
3	Reset	Used to reset settings.
4	Force	Used to set the force.
5	Power	Used to set the power.
6	Speed	Used to set the speed.
7	Momentum	Used to set the momentum.
8	Collision	Used to set the collision.
9	Save	Used to save the applicable setting.



Menu Items

	Item	Description
1	Lock Toggle Button	Used to lock the set value. The safety password is required for modifying the set value.
2	Joint Speed	Large classification of robot limits.
3	Reset	Used to reset settings.
4	J1	Used to set the settings for Normal and Reduced modes respectively.
5	J2	Used to set the settings for Normal and Reduced modes respectively.
6	J3	Used to set the settings for Normal and Reduced modes respectively.

	Item	Description
7	J4	Used to set the settings for Normal and Reduced modes respectively.
8	J5	Used to set the settings for Normal and Reduced modes respectively.
9	J6	Used to set the settings for Normal and Reduced modes respectively.
10	Save	Used to save the applicable setting.



Menu Items

	Item	Description
1	Lock Toggle Button	Used to lock the set value. The safety password is required for modifying the set value.
2	Joint Angle	Large classification of robot limits.

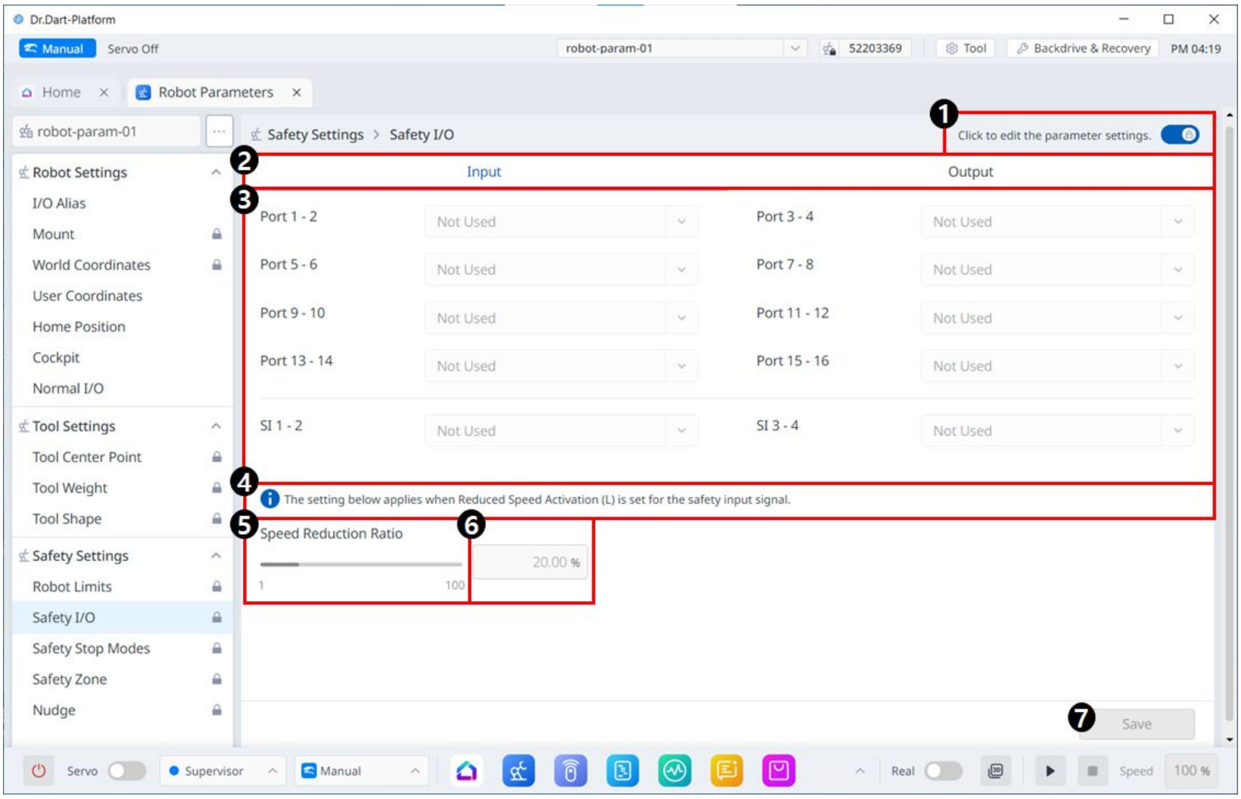
	Item	Description
3	Reset	Used to reset settings.
4	J1	Used to set the settings for Normal and Reduced modes respectively.
5	J2	Used to set the settings for Normal and Reduced modes respectively.
6	J3	Used to set the settings for Normal and Reduced modes respectively.
7	J4	Used to set the settings for Normal and Reduced modes respectively.
8	J5	Used to set the settings for Normal and Reduced modes respectively.
9	J6	Used to set the settings for Normal and Reduced modes respectively.
10	Save	Used to save the applicable setting.

Safety I/O Setting

This function inputs/outputs safety-related signals through a redundant terminal. If any signal that is different from the redundant safety input or output signal is detected, the system determines whether it is a short circuit or hardware defect and stops the robot with STO Stop Mode.

- Safety Signal I/O) can be set in **Robot Parameters > Safety Settings > Safety I/O**.

For more information, see Safety Signal I/O(p. 33) .

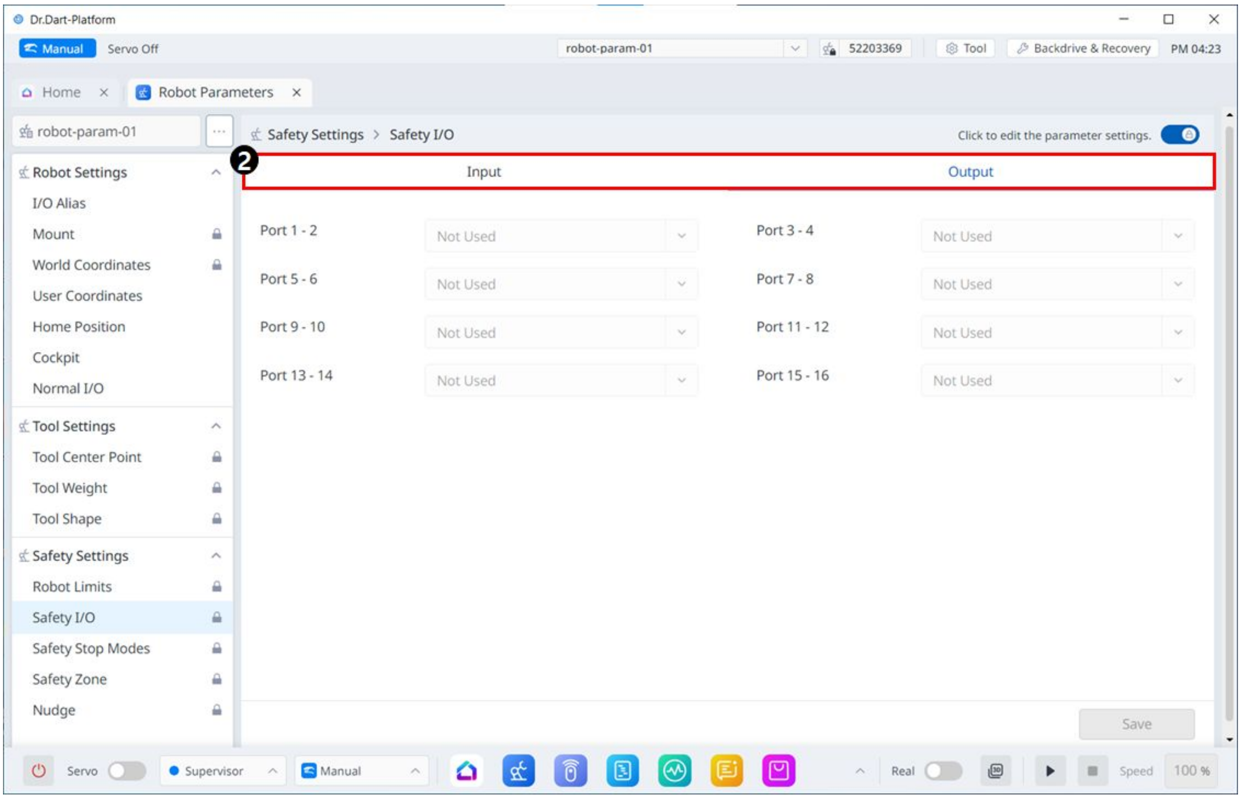


Menu Items

	Item	Description
1	Lock Toggle Button	Used to lock the set value. The safety password is required for modifying the set value.
2	Input/Output	Either Input/Output can be selected to be set.

	Item	Description
3	Port list	This is a list of Ports in the corresponding category. The drop-down menus include: Not Used Emergence Stop (L) Emergence Stop - No Loopback (L) Protective Stop (L) Protective Stop - STO (L) Protective Stop - SS1 (L) Protective Stop - SS2 (L) Protective Stop (L) - Auto Reset & Resume (R) Interlock Reset (R) Reduced Speed Activation (L) 3-Pos Enable Switch (H) Handguiding Enable Switch (H) Remote Control Enable (H) Safety Zone Dynamic Enable (H) Safety Zone Dynamic Enable (L) HGC End & Task Resume (R)
4	Caution Message	A note of caution for setting up Safety I/O.
5	Velocity Reduction Rate Slider	You can use the slider to set the Speed Reduction Ratio. It can be set from 0 to 100.
6	Velocity Reduction Rate Input	The velocity reduction rate can be directly entered. It can be set from 0 to 100%.
7	Save	This button allows you to save the setting you entered.

The Output screen appears as follows, similar to Input.



Safety Stop Modes Setting

MANDATORY **EASY** **5 MIN**

Learn the types of safety stops and how to engage/disengage safety stop.

Types of Safety Stops

The stop modes provided to ensure user safety are as follows:

- STO (Safe Torque Off): Stops Servo Off (motor power is immediately turned off)
- SS1 (Safe Stop 1): Servo Off after maximum deceleration stop
- SS2 (Safe Stop 2): Standby after maximum deceleration stop (pause)
- RS1: Upon collision, it moves in the opposite direction of the collision and then enters standby (can only be set in Collision Detection/TCP Force Limit Violation)

Doosan Robotics robots have two types of safety stop functions. Emergency Stop is used for general emergency situations, and the robot can resume operation with Servo On after releasing the emergency stop. In case of Protective Stop, the robot can resume operation by resolving the cause of Protective Stop and releasing the stop.

- Emergency Stop: It sets the stop mode when the Emergency Stop button of the teach pendant or an additionally installed external device is activated
  - It activates when the Emergency Stop switch of the teach pendant or the one connected to the TBSFT EM terminal is pressed.

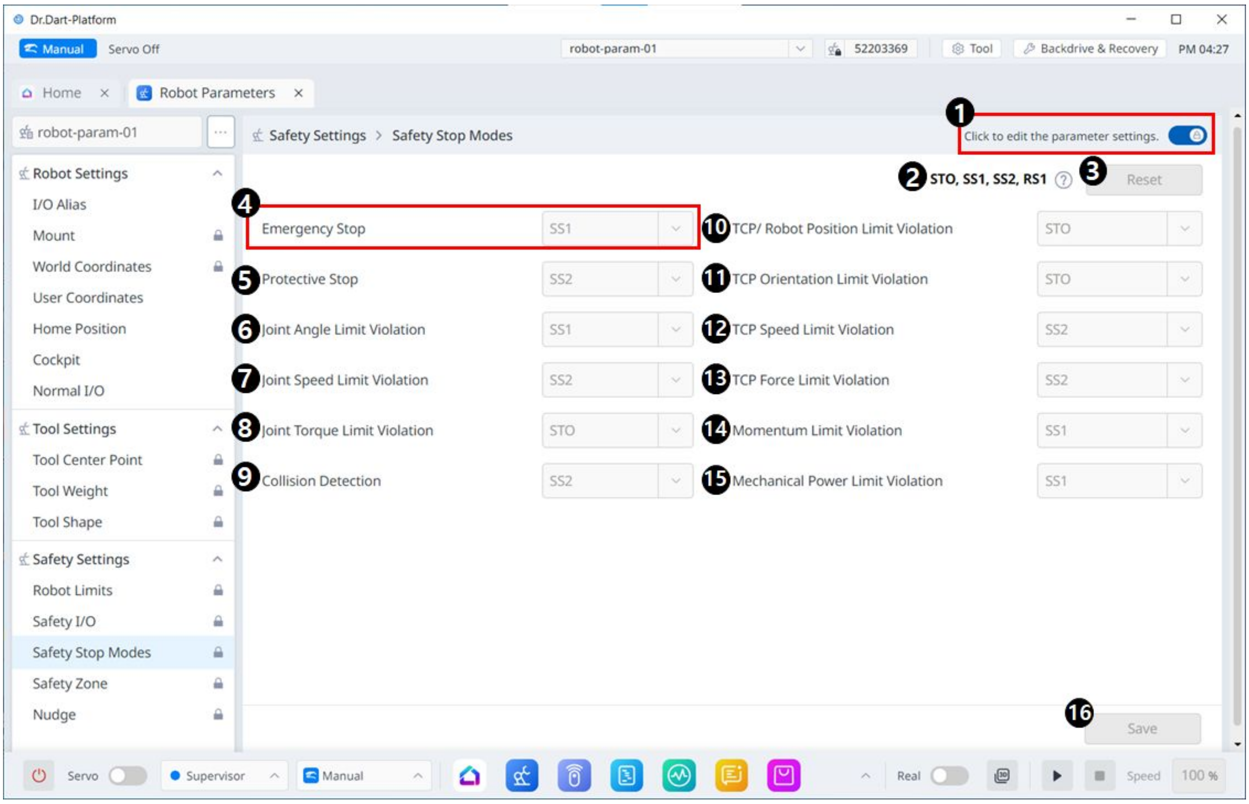
- Only STO or SS1 can be selected.
- Protective Stop: It sets the stop mode when the externally connected protective equipment is activated
    - It activates when the protective equipment connected to the TBSFT PR terminal is activated.

For more information about the Safety Stop functions, refer to Safety Function(p. 20).

How to engage/disengage Safety Stop

Press the Emergency Stop button on the teach pendant or activate the safety device connected to the Safety I/O to activate emergency stop. Safety devices can be connected to Emergency Stop or Protective Stop through **Workcell Manager > Robot > Safety I/O** functions of the teach pendant screen.

- For more information about connecting a safety device to Safety I/O, refer to Connect Controller I/O(p. 167).
- For information on how to set the safety stop function for this connection in the program, See Safety Signal I/O(p. 278).



Menu Items

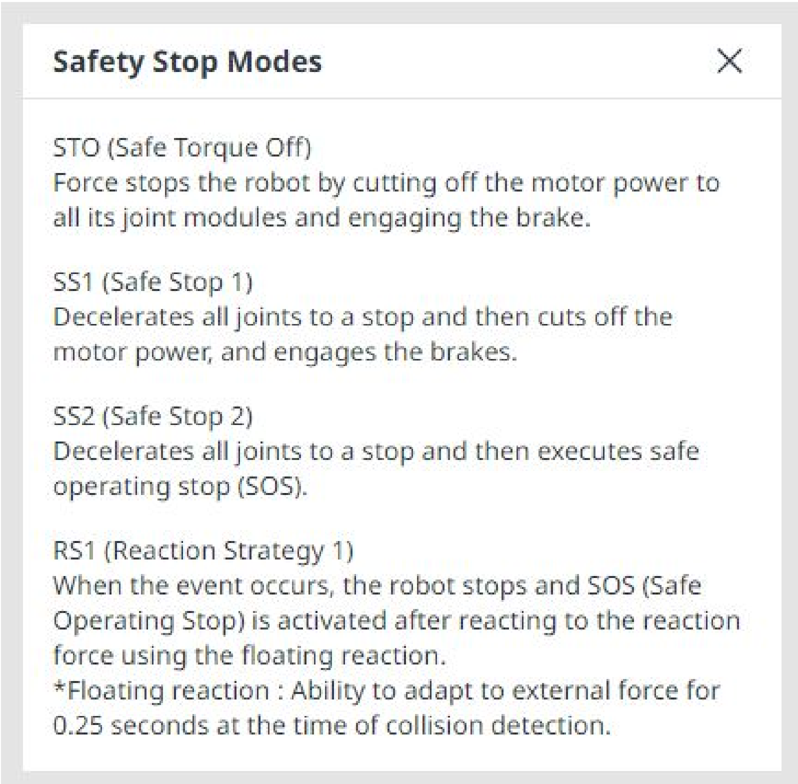
	Item	Description
1	Lock Toggle Button	Used to lock the set value. The safety password is required for modifying the set value.
2	Information message	A message providing information necessary for setting.

	Item	Description
3	Reset	A button to reset the settings.
4	Emergency Stop	A Safety Stop can be selected to be used for the corresponding item. The drop-down menu includes the following: STO SS1
5	#Protective Stop#	A Safety Stop can be selected to be used for the corresponding item. The drop-down menu includes the following: SS1 SS2
6	Joint Angle Limit Violation	A Safety Stop can be selected to be used for the corresponding item. The drop-down menu includes the following: STO SS1 SS2
7	Joint Speed Limit Violation	A Safety Stop can be selected to be used for the corresponding item. The drop-down menu includes the following: STO SS1 SS2
8	Joint Torque Limit Violation	Only STO is available.
9	Collision Detection	A Safety Stop can be selected to be used for the corresponding item. The drop-down menu includes the following: STO SS1 SS2 RS1

	Item	Description
10	TCP Robot Position Limit Violation	A Safety Stop can be selected to be used for the corresponding item. The drop-down menu includes the following: STO SS1 SS2
11	TCP Orientation Limit Violation	A Safety Stop can be selected to be used for the corresponding item. The drop-down menu includes the following: STO SS1 SS2
12	TCP Speed Limit Violation	A Safety Stop can be selected to be used for the corresponding item. The drop-down menu includes the following: STO SS1 SS2
13	TCP Force Limit Violation	A Safety Stop can be selected to be used for the corresponding item. The drop-down menu includes the following: STO SS1 SS2
14	Momentum Limit Violation	A Safety Stop can be selected to be used for the corresponding item. The drop-down menu includes the following: STO SS1 SS2

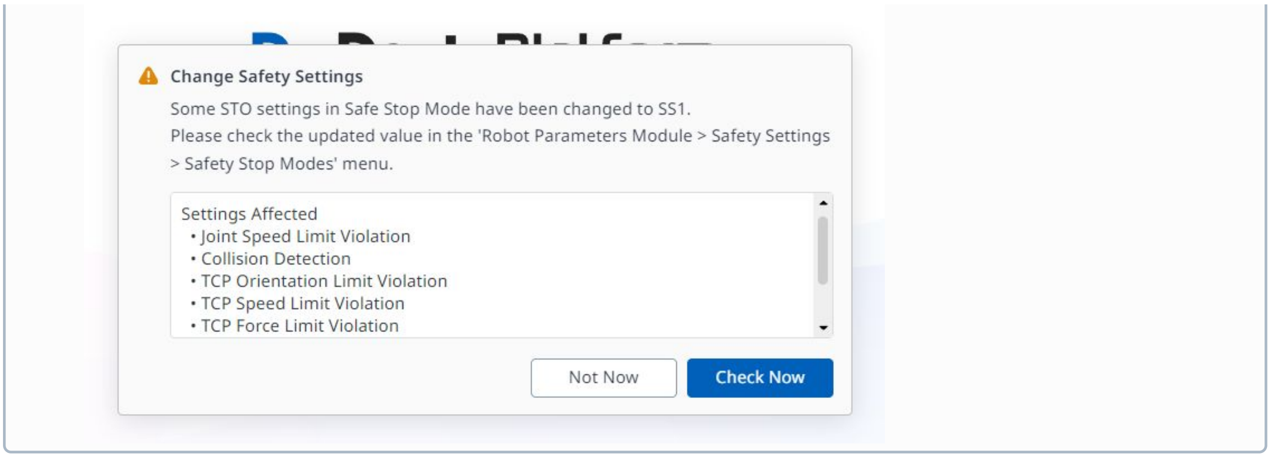
	Item	Description
15	Mechanical Limit Violation	A Safety Stop can be selected to be used for the corresponding item. The drop-down menu includes the following: STO SS1 SS2
16	Save	This button allows you to save the setting values.

The following pop-up appears on the information message:

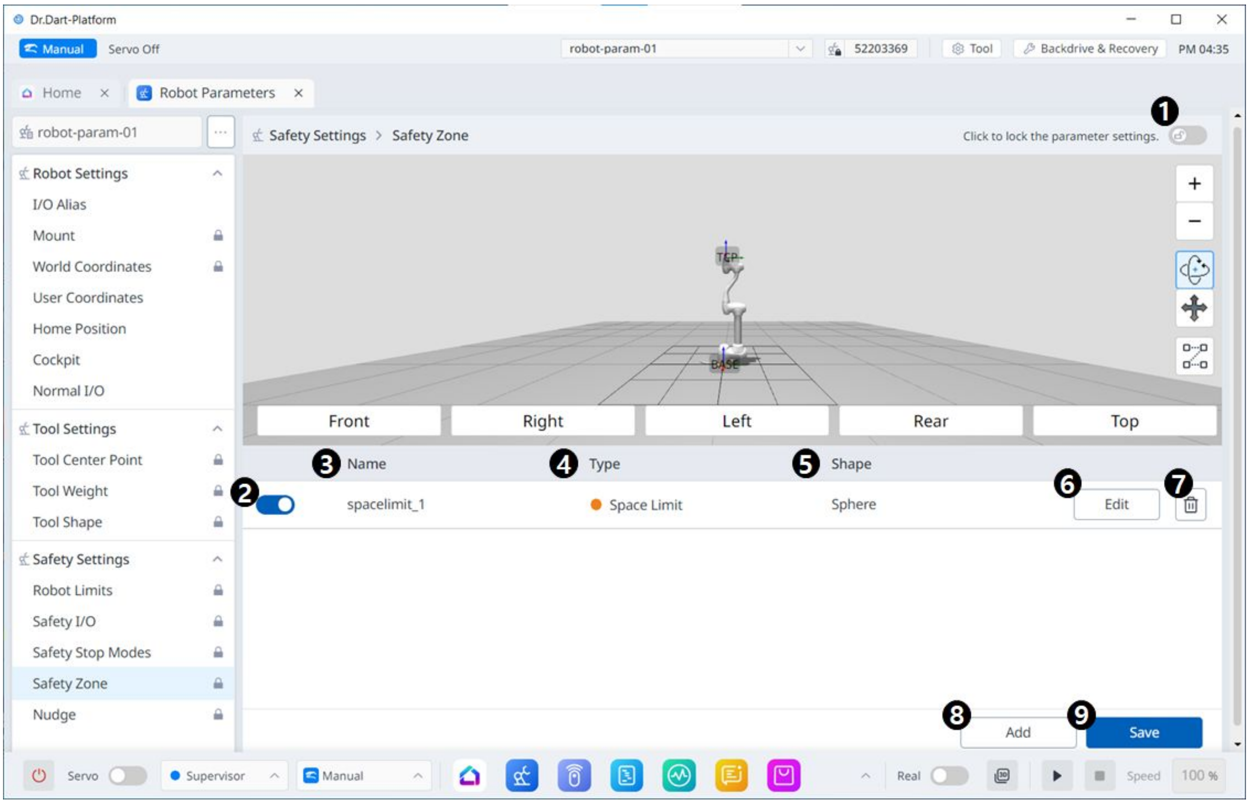


Note

From version 3.2.2, some STO settings in the H model's Safety Stop Modes have been changed to SS1. If the values in use have been updated, the following popup will appear.



Safety Zone

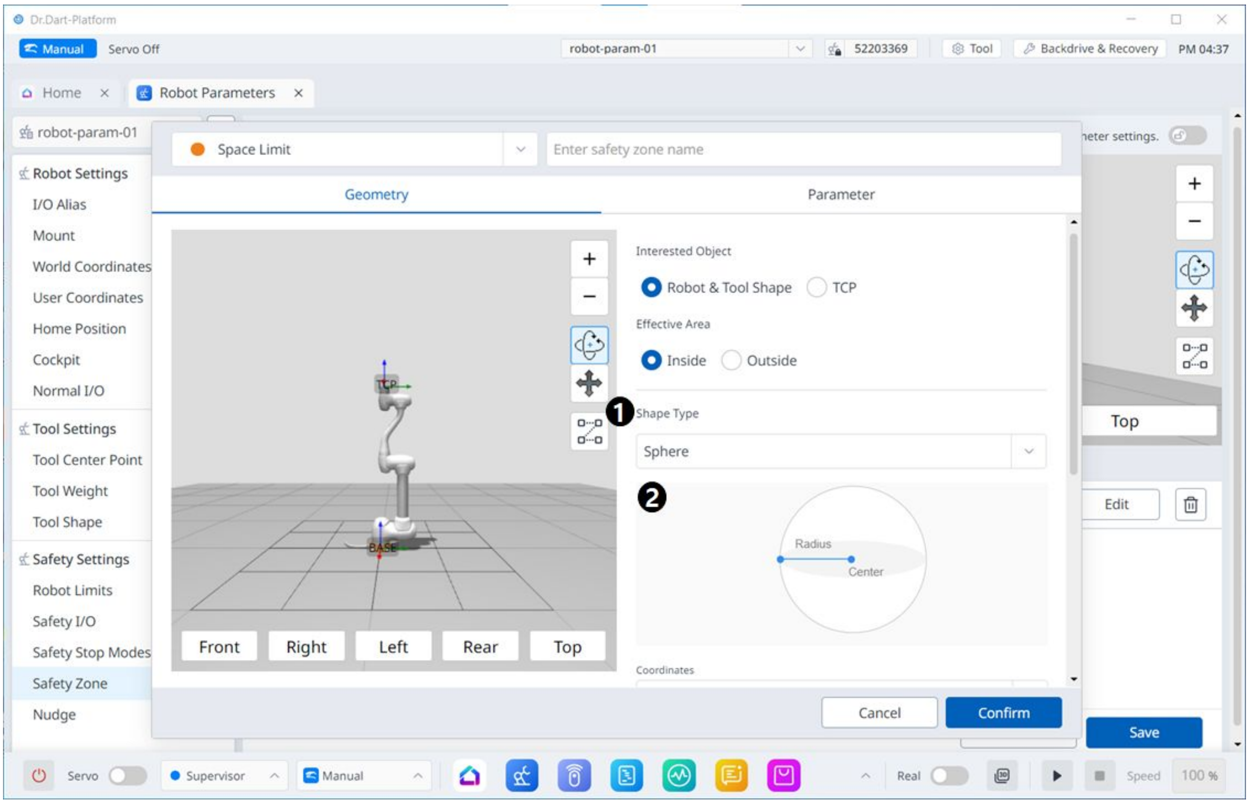


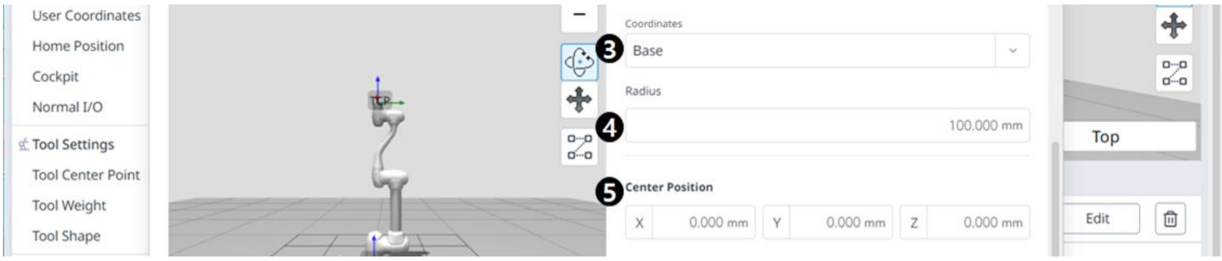
Menu Items

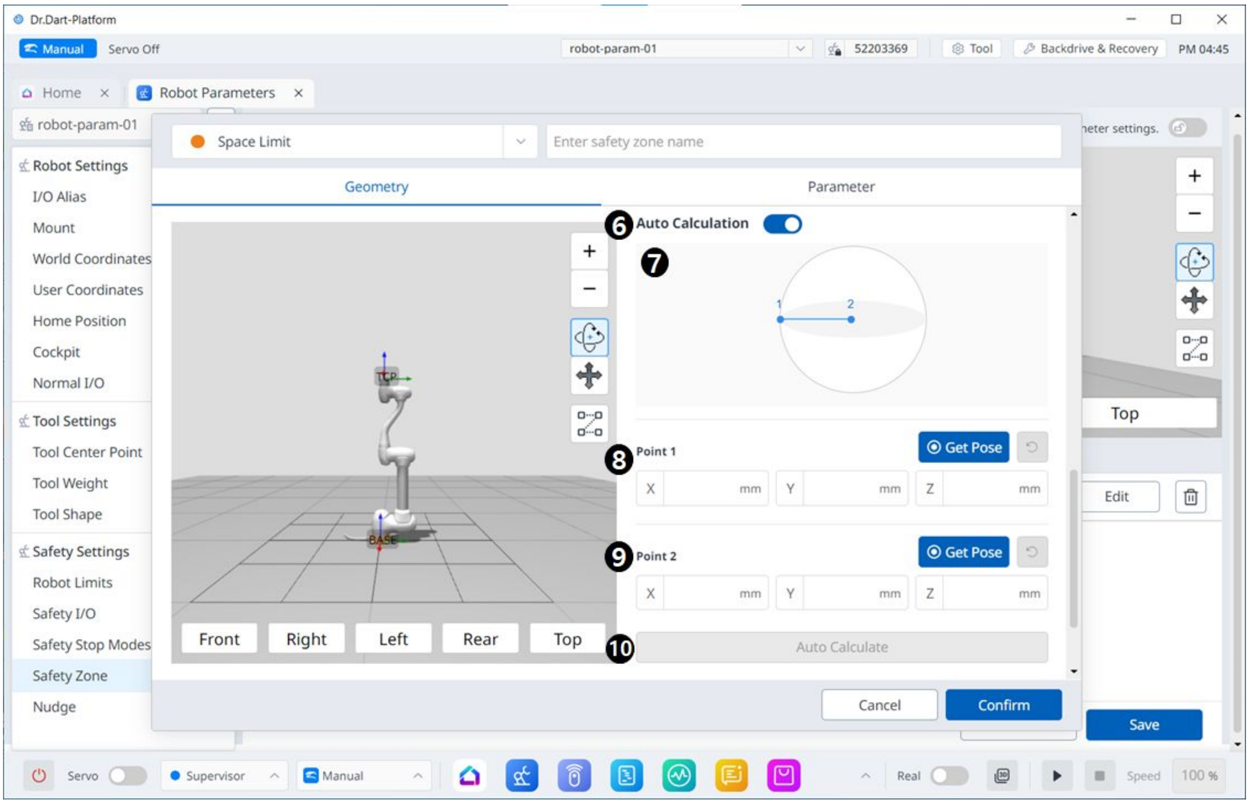
	Item	Description
1	Lock Toggle Button	Used to lock the set value. The safety password is required for modifying the set value.
2	Choose Whether to Enable	This button allows you to apply/unapply the created Safety Zone.

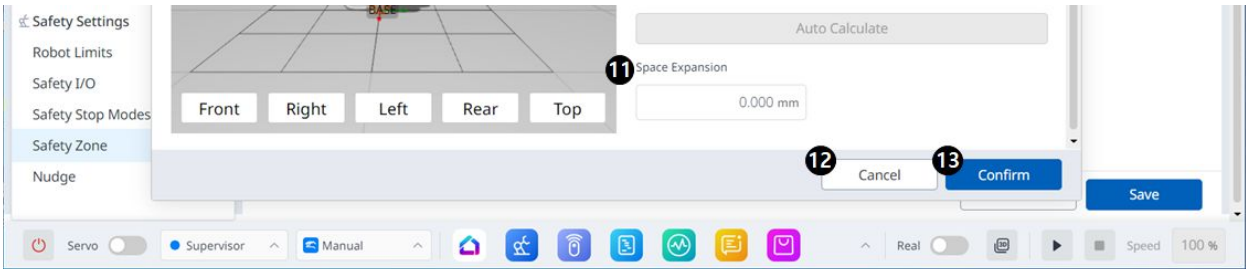
	Item	Description
3	Zone Name	The name given by the user when creating the Safety Zone
4	Zone Type	Safety Zone types (each type has different parameters to set) • Space Limit • Collaborative Zone • Crushing Prevention Zone • Collision Sensitivity Reduction Zone • Tool Orientation Limit Zone • Custom Zone
5	Zone Shape	Safety Zone shapes • Cuboid • Cylinder • Sphere • Tilted Cuobid • Multi-plane Box
6	Edit	• This button allows the settings of the created Safety Zone to be edited. • Pressing this button brings up a pop-up that allows the Safety Zone to be edited.
7	Delete	This button allows the safe zone to be deleted.
8	Add	• This button allows the safe zone to be added. • This button brings up a pop-up that allows the safe zone to be added.
9	Save	This button allows any changes to the settings in relation to the Safety Zone to be saved.

Sphere


Dr.Dart-Platform
Manual
Servo Off
robot-param-01
52203369
Tool
Backdrive & Recovery
PM 04:37
Home
Robot Parameters
robot-param-01
Robot Settings
I/O Alias
Mount
World Coordinates
User Coordinates
Home Position
Cockpit
Normal I/O
Tool Settings
Tool Center Point
Tool Weight
Tool Shape
Safety Settings
Robot Limits
Safety I/O
Safety Stop Modes
Safety Zone
Nudge
Space Limit
Enter safety zone name
Geometry
Parameter
Interested Object
Robot & Tool Shape
TCP
Effective Area
Inside
Outside
1
Shape Type
Sphere
2
Radius
Center
Coordinates
Front
Right
Left
Rear
Top
Cancel
Confirm
Top
Edit
Save
Servo
Supervisor
Manual
Real
Speed
100 %


User Coordinates
Home Position
Cockpit
Normal I/O
Tool Settings
Tool Center Point
Tool Weight
Tool Shape
Coordinates
3
Base
Radius
4
100.000 mm
5
Center Position
X
0.000 mm
Y
0.000 mm
Z
0.000 mm
Top
Edit



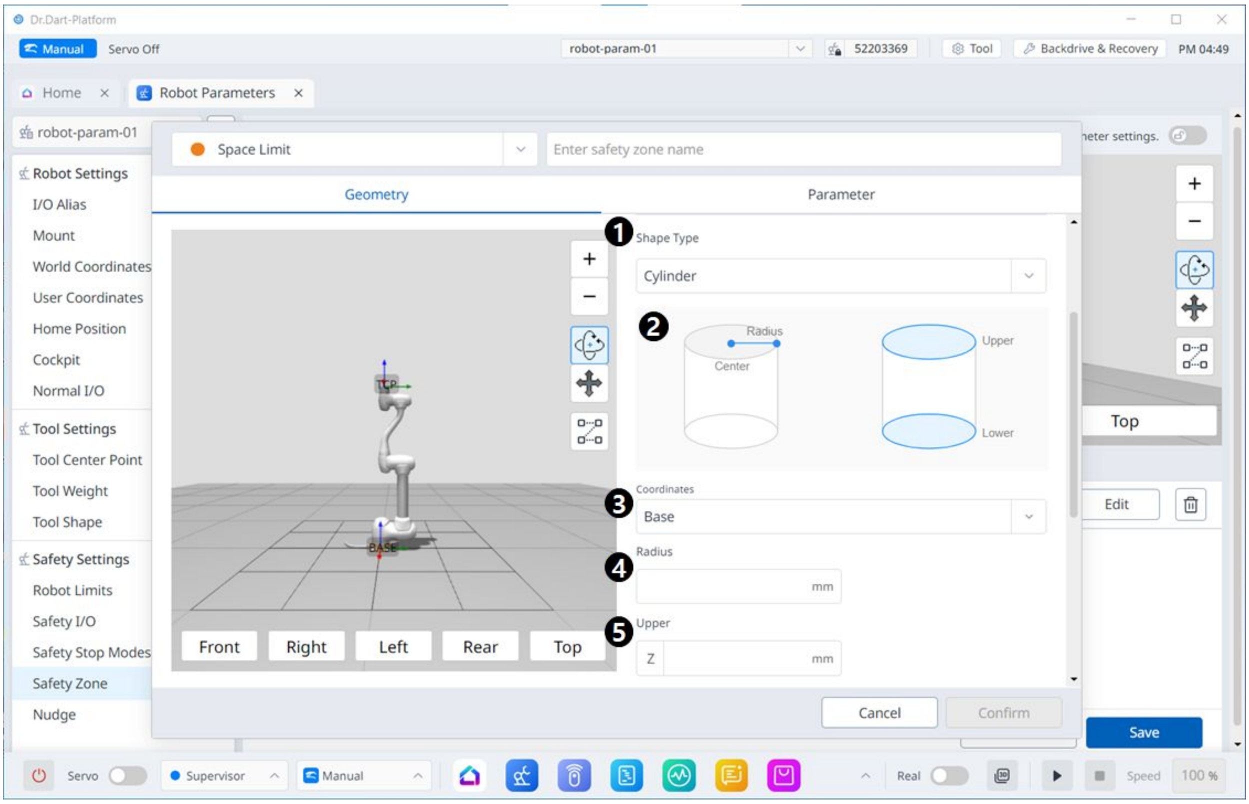


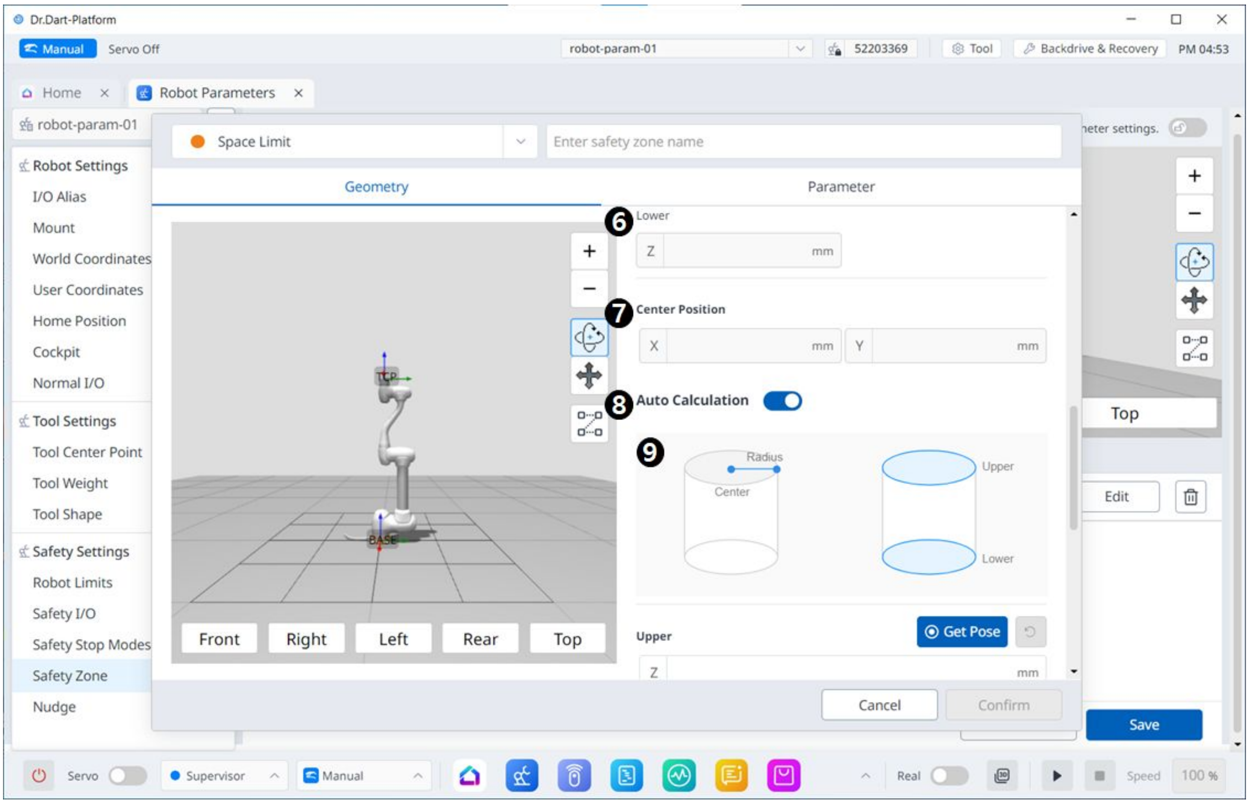
Menu Items

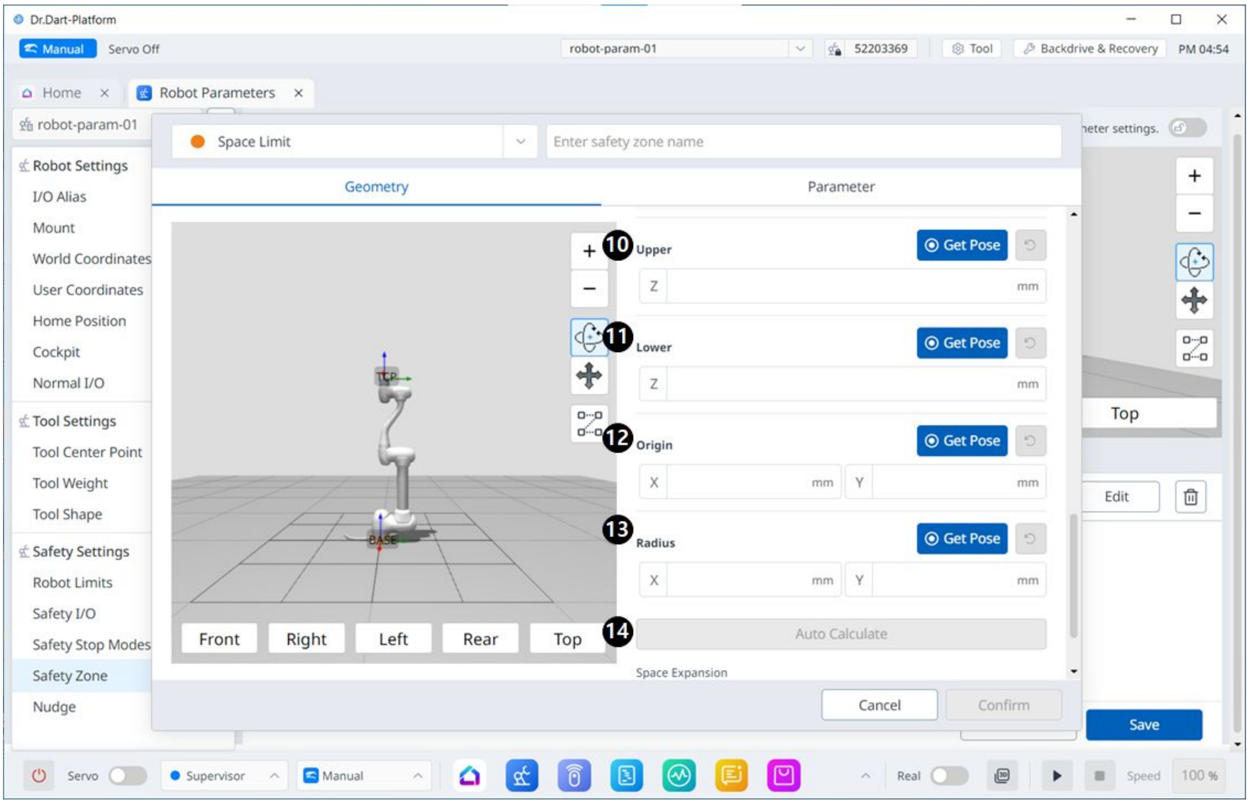
	Item	Description
1	Shape Type	The desired Shape type can be selected from this drop-down.
2	Shape Image	This is the area where the image of the selected type is seen.
3	Coordinates	Either Base or World coordinates can be selected from this drop-down.
4	Radius	This is where the radius value is entered.

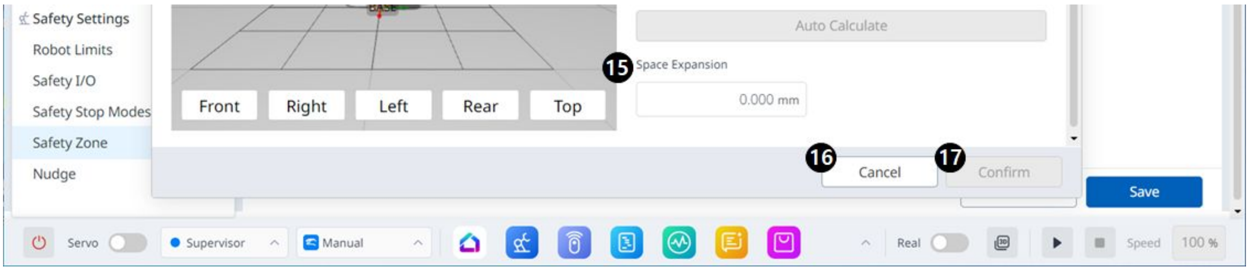
	Item	Description
5	Center Position	The center value can be set in these fields for each of the X-, Y-, and Z-axes.
6	Auto Calculation	This button allows the Auto Measure option to be enabled.
7	Auto Calculation Image	This area is where the image required for Auto Measure is seen. This appears when the Auto Measure option is enabled.
8	Point 1	Each field is where the value for Point 1 is entered.
9	Point 2	Each field is where the value for Point 2 is entered.
10	Auto Calculate	This button allows Auto Measure to be triggered.
11	Space Expansion	This field is where the Space Expansion can be set.
12	Cancel	This button allows the setting to be canceled.
13	Confirm	This button allows you to confirm the setting.

Cylinder


Dr.Dart-Platform
Manual
Servo Off
robot-param-01
52203369
Tool
Backdrive & Recovery
PM 04:49
Home
Robot Parameters
robot-param-01
Robot Settings
I/O Alias
Mount
World Coordinates
User Coordinates
Home Position
Cockpit
Normal I/O
Tool Settings
Tool Center Point
Tool Weight
Tool Shape
Safety Settings
Robot Limits
Safety I/O
Safety Stop Modes
Safety Zone
Nudge
Space Limit
Enter safety zone name
Geometry
Parameter
1
Shape Type
Cylinder
2
Radius
Center
Upper
Lower
3
Coordinates
Base
4
Radius
mm
5
Upper
Z
mm
TCP
BASE
Front
Right
Left
Rear
Top
Cancel
Confirm
Edit
Save
Servo
Supervisor
Manual
Real
Speed
100 %


Dr.Dart-Platform
Manual
Servo Off
robot-param-01
52203369
Tool
Backdrive & Recovery
PM 04:53
Home
Robot Parameters
robot-param-01
Robot Settings
I/O Alias
Mount
World Coordinates
User Coordinates
Home Position
Cockpit
Normal I/O
Tool Settings
Tool Center Point
Tool Weight
Tool Shape
Safety Settings
Robot Limits
Safety I/O
Safety Stop Modes
Safety Zone
Nudge
Space Limit
Enter safety zone name
Geometry
Parameter
6
Lower
Z
mm
7
Center Position
X
mm
Y
mm
8
Auto Calculation
9
Radius
Center
Upper
Lower
Upper
Get Pose
Z
mm
TCP
BASE
Front
Right
Left
Rear
Top
Cancel
Confirm
Edit
Save
Servo
Supervisor
Manual
Real
Speed
100 %



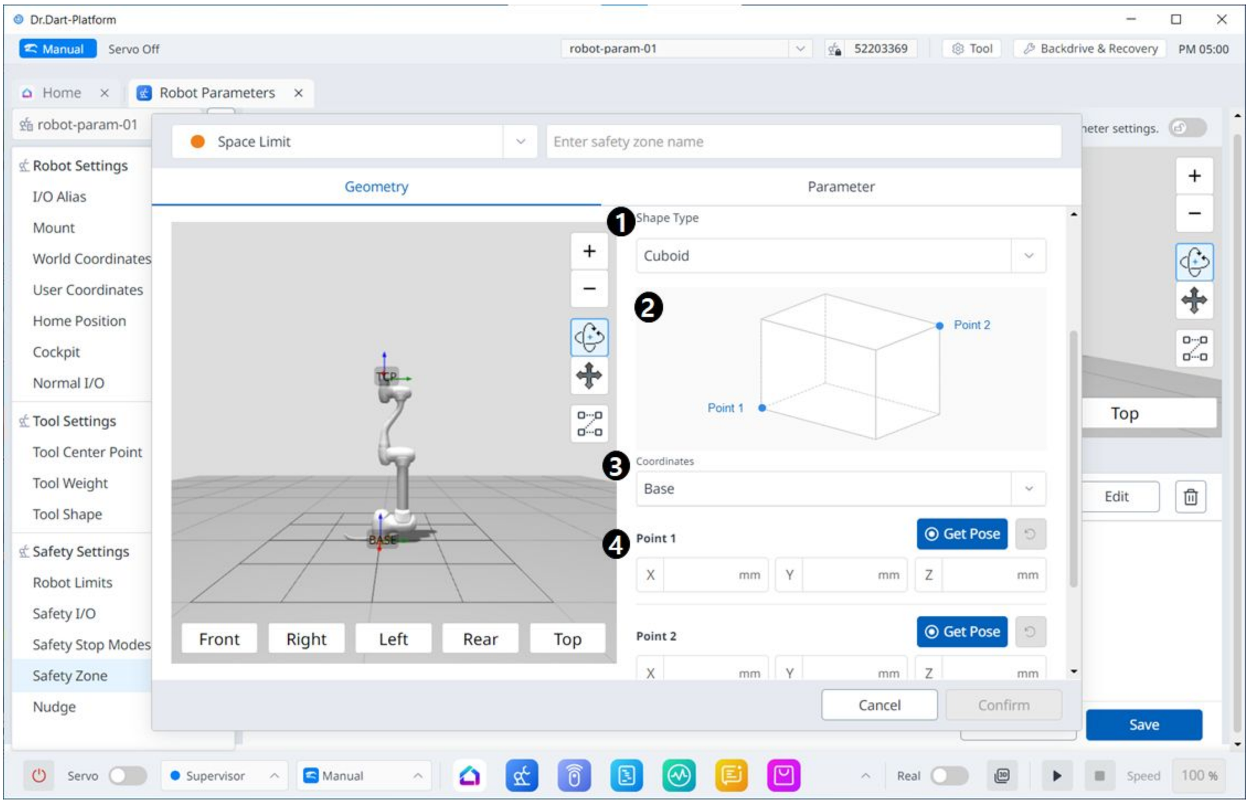


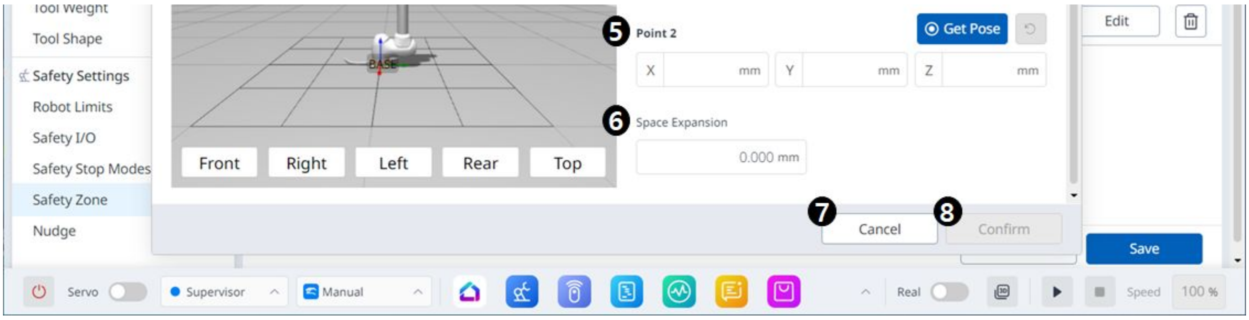
Menu Items

	Item	Description
1	Shape Type	The desired Shape type can be selected from this drop-down.
2	Shape Image	This is the area where the image of the selected type is seen.
3	Coordinates	Either Base or World coordinates can be selected from this drop-down.
4	Radius	This is where the radius value is entered.
5	Upper	This field is where the upper value is entered.

	Item	Description
6	Lower	This field is where the lower value is entered.
7	Center Position	The center value can be set in these fields for each of the X- and Y-axes.
8	Auto Calculate	This button allows the Auto Measure option to be enabled.
9	Auto Calculate Image	This area is where the image required for Auto Measure is seen. This appears when the Auto Measure option is enabled.
10	Upper	This field is where the upper value is entered.
11	Lower	This field is where the lower value is entered.
12	Origin	This field is where the origin value is entered.
13	Radius	This field is where the radius value is entered.
14	Auto Calculate	This button allows the Auto Calculate to be executed.
15	Space Expansion	This field is where the Space Expansion can be set.
16	Cancel	This button allows the setting to be canceled.
17	Confirm	This button allows you to confirm the setting.

Cuboid

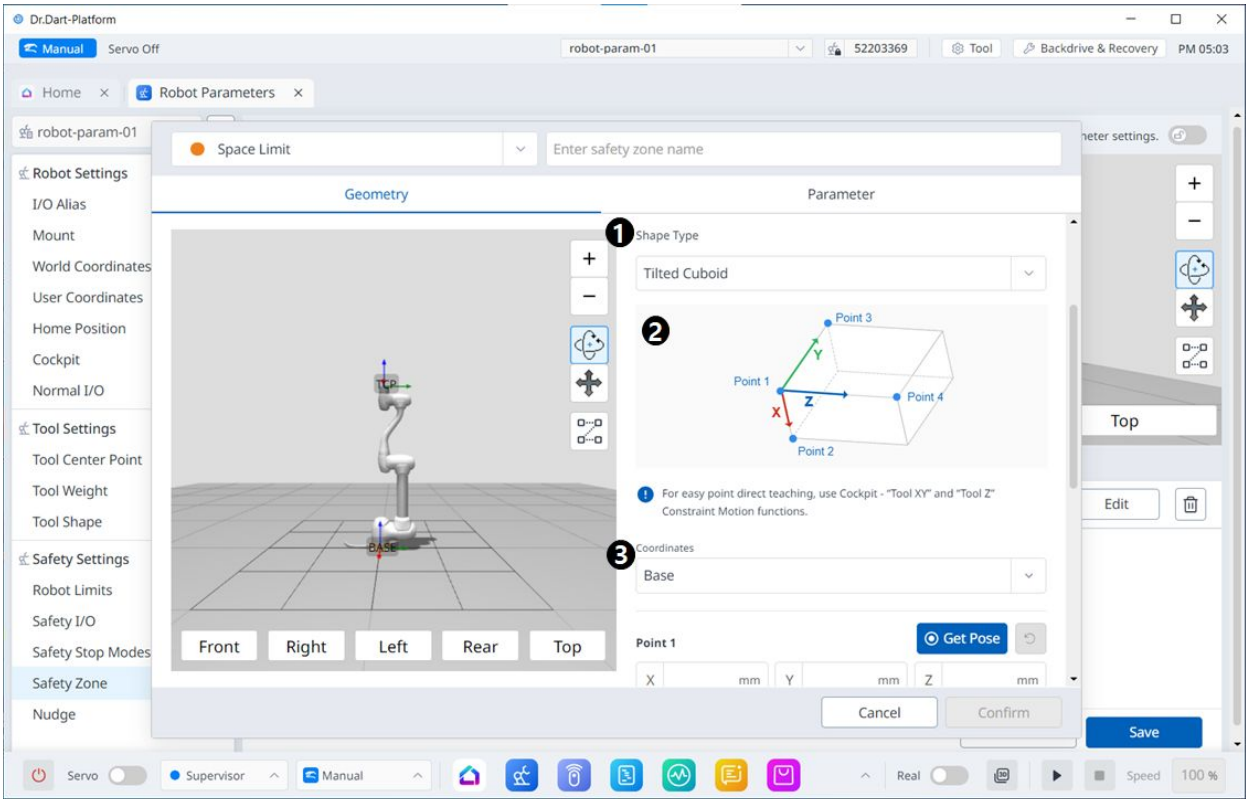


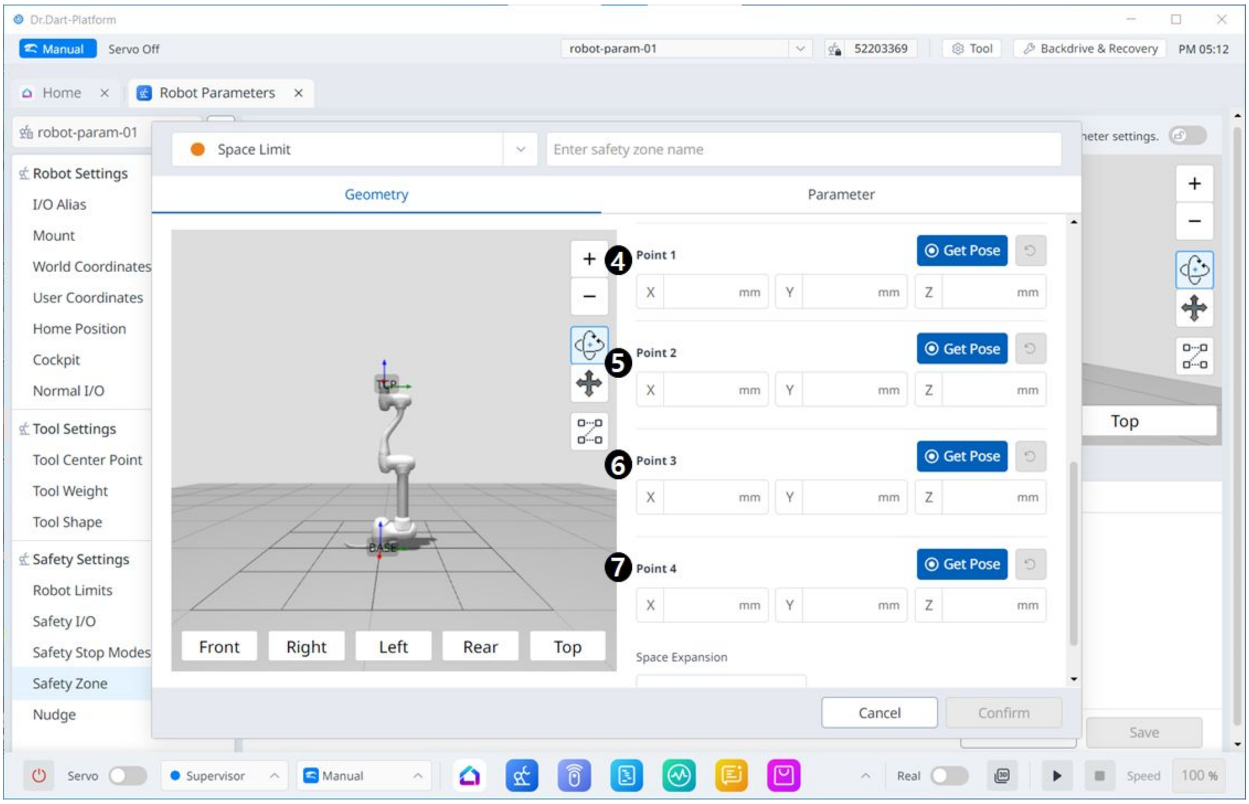


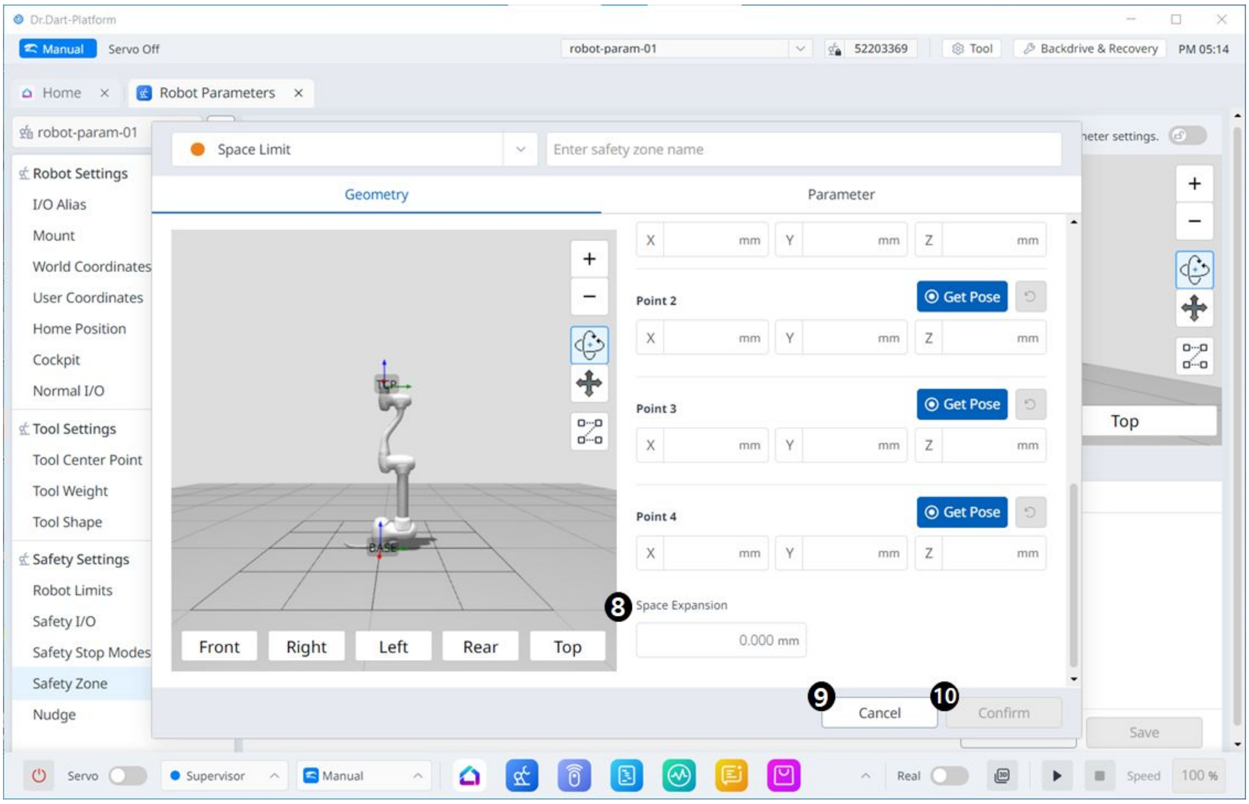
	Item	Description
1	Shape Type	The desired Shape type can be selected from this drop-down.
2	Shape Image	This is the area where the image of the selected type is seen.
3	Coordinates	Either Base or World coordinates can be selected from this drop-down.
4	Point 1	Each field is where the value for Point 1 is entered.
5	Point 2	Each field is where the value for Point 2 is entered.

	Item	Description
6	Space Expansion	This field is where the Space Expansion can be set.
7	Cancel	This button allows the setting to be canceled.
8	Confirm	This button allows you to confirm the setting.

Tilted Cuboid



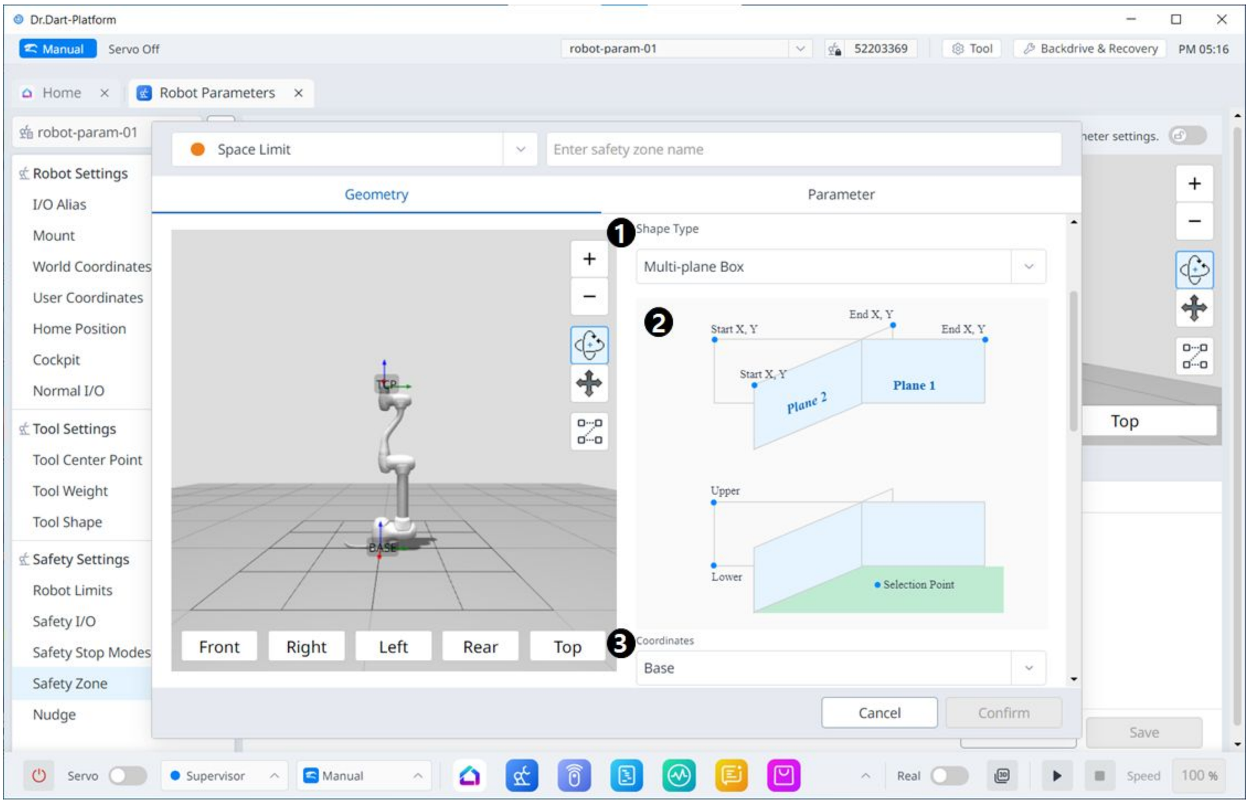


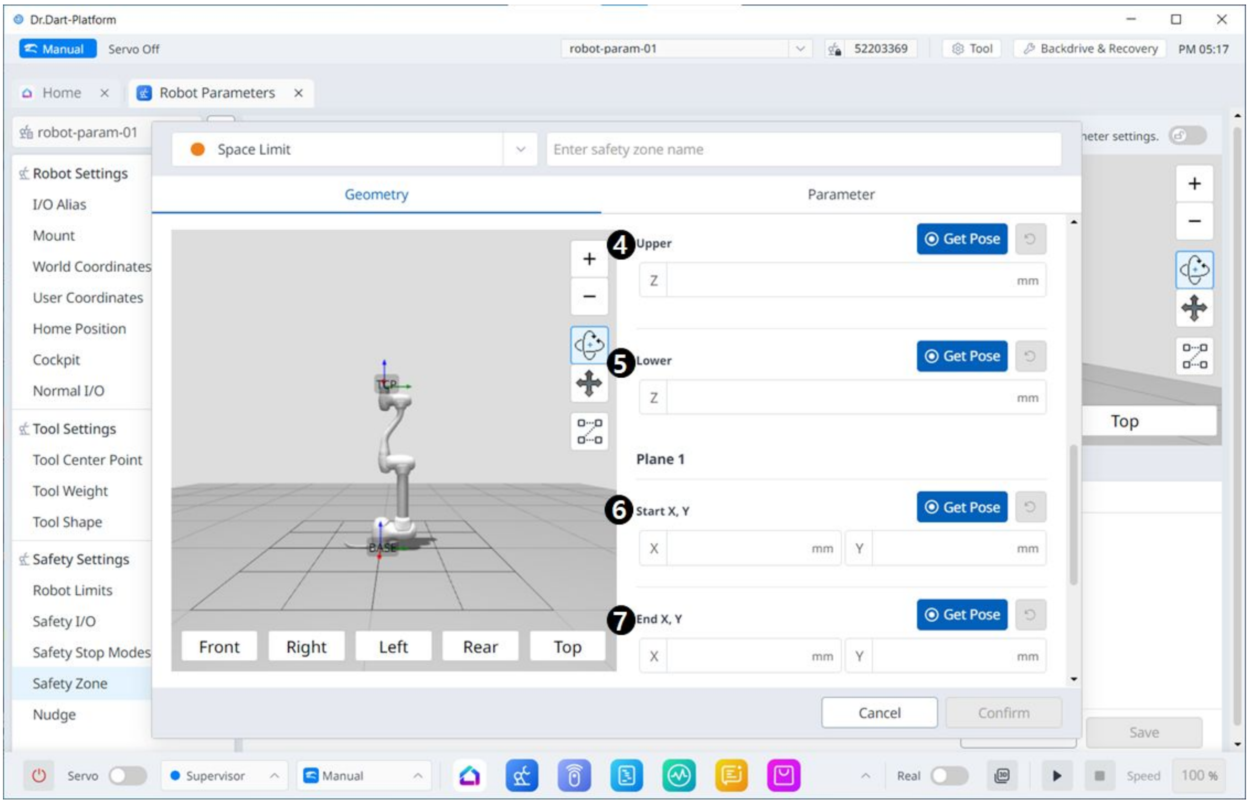


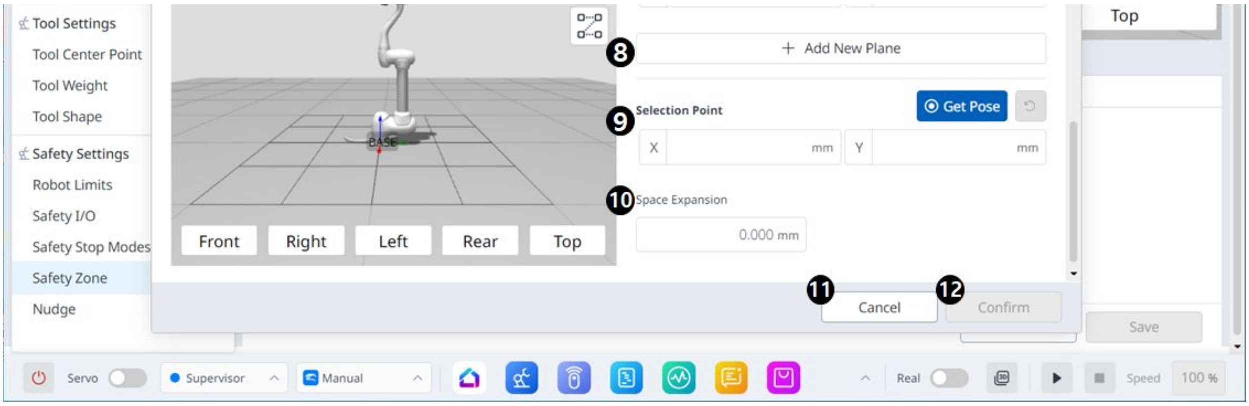
Menu Items

	Item	Description
1	Space Type	The desired Shape type can be selected from this drop-down.
2	Space Image	This is the area where the image of the selected type is seen.
3	Info. Message	This is an informative message required for the setting.
4	Coordinates	Either Base or World coordinates can be selected from this drop-down.
5	Point 1	Each field is where the value for Point 1 is entered.
6	Point 2	Each field is where the value for Point 2 is entered.
7	Point 3	Each field is where the value for Point 3 is entered.
8	Point 4	Each field is where the value for Point 4 is entered.
9	Space Expansion	This field is where the Space Expansion can be set.
10	Cancel	This button allows the setting to be canceled.
11	Confirm	This button allows you to confirm the setting.

Multi-plane Box







Menu Items

	Item	Description
1	Shape Type	The desired Shape type can be selected from this drop-down.
2	Shape Image	This is the area where the image of the selected type is seen.
3	Coordinates	Either Base or World coordinates can be selected from this drop-down.
4	Upper	This field is where the upper value is entered.
5	Lower	This field is where the lower value is entered.
6	Plane Start X, Y	This field is where the start point of the plane is entered.
7	Pane End X,Y	This field is where the end point of the plane is entered.
8	Add New Plane	Clicking this button adds a new plane.
9	Selection Point	Each field is where the Selection Point values are entered.
10	Space Expansion	This field is where the Space Expansion can be set.
11	Cancel	This button allows the setting to be canceled.
12	Confirm	This button allows you to confirm the setting.

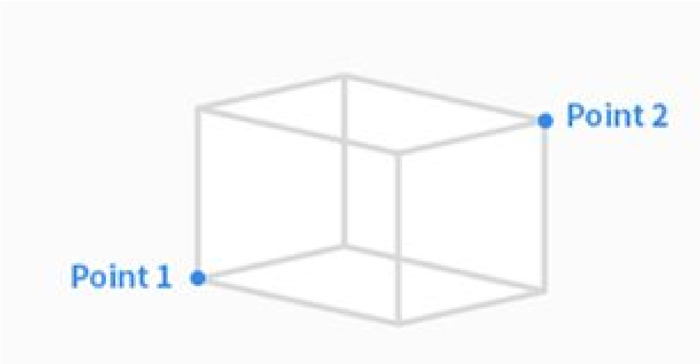
Overview of Space Limit and Zone settings.

For more information on Space Limits and Zones, see the PART 1. Safety Manual(p. 8), which includes the following topics.

- Space Limit(p. 39)
- Zone(p. 40)

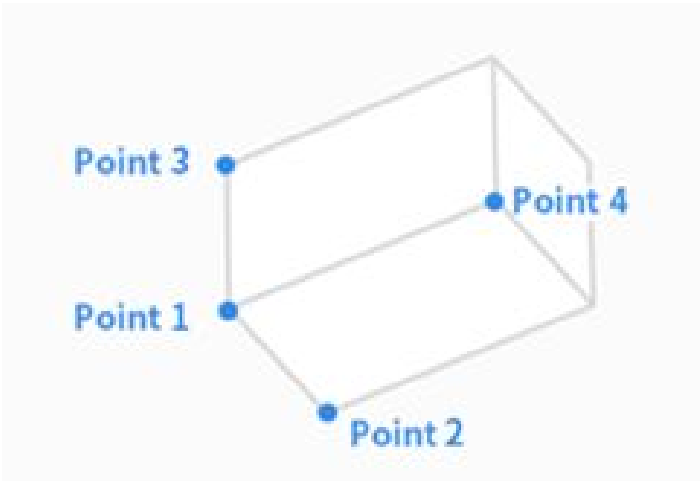
Overview of Space Limit and Shape of Zones

How to set the shape of the **Space Limit**/**Zone** is as follows.

Item	Description
Cuboid	The shape of the **Space Limit**/**Zone** is created as a cuboid. • Enter the lower endpoint (Point 1) and upper endpoint (**Point 2**) of the cuboid and tap the Save Pose button. 

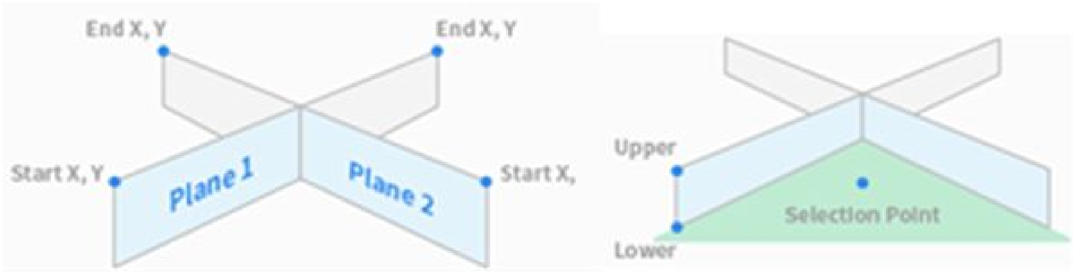
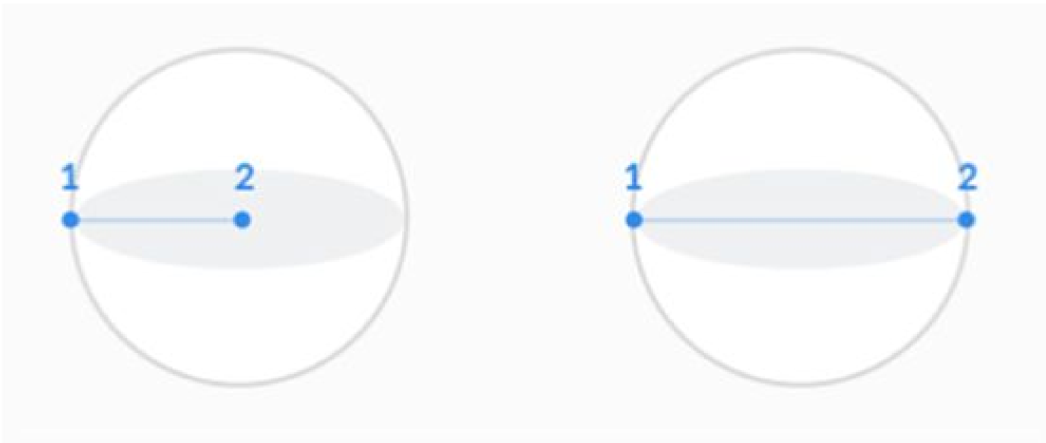
<table>
<tr><th>Item</th><th>Description</th></tr>
<tr><td>Tilted Cuboid</td><td>The shape of the Space Limit /Zone is created as a tilted cuboid.

Enter the reference point (point 1), x-axis end point (point 2), y-axis end point (point 3), and z-axis end point (point 4)of the tilted cuboid and tap the Save Pose button.
3 lines (Point 1-Point2, Point 1-Point 3, Point 1-Point 4) must cross each other at a right angle. (a deviation of +/- 5 degrees is acceptable)
If you use constrained motion functions such as "Plane Constraint" and "Axis Constraint" in the Cockpit using Point 1 as the reference point, the points for point 2, point 3, and point 4are more easily found.


</td></tr>
<tr><td>Cylinder</td><td>The shape of the Space Limit/Zone is created as a cylinder.

Enter the point at a radius distance, the point of the upper plane and the point of the lower plane of the cylinder, and tap the Save Pose button.

</td></tr>
</table>

Item	Description
Multi-plane Box	The shape of the **Space Limit**/**Zone** is created as a multiplane box. • Set the height of the top and bottom of the multi-plane box and press the **Add Pose** button to add a plane. • Select X and Y coordinates to set the direction of the plane and tap the Save Pose button. Up to six planes can be configured. • Set the coordinates of the point on the area you want to set. 
Sphere	**The shape of the Space Limit**/**Zone** is created as a sphere. • To configure the radius, enter the positions of the center point and endpoint of the sphere, and to configure the diameter, enter two endpoints of the sphere, then tap the Save Pose button. 

Space Limit Setting

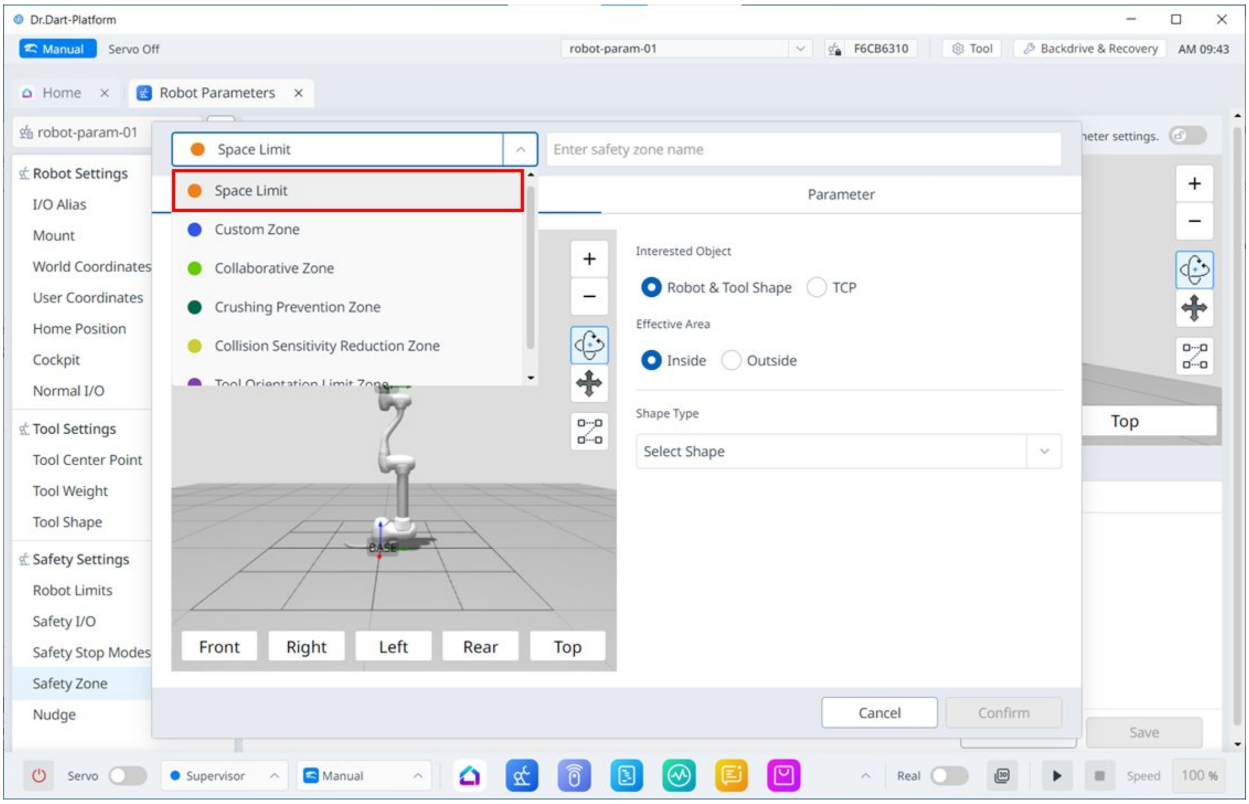
The space limit Workcell Item sets a virtual boundary at the outermost zone of the robot. The robot can be operated without setting space limits, but it is recommended to set space limits to ensure safe operation of the robot.

Space Limit can be reached through the drop-down menu at the top left in **Robot Parameters > Safety Settings > Safety Workspaces > Add New Workspace**, and under Shape type, you can select Sphere, Cylinder, Cube, Tilted Cuboid, or Polyhedron to set.

- Inspection Point can be set as the robot or TCP, and the valid space can be set as interior or exterior.

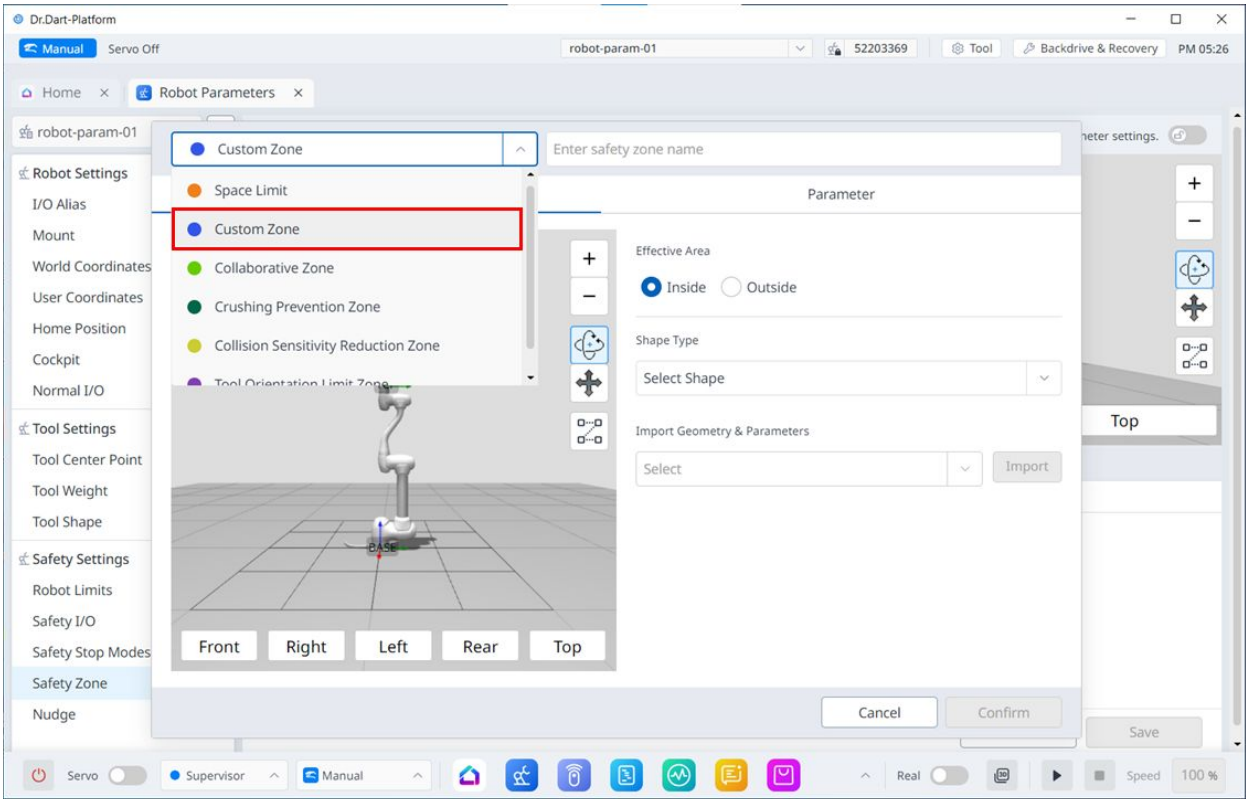
- The monitoring zone can be set as robot or TCP. It sets whether to detect the interior or exterior zone or not.
- The default value is the entire zone and the set interior.
- The robot can be set properly after it is positioned in the set safety zone.

To set **a Space Limit** for the robot, under **Safety Workspaces tap the Add New Workspace** button, and under **Shape Type**, **select one of the following types: Cube**, **Cylinder**, **Multi-plane Box, Sphere, or Tilted Cuboid**. The safety password is required during setup and enablement.



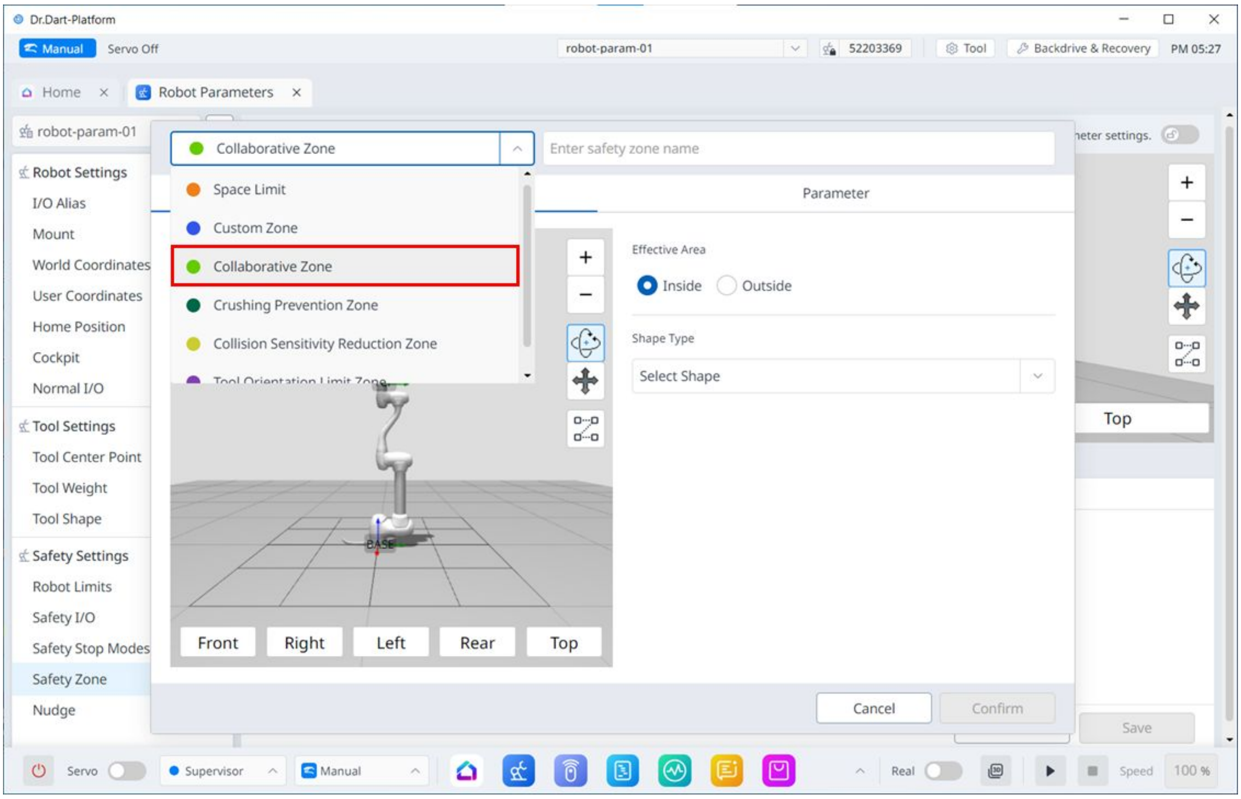
Setting the custom zone

To set a **Custom Zone**, under **Safety Workspaces** tap the **Add New Workspace** button, and under **Custom Zone**, select one of the following types: **Cube**, **Cylinder**, **Multiplane Box, Sphere, or Tilted Cuboid**. The safety password is required during setup and enablement.



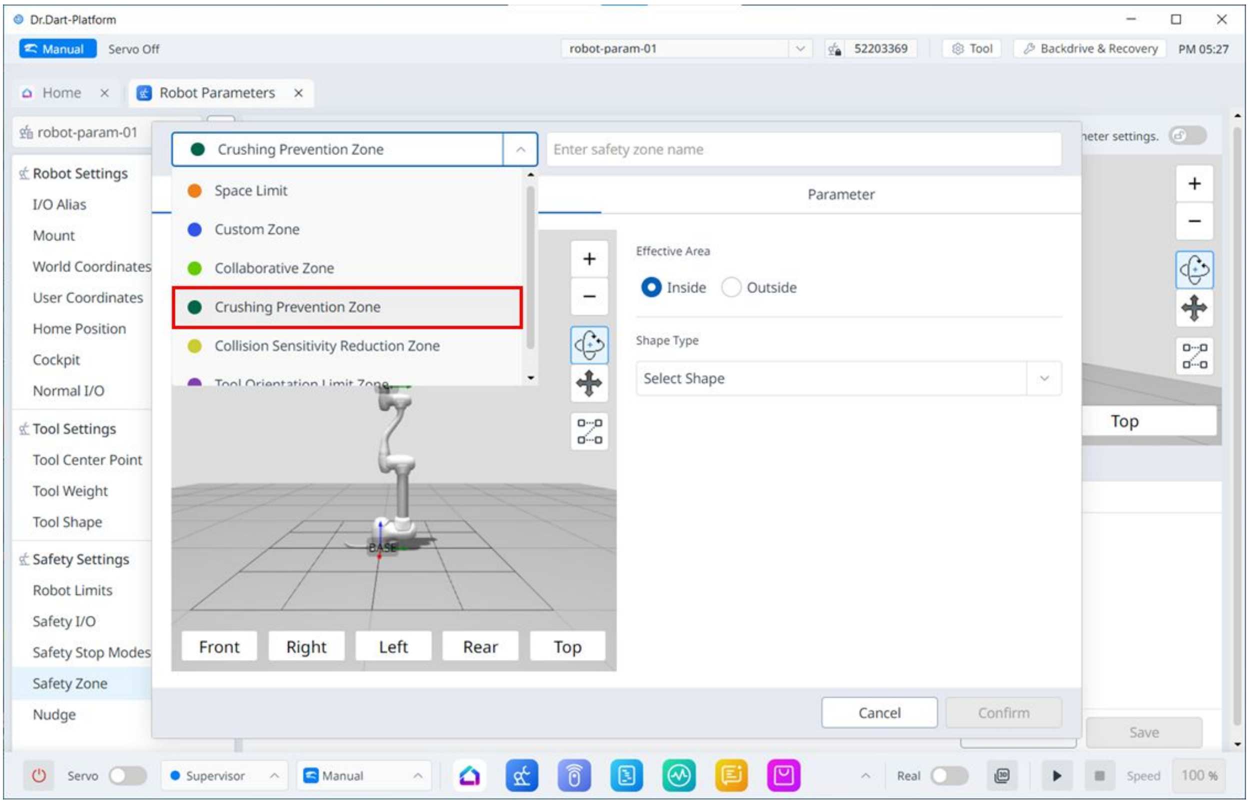
Setting the Collaborative Zone

To set **a Collaborative** Zone, under **Safety Workspaces tap the Add New Workspace** button, and under **Collaborative Zone, select one of the following types: Cube**, **Cylinder**, **Multiplane Box, Sphere, or Tilted Cuboid**. The safety password is required during setup and enablement.



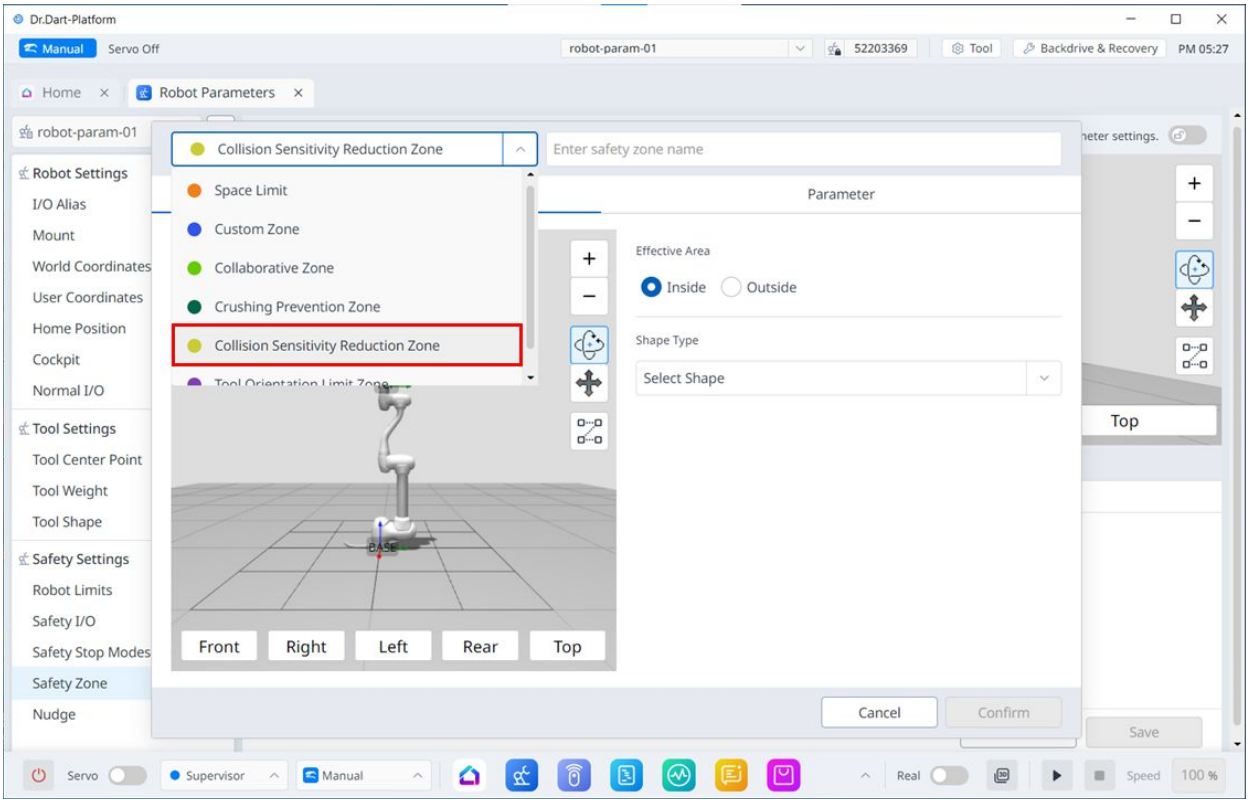
Overview of Crushing Prevention Zone

To set a Crushing Prevention Zone, under **Safety Workspaces** tap the **Add New Workspace , and under Crushing Prevention Zone**, select one of the following types: **Cube**, **Cylinder**, **Multiplane Box Sphere, Sphere, or Tilted Cuboid**. The safety password is required during setup and enablement.



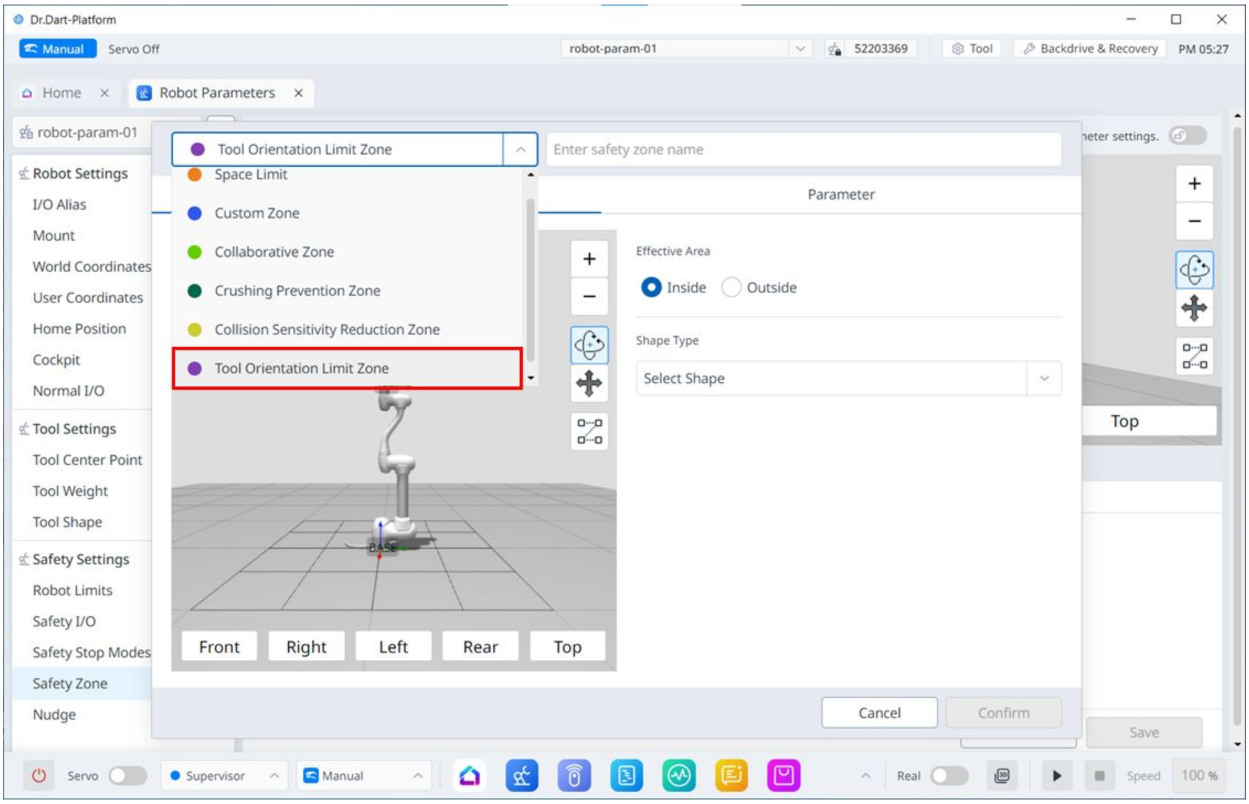
Collision Sensitivity Reduction Zone

To set **a Collision Sensitivity Reduction** Zone, under **Safety Workspaces tap the Add New Workspace** button, and under **Collision Sensitivity Reduction Zone, select one of the following types: Cube**, **Cylinder**, **Multipleane Box, Sphere, or Tilted Cuboid.** The safety password is required during setup and enablement.



Tool Orientation Limit Zone

To set **a Tool Orientation Limit Zone**, under **Safety Workspaces tap the Add New Workspace** button, and under **Tool Orientation Limit Zone**, **select one of the following types: Cube**, **Cylinder**, **Multiplane Box, Sphere, or Tilted Cuboid**. The safety password is required during setup and enablement.



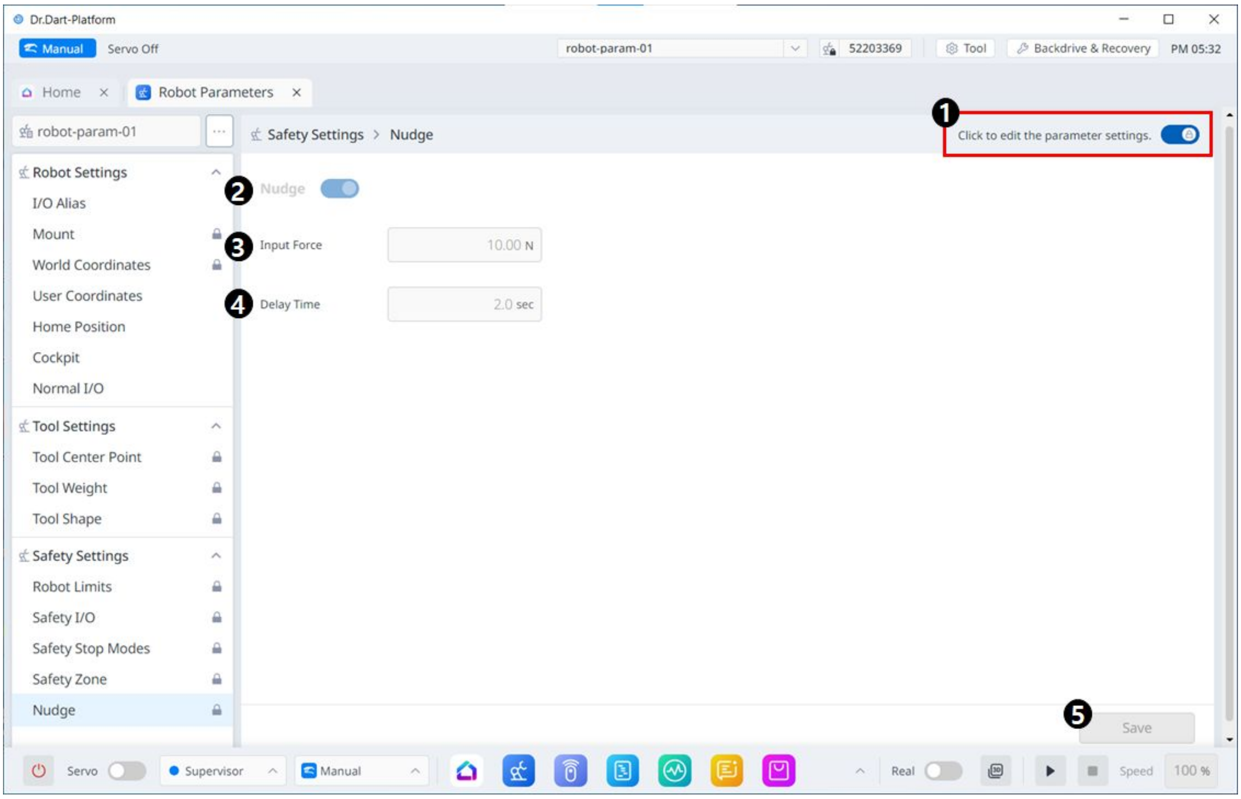
Nudge

Nudge Setting

If the robot stops in the collaborative zone due to safety stop mode SS2 or RS1,, reset is unavailable in Interrupted state but work can be resumed with nudge input

- To set Nudge, select **Robot > Nudge** item from the **Robot Workcell**.

For more information, see Nudge Setting(p. 39).



Menu Items

	Item	Description
1	Lock Toggle Button	Used to lock the set value. The safety password is required for modifying the set value.
2	Whether to use Nudge	This button allows you to choose whether to use Nudge.
3	Force Input	This field is where the desired Force value is entered.
4	Delay Time	This field is where the delay time is set.
5	Save	This button allows you to save the value you set.

5.7.4 Safety Setting Review

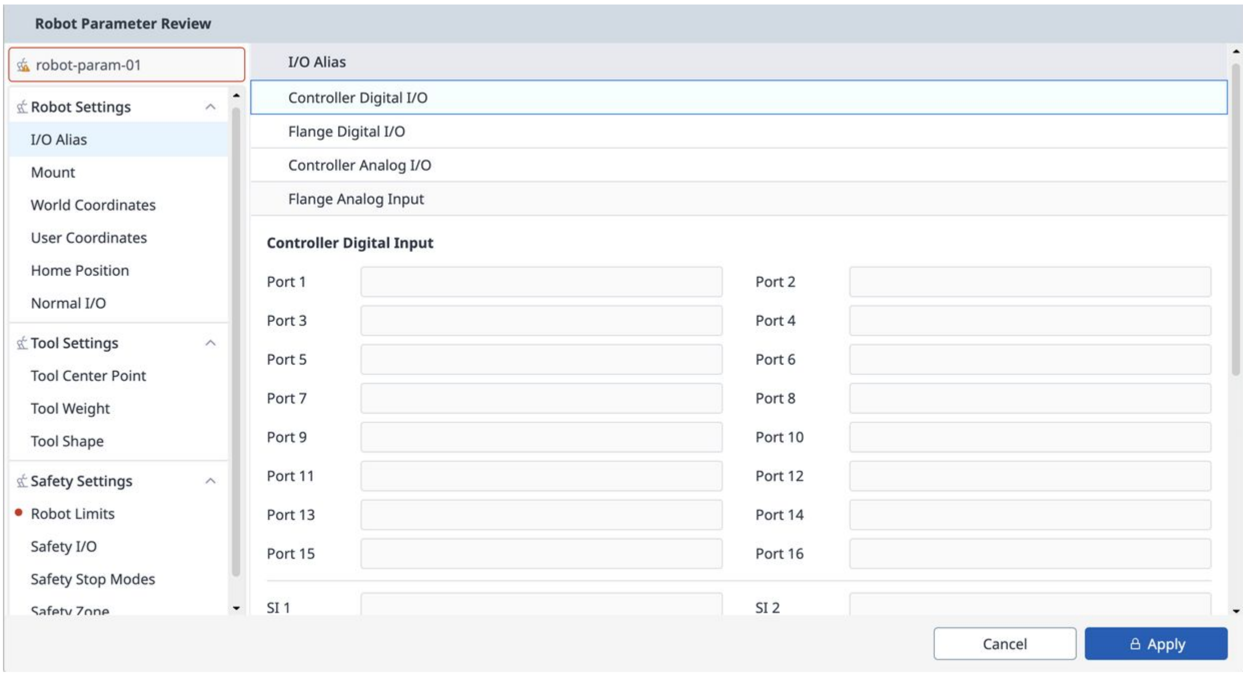
If the robot data setting value has changed on the Robot Parameter module, the changed setting values can be stored through the Safety Setting Review pop-up.

The Safety Setting Review pop-up can be opened by clicking on the Robot Parameters file information entry in the Header, or within the Robot Parameters module.

Full Settings Review Pop-up

Displays information about the currently applied parameter file at once.

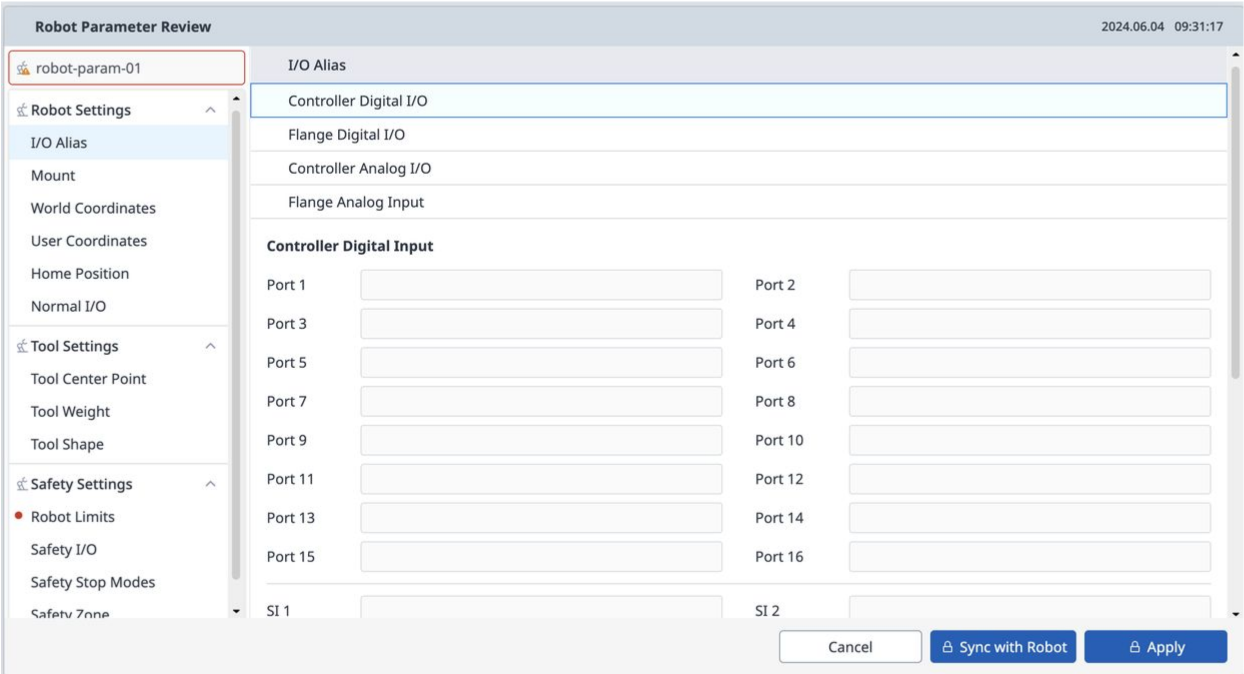
If the settings in the menu are inconsistent with the settings applied to the bottom, a red dot is displayed on the left side of the item.



When a Safety Setting Review pop-up is generated through the Header, Sync with Robot, Apply buttons are displayed if there is information that does not match the settings applied to the lower part of the menu.

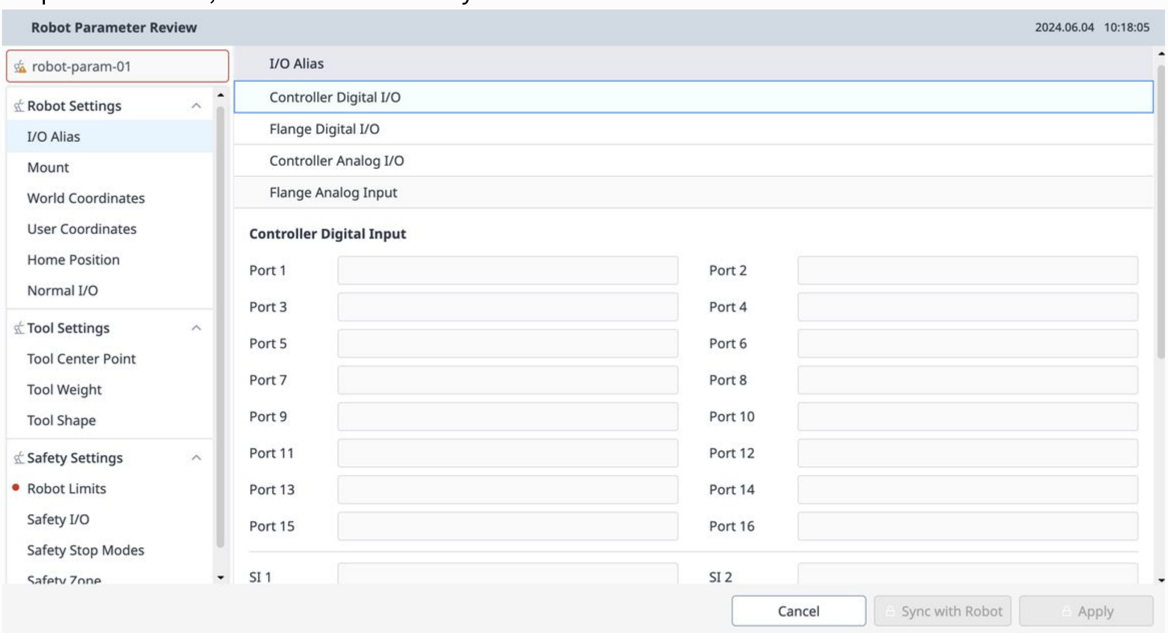
When selecting the Sync with Robot button, apply the parameter settings of the controller to the current parameter file.

When you select the Apply button, apply the settings in the current parameter file to the controller.

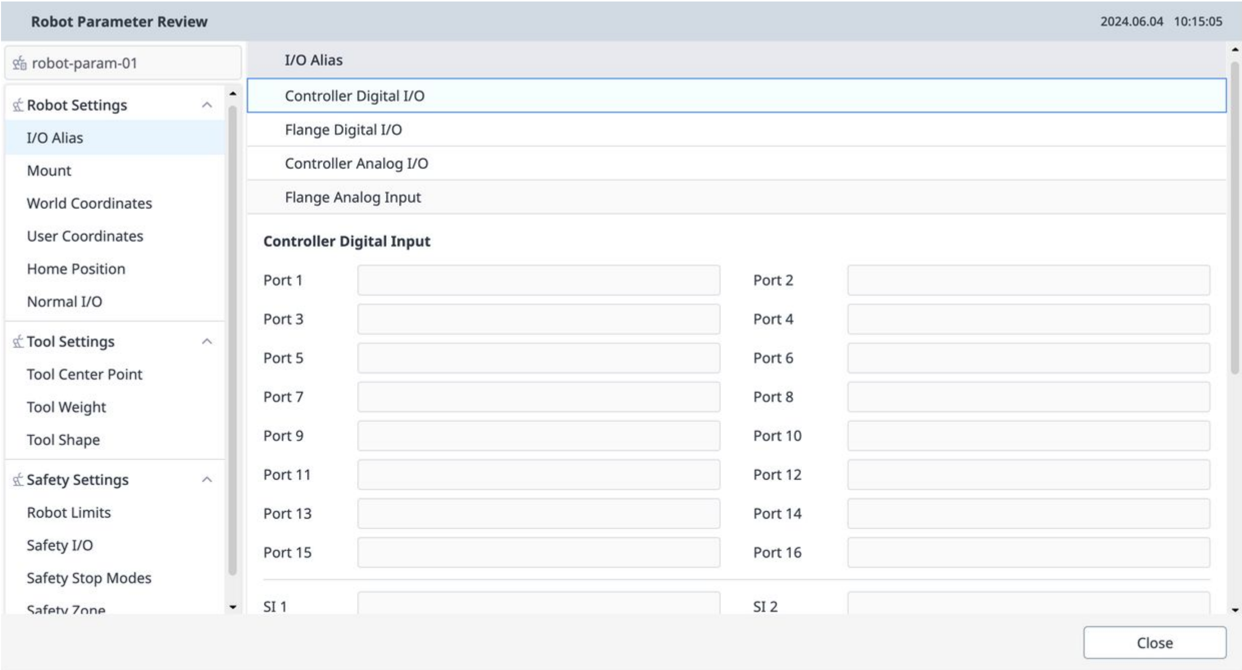


알아두기

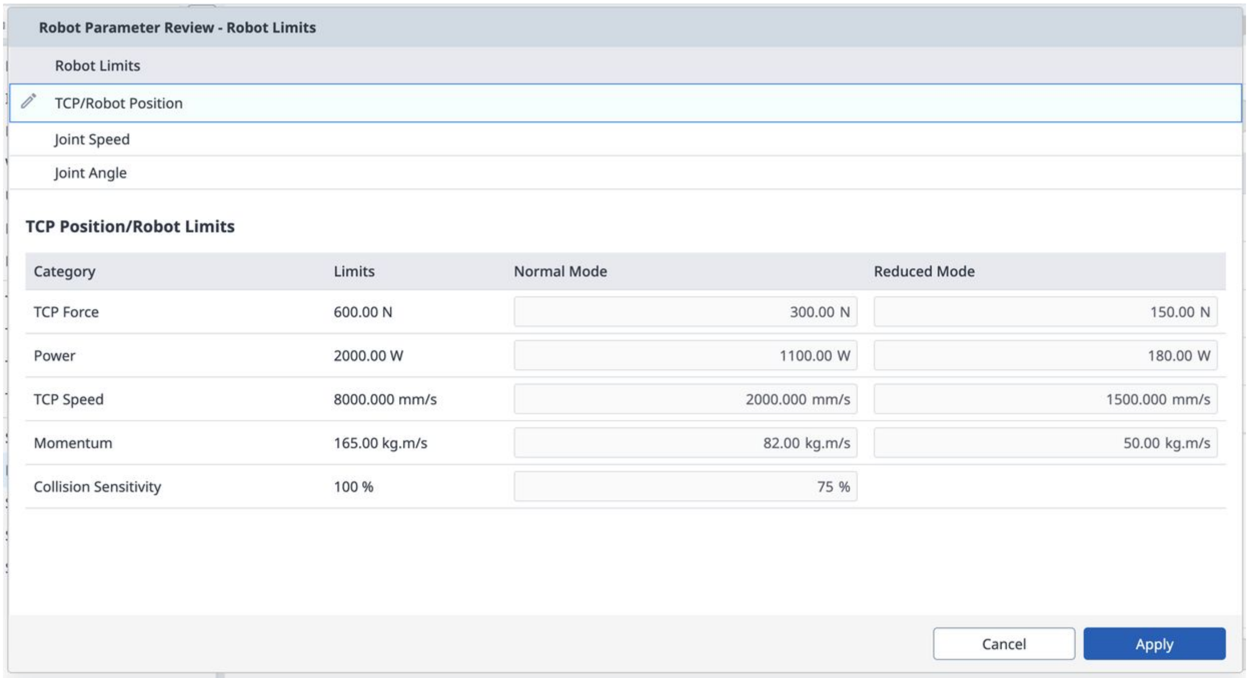
For parameter files, modifications can only be made in the Manual state.



If you have entered the Safety Setting Review pop-up through the Header and no changes are made, only the Close button is displayed.



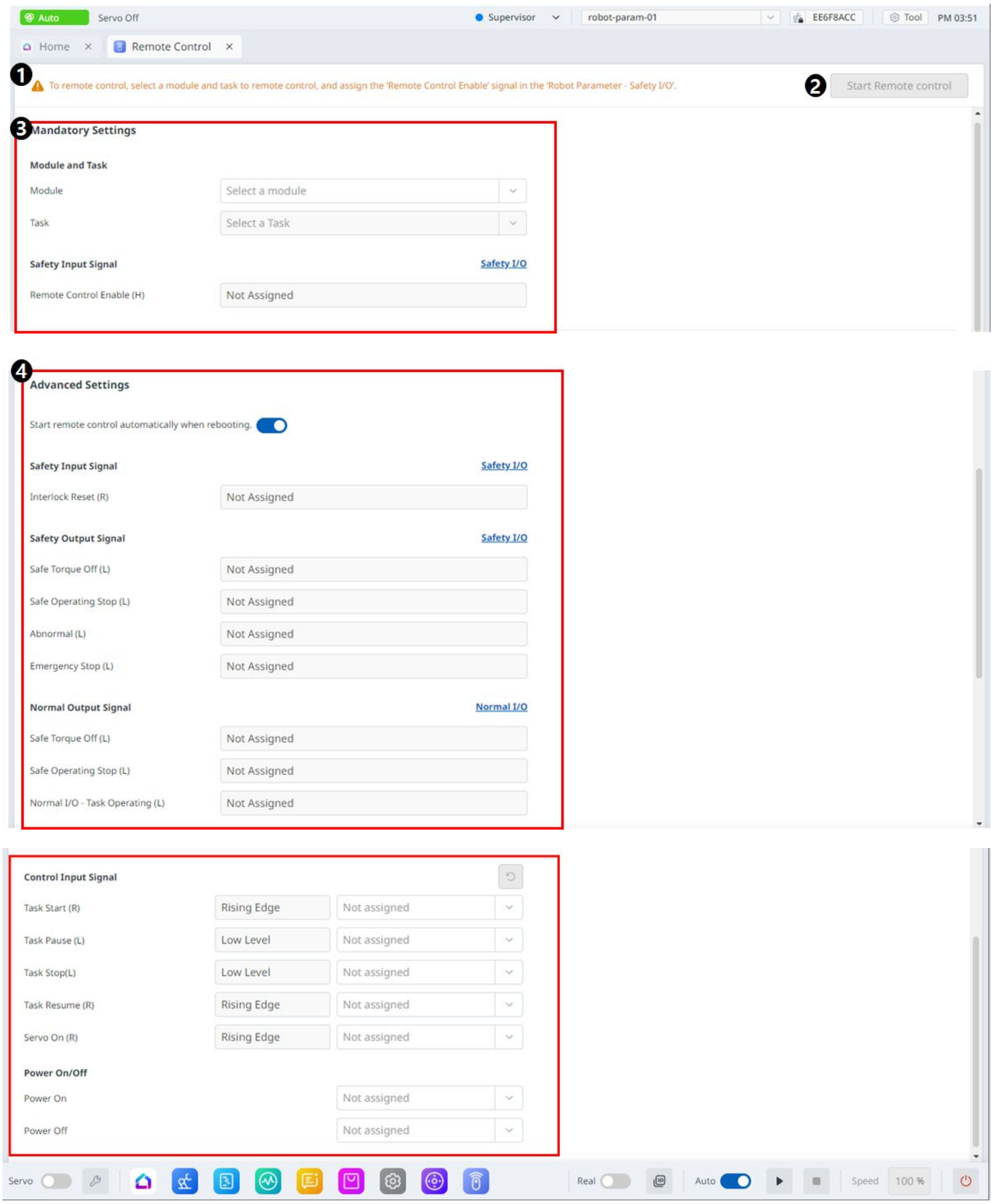
The single setup review pop-up within the parameter module is as follows.



5.8 Remote Control Module

The Remote Control module enables remote control to be executed for tasks that you have already created.

This module can be run at the administrator level.

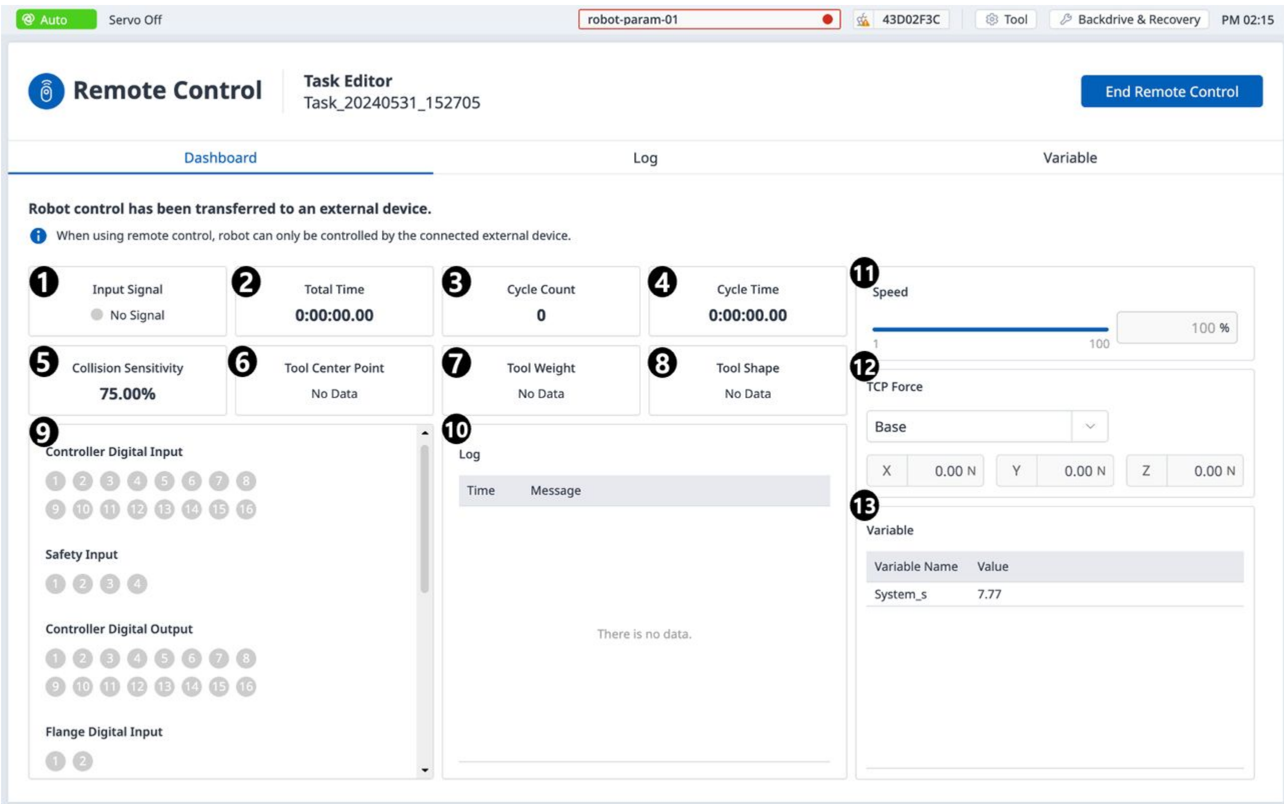


Menu Layout

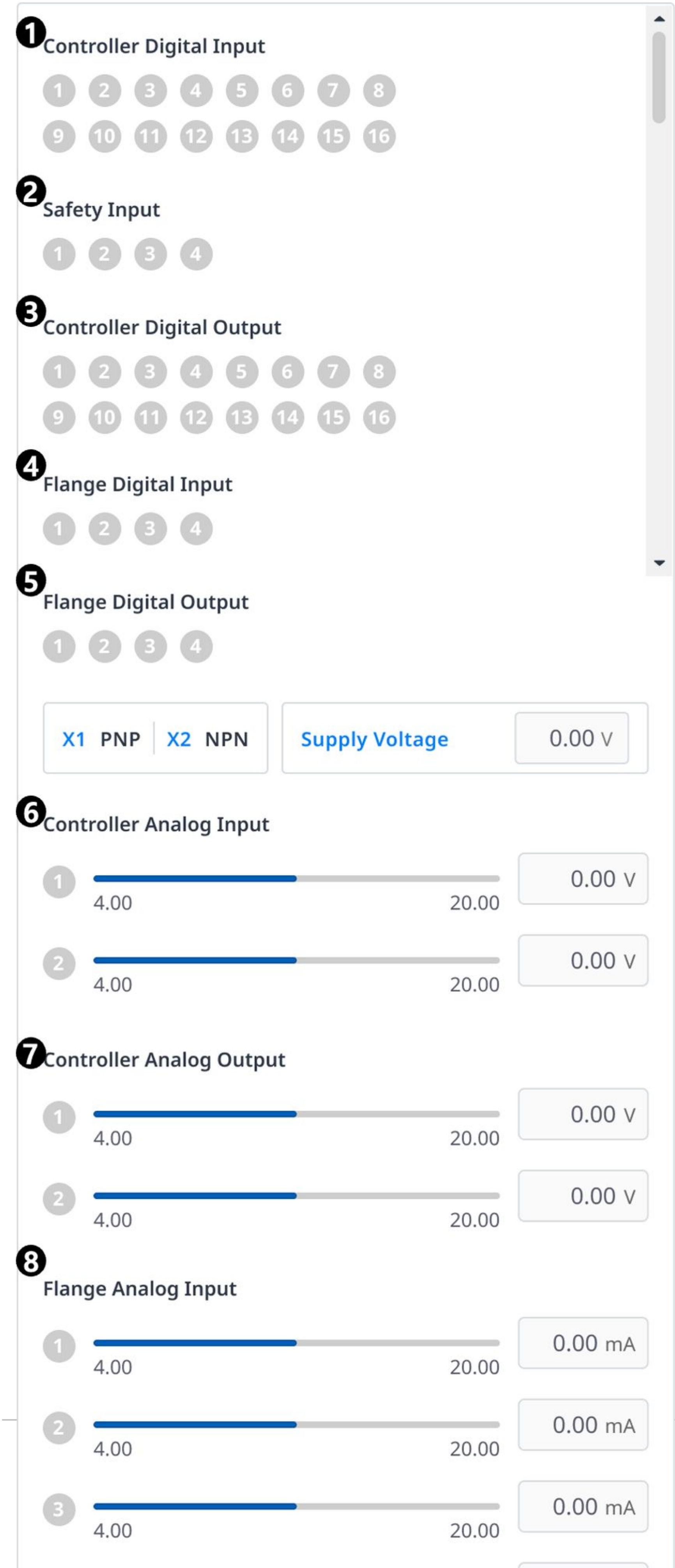
	Item	Description
1	Warning	This will show the necessary precautions when using the module.
2	Start Remote Control	This button allows you to start remote control after all settings have been completed.
3	Mandatory Settings	This is a mandatory setting for remote control. You can set modules and tasks and set safe input signals.
4	Advanced Settings	This allows for advanced settings for remote control. You can set each port for the task to start/pause/stop/resume/servo on. If remote control is set to run automatically after rebooting, it will run as soon as Dart-Platform reboots.

You can go to the Remote Control Mode screen when you start remote control.

5.8.1 Dashboard



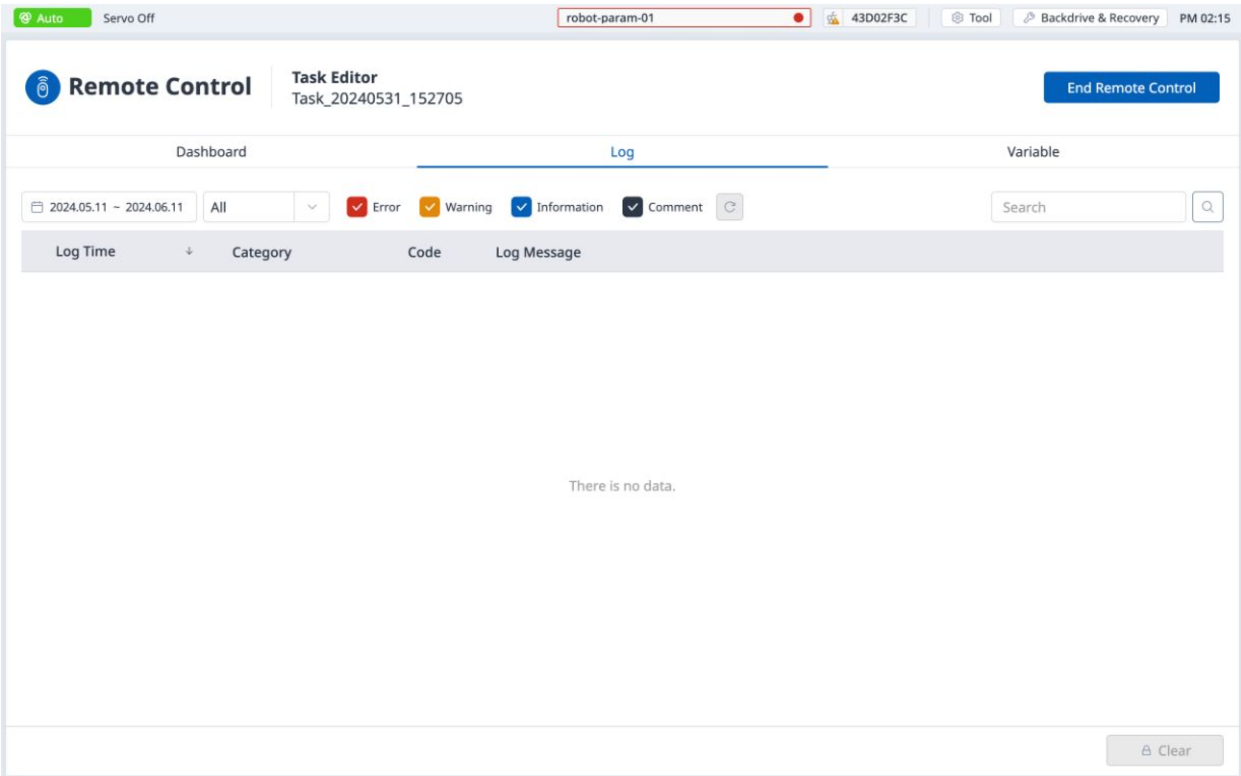
	Item	Description
1	Input Signal	Among the safety input signal items set in the safe input/output, a remote control activation signal is received and displayed.
2	Total Time	Displays the time when the task was executed.
3	Cycle Count	Displays the number of repetitions of the task.
4	Cycle Time	Displays the one-cycle time of the task.
5	Collision Sensitivity	Displays the collision sensitivity value. If inside the zone, displays the impact sensitivity value set in that zone. If outside the Zone, displays the crash sensitivity value set in the robot limit.
6	Tool Center Point	Displays the tool center point specified in the task.
7	Tool Weight	Displays the tool weight specified in the task.
8	Tool Shape	Displays the tool shape specified in the task.
9	Signal Input/Output	Displays the respective signal input/output values.
10	Log	Displays system log information.
11	Speed	You can set the speed of the task.
12	TCP Force	Displays the force applied to TCP in real time.
13	Variable	Displays the variable values used by the running task.


❶ Controller Digital Input
1 2 3 4 5 6 7 8
9 10 11 12 13 14 15 16
❷ Safety Input
1 2 3 4
❸ Controller Digital Output
1 2 3 4 5 6 7 8
9 10 11 12 13 14 15 16
❹ Flange Digital Input
1 2 3 4
❺ Flange Digital Output
1 2 3 4
X1 PNP
X2 NPN
Supply Voltage
0.00 V
❻ Controller Analog Input
1 4.00 20.00 0.00 V
2 4.00 20.00 0.00 V
❼ Controller Analog Output
1 4.00 20.00 0.00 V
2 4.00 20.00 0.00 V
❽ Flange Analog Input
1 4.00 20.00 0.00 mA
2 4.00 20.00 0.00 mA
3 4.00 20.00 0.00 mA

	Item	Description
1	Controller Digital Input	Displays the controller digital input settings.
2	Safety Input	Displays the controller safety input settings.
3	Controller Digital Output	Displays the controller controller digital output settings.
4	Flange Digital Input	Displays the flange digital input settings.
5	Flange Digital Output	Displays the flange digital output settings.
6	Controller Analog Input	Displays the controller analog input settings.
7	Controller Analog Output	Displays the controller analog output settings.
8	Flange Analog Input	Displays the flange analog input settings.

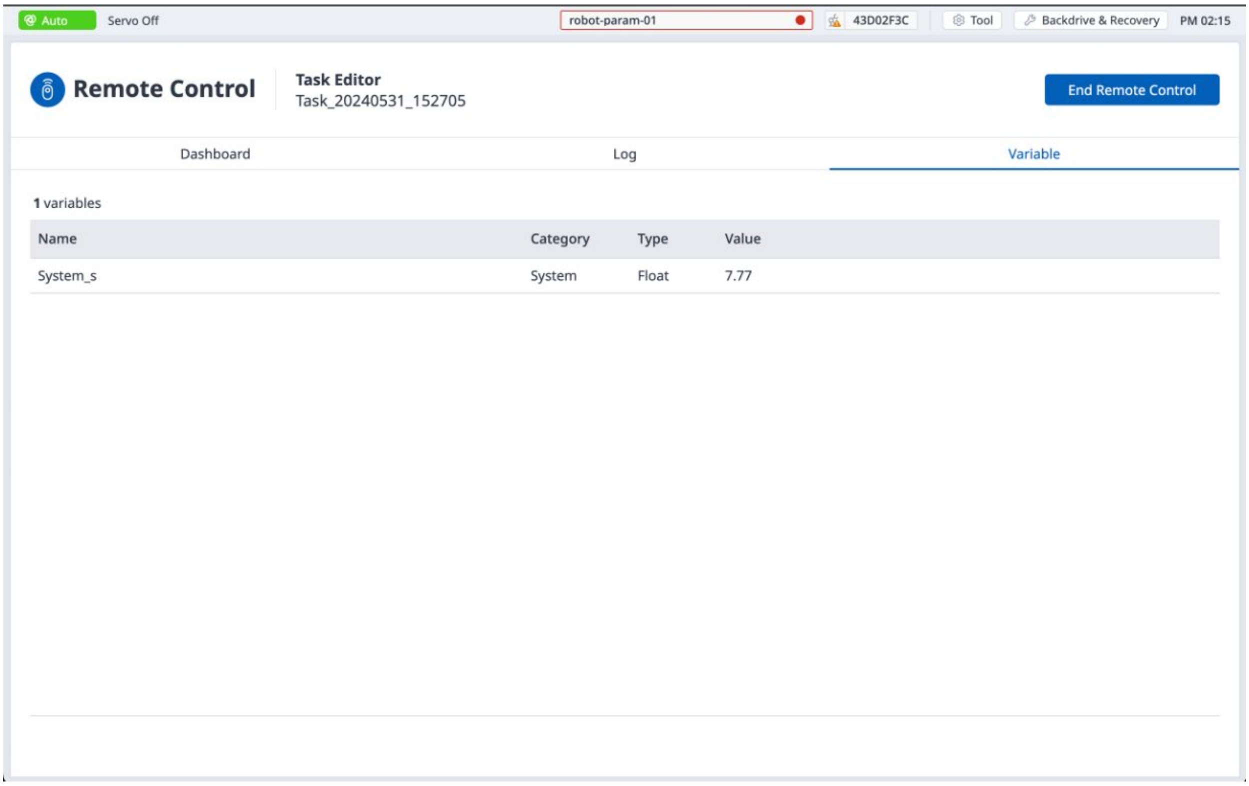
5.8.2 Log

Displays system log information.

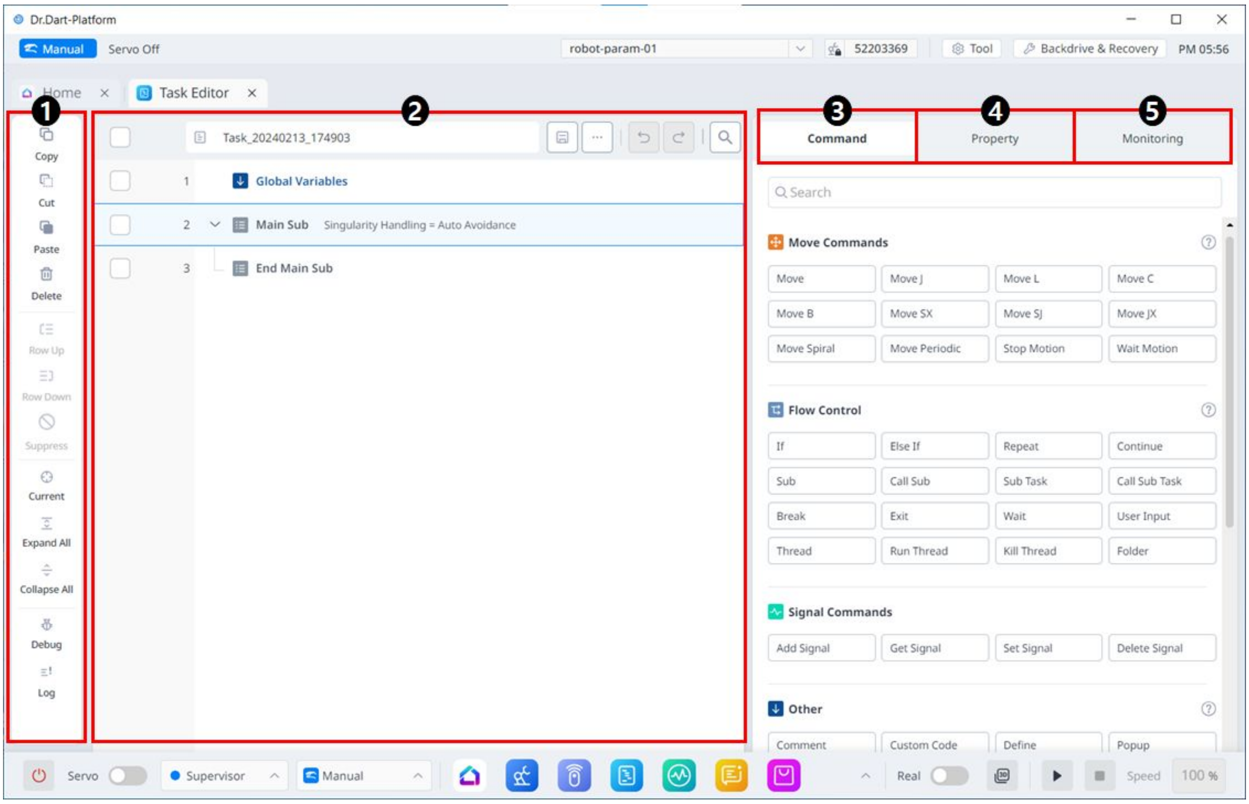


5.8.3 Variable

Displays the variable values used by the running task.



5.9 Task Editor Module

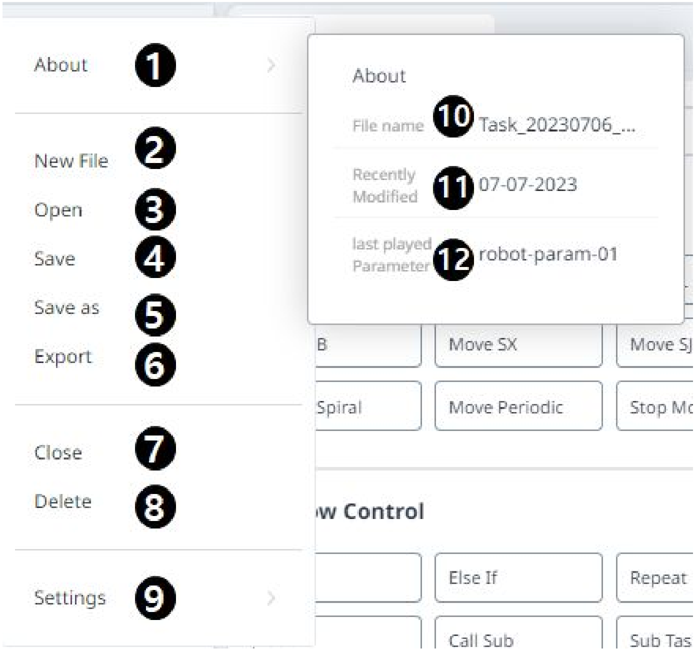


Menu Layout

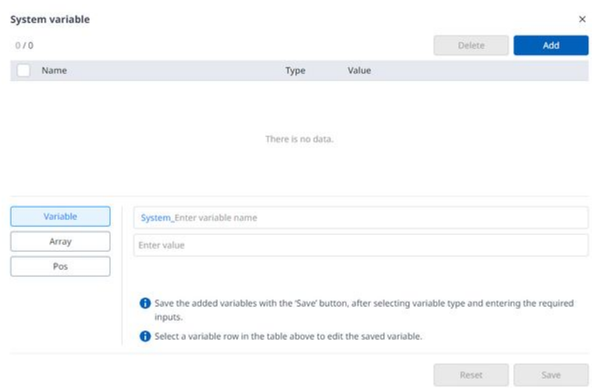
	Item	Description
1	Edit Command Tool (CTR)	• Copy: Copies a command. • Cut: Cuts a command. • Paste: Pastes a copied or cut command. • Delete: Deletes a command. • Row Up: Moves a command up by a line. • Row Down: Moves a command down by a line. • Suppress: Annotates a command to exclude the corresponding command from execution during task execution.

	Item	Description
2	Task List	Displays the task order and a list of commands added from the Command tab. Once the task is created, the **Global Variables, Main Sub, and End Main Sub** commands are automatically added. The list includes the following functions: • Multi Select: Allows you to select multiple commands. • Task Name: Allows you to edit the name. • Save: Allows you to save the created Task. • View More: Allows more functions related to the task to be performed. * For more information about the View More button, see the section below. • Undo: Allows you to cancel the very last action executed. • Redo: Allows you to redo a canceled action.
3	Command	Displays a list of commands to add to the Task List. Once a command is selected, it is added to the Task List.
4	Property	In this section, you can view and modify the settings of commands added to the Task List.
5	Monitoring	In this section, you can simulate and further configure the commands added to the Task List.

View More is organized as follows:



	Item	Description
1	About	Provides more information about the task.
2	New File	Creates a new file.
3	#Open#	Opens a task that already exists.
4	Save	Saves the current task.
5	Save as	Saves the current task with a different name.
6	Export	Exports the current task.
7	Close	Closes the task.
8	Delete	Deletes the task.

	Item	Description
9	Settings	Sets system variables. 
10	About_File name	This is where the file name is seen.
11	About_Recently Modified	This is where the date of the last modification is seen.
12	About_Last played Parameter	This is where the very last parameter executed is seen.

Note

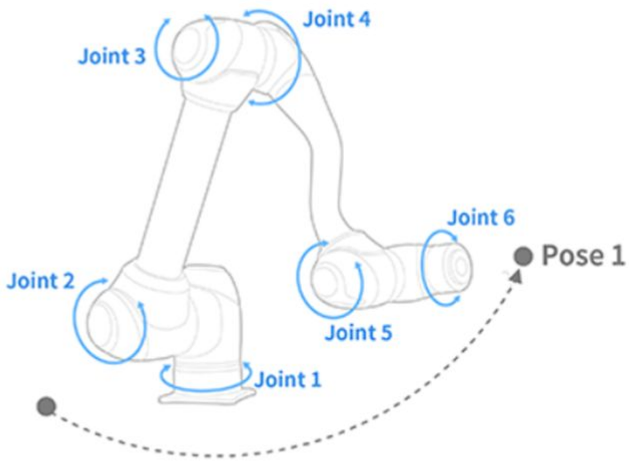
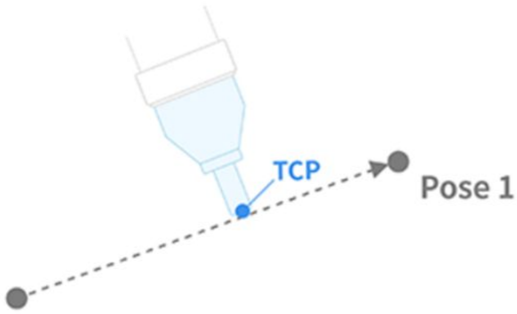
- **Global Variables**: **The global variable** and **global** pose of the task program can be entered in the Properties tab of Global Variables, and predefined global variables and global poses can be used in the property screen of the command added in the task list.
- **Main Sub**, **End Main Sub**: The commands you select are added to the bottom of Main Sub, and are executed in order from top to bottom, from the commands listed at the bottom of Main Sub to the commands listed at the top of End Main Sub.
- When monitoring is performed with a variable registered in the Variable tab, the value change frequency may be too fast to display the value on the screen**.**
- System variables can be registered without any limit on the number starting from software version V2.8.
- If there are too many system variables registered, there may be long loading times for task execution.
- Excessive use of TP_LOG or SET commands within loops may cause CPU overload.

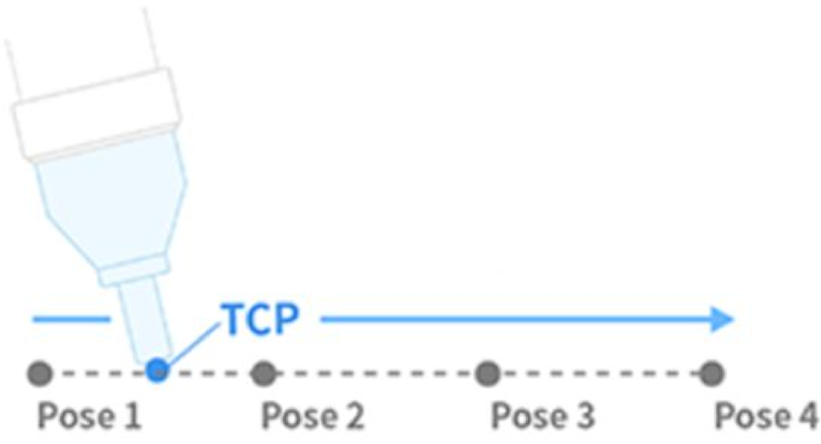
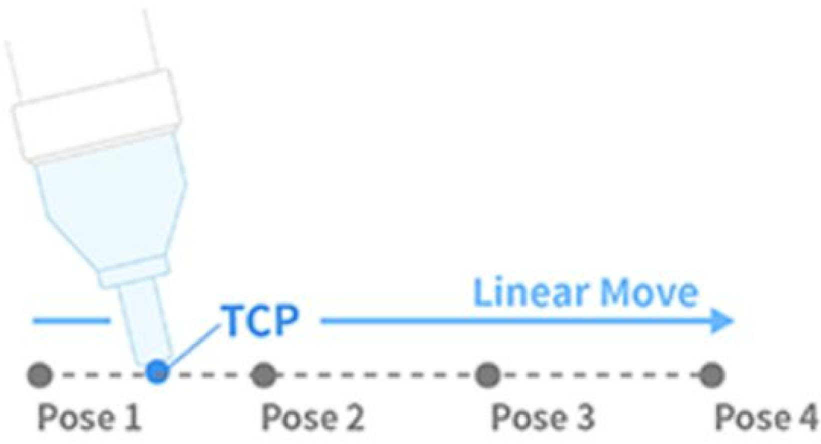
5.9.1 Overview of the Basic Concepts behind the Task Editor Move Command

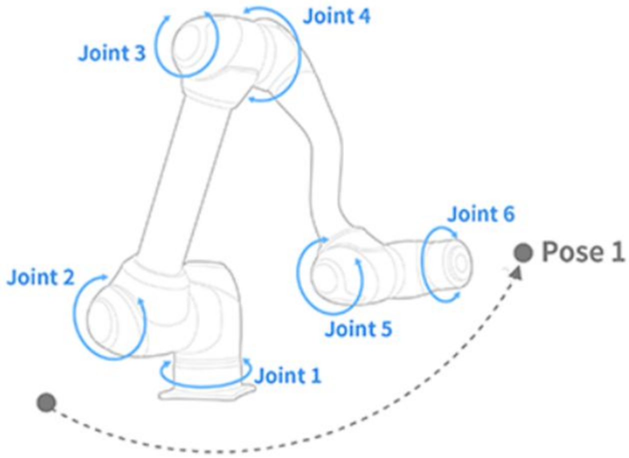
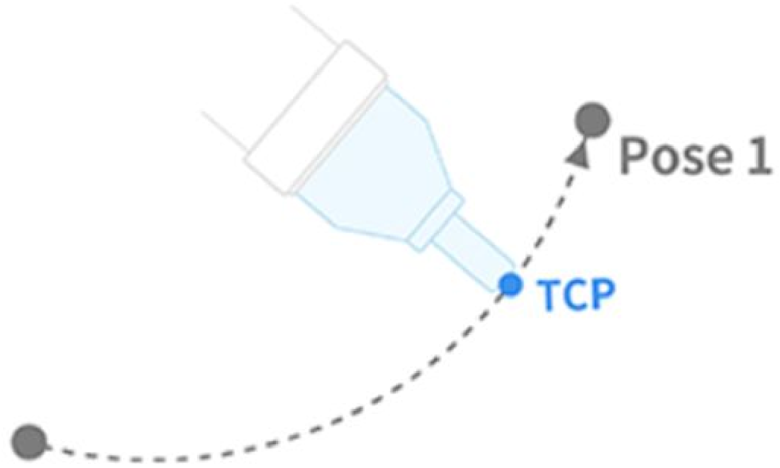
MANDATORY EASY 5 MIN

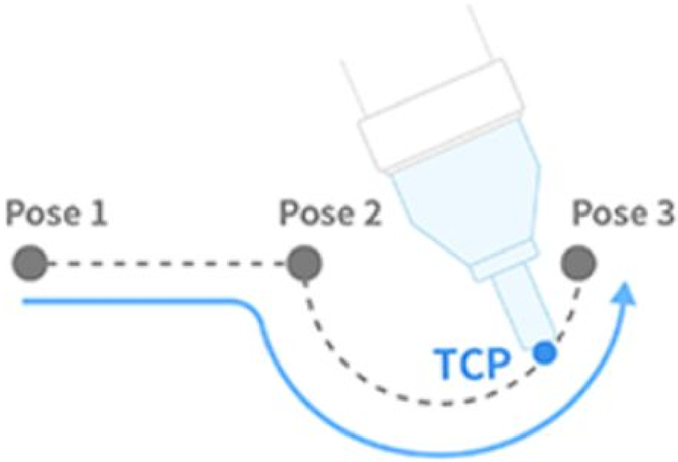
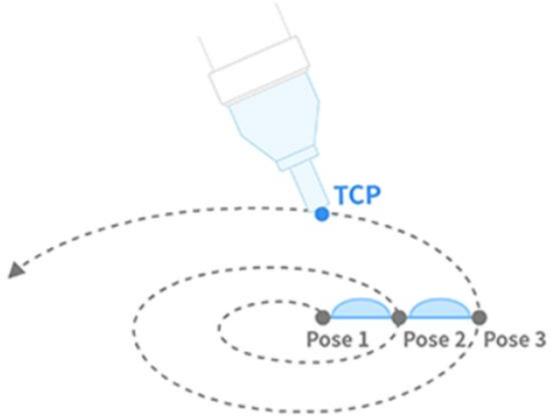
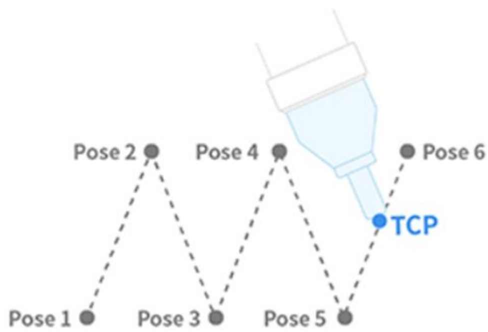
Doosan Robotics robots offer nine motions. Robot movement is controlled by standard motions, MoveJ and MoveL, and 7 motions derived from these two motions.

Types of Robot Motion

	Motion	Feature
1	**MoveJ**	Each joint of the robot moves from the current angle to the target angle and stops simultaneously • Enter target joint angle: Joint1, Joint2, Joint3, Joint4, Joint5, Joint6 
2	**MoveL**	Robot moves to the target point while maintaining the robot TCP straight • Enter target position and rotation values: X, Y, Z, RZ, RY, RX 

3	**MoveSJ**	Robot moves throughout all angles set by the robot • Continuous MoveJ motion movement • As it is a robot joint movement, the path cannot be estimated 
4	**MoveSX**	Robot TCP moves throughout all points • Continuous MoveL motion movement • A straight path is maintained 

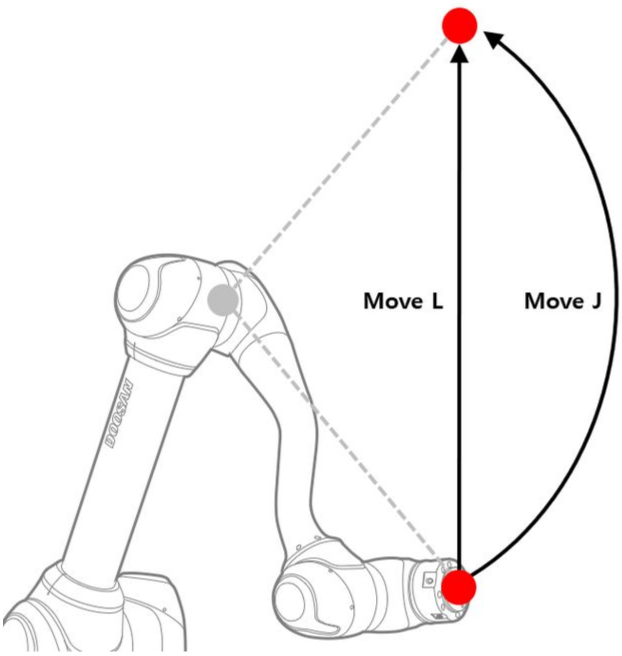
5	**MoveJ X**	The robot pose is designated as the robot TCP moves to the target point • MoveJ motion movement to the target point (X, Y, Z, RZ, RY, RX) • As it is a robot joint movement, the path cannot be estimated 
6	**MoveC**	Robot TCP moves to target point while maintaining an arc 

7	**MoveB**	Robot moves to the final target point through a section consisting of continuous straight lines and arcs 
8	**MoveSpiral**	Robot moves from the spiral center to the maximum radius 
9	**MovePeriodic**	Robot moves in a path with a constant amplitude and cycle 

MoveJ&MoveL

Before using robot motion, it is critical to understand the standard motions MoveJ and MoveL.

- J in MoveJ refers to joints. In this motion, each joint moves to the target angle and stops simultaneously.
- L in MoveL refers to linear. In this motion, the TCP on the robot end moves to the target pose (position and angle) with linear motion.



	Type	MoveJ	MoveL
1	**Move Method**	• All joints of the robot move from the current angle to the target angle and stop simultaneously	• TCP on the robot end moves to the selected coordinates with linear motion
2	**Advantage**	• Fast movement speed • Not influenced by a robot singularity	• As TCP path maintains a straight line, the movement path of the robot can be estimated • As target point is indicated using position and rotation (X, Y, Z, RZ, RY, RX), the approximate robot end point can be estimated

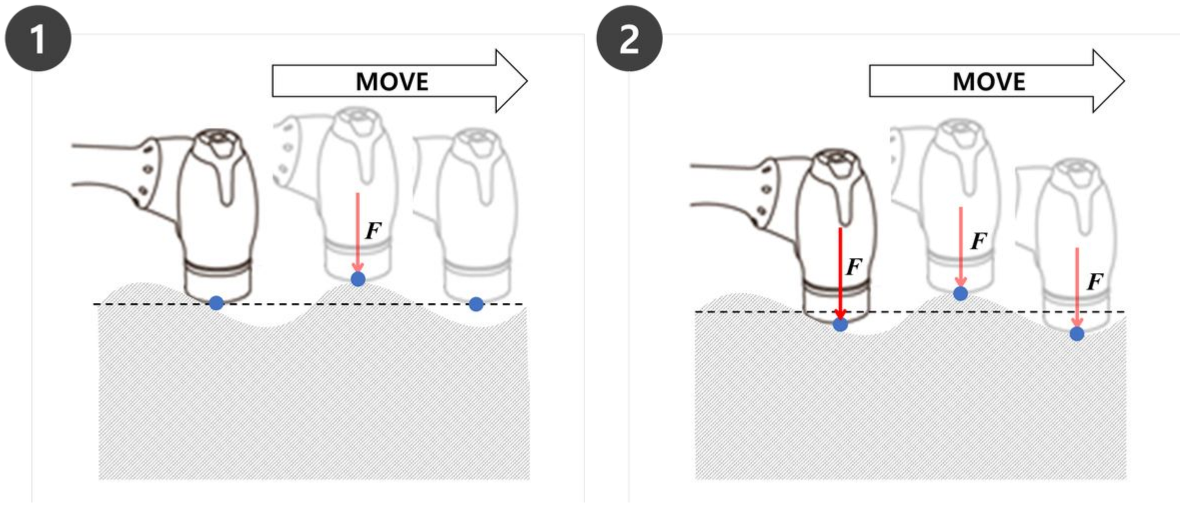
3	**Disadvantage**	• As all axes rotate to the target angle simultaneously, movement path cannot be estimated • As target angle is indicated with the angle of each axis, it is difficult to estimate the robot end point and robot pose	• Motion speed is relatively slower than MoveJ • Influenced by a robot singularity
4	**Utilization**	• As it is not influenced by a robot singularity, it is used to avoid singularities • It is ideal in moving long distances	• It is ideal in avoiding objects and fine movement

5.9.2 Overview of the Concept of Compliance/Force Control of the Task Editor Command

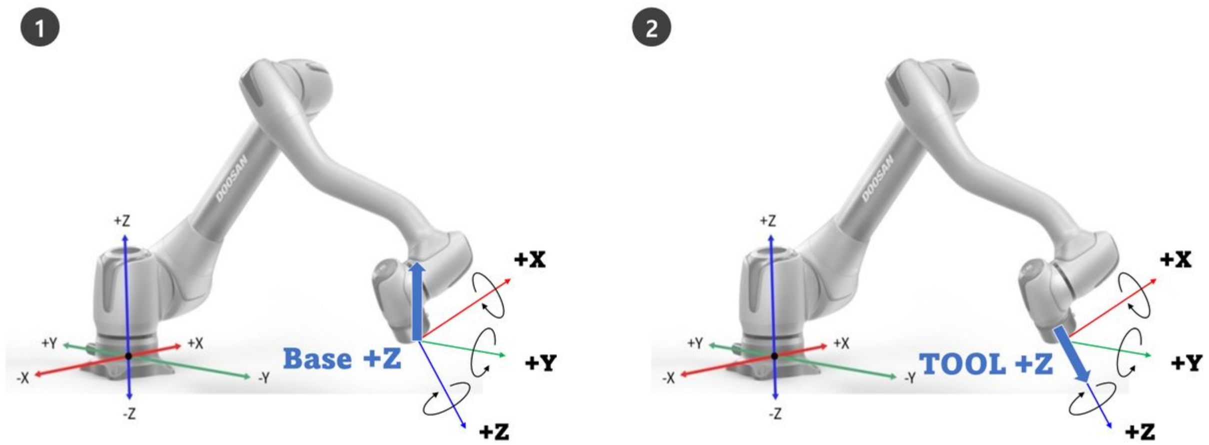
OPTIONAL HARD 20 MIN

Force Control and Compliance Control are functions that control the force of the robot. Also, with the addition of motion commands, the force can be controlled at the same time as the motion is made. Compliance Control and Force Control have the following differences, respectively.

1. Compliance Control
    - In the case of Compliance Control, the robot complies to the external force at the end TCP of the robot and when the external force is removed, a force is generated to move the robot back to where it should be.
    - This approach can be utilized when a robot is moving in a straight line on a bumpy surface and you want to ensure that the robot moves without causing damage to itself or the surface. This can also be utilized to prevent unexpected collisions near workpieces.
2. Force control
    - In the case of Force Control, the force is applied to the TCP at the end of the robot. Acceleration is generated in the direction in which the force is generated, causing the robot to simultaneously move in the direction of the force in addition to the direction of motion.
    - When the robot comes into contact with an object, the force is applied to the object until the set force and the object's repulsive force are in equilibrium.
    - This approach can be utilized when a robot is moving in a straight line on a bumpy surface and you want to ensure that a constant force is applied to a surface. This can also be utilized for tasks that require the robot to push with a constant force, i.e., polishing work.



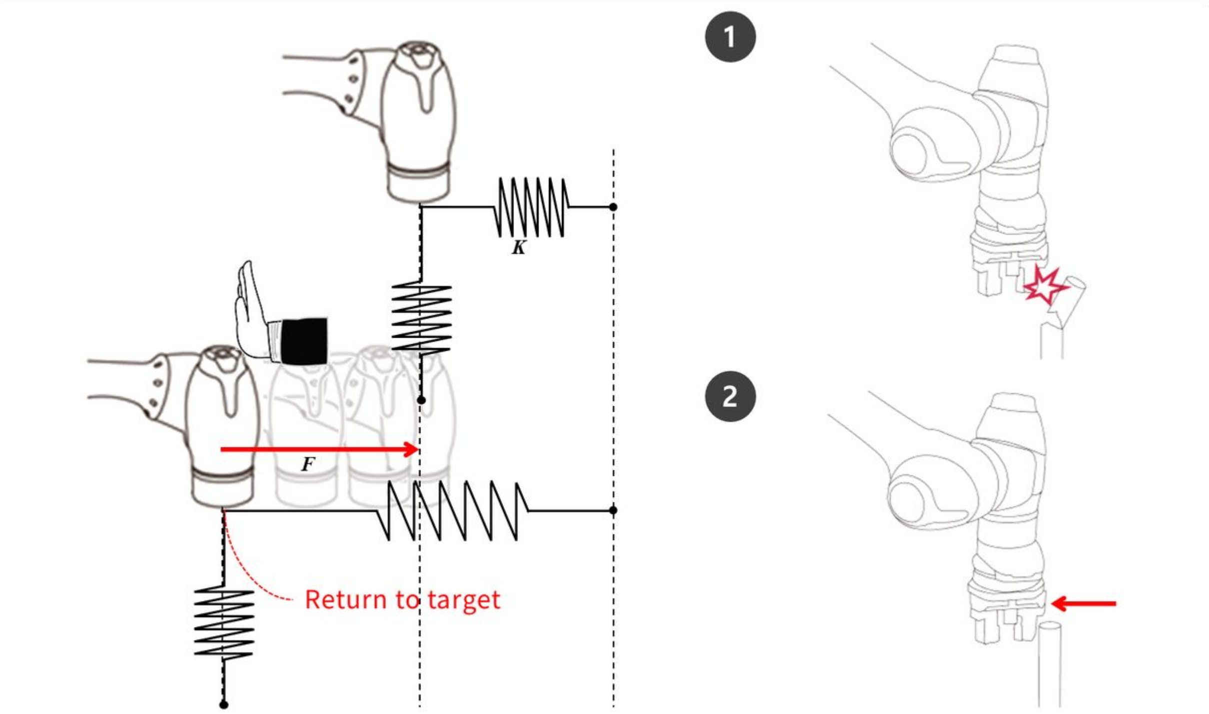
> **Note**
>
> Compliance and Force Commands are executed based on the current coordinates. The default coordinate of a task is the Base coordinates, and the coordinates can be changed with the Set command.
>
> 1. Fig. 1 is the operating direction when force/compliance control in the +Z direction is applied on the base coordinates.
> 2. Fig. 2 is the operating direction when force/compliance control in the +Z direction is applied on the tool coordinates.



Compliance Control

Compliance control is the function that complies to external force according to the set stiffness when force is applied on the TCOP at the end of the robot. It balances forces at the target point, and it is a control method that generates repelling force if displacement occurs away from the balancing point. During compliance control, the robot end bounces like a spring.

1. If collision is made when motion control is used alone, it is possible that the collided object may get damaged.
    - Doosan Robotics robots stop safely when a collision occurs, but depending on the user setting, such as **Safety Limits > Collision Sensitivity**, the following situations may occur.
2. If compliance control is set to on during motion control, the robot will move while complying to the collided object.



If F is external force, K is stiffness and X is distance, the following formulas are true.

- F = K * X
- K = F / X
- X = F / K

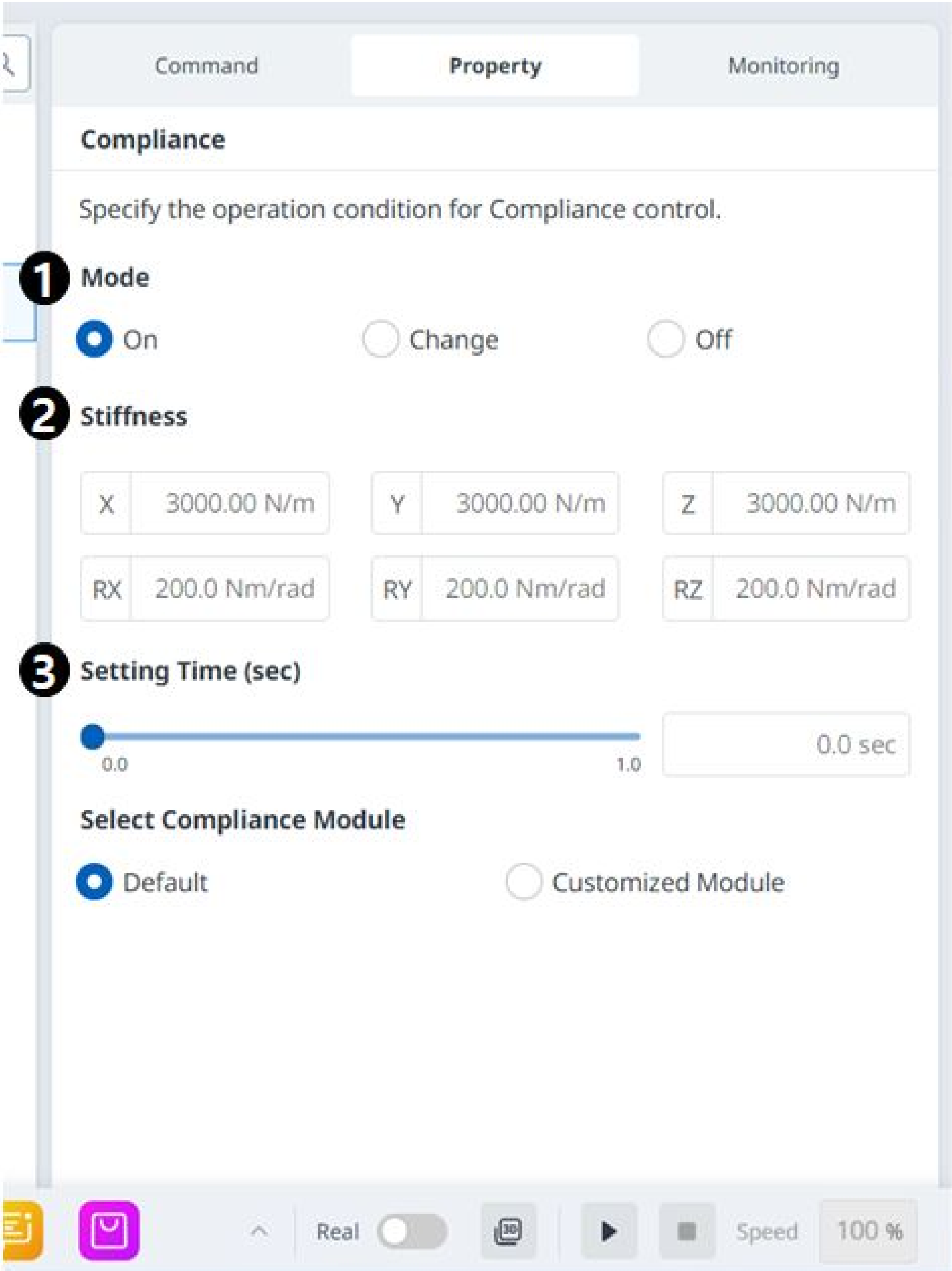
Based on the above formulas, if the stiffness of compliance control is set to 1000N/m and if the robot moves 1 mm, the external force generated is 1N.

- F=1000 N/m*0.001 m=1 N (0.001 m=1 mm)

Note

On the Property of Compliance Command, the following values can be set:

1. Mode
    - On: Enables compliance control
    - Change: If compliance mode is set to On, it changes to stiffness
    - Off: Disables compliance control
2. Stiffness Range
    - M/H Series: Translation(0~20000N/m), Rotation(0~1000Nm/rad)
    - A Series: Translation(0~10000N/m), Rotation(0~300Nm/rad)
    - Lower stiffness values will respond to external force more gently and will require more time to return to the target point
3. Setting Time
    - It is the time required for the current stiffness value to reach the set stiffness value (0-1s)



Caution

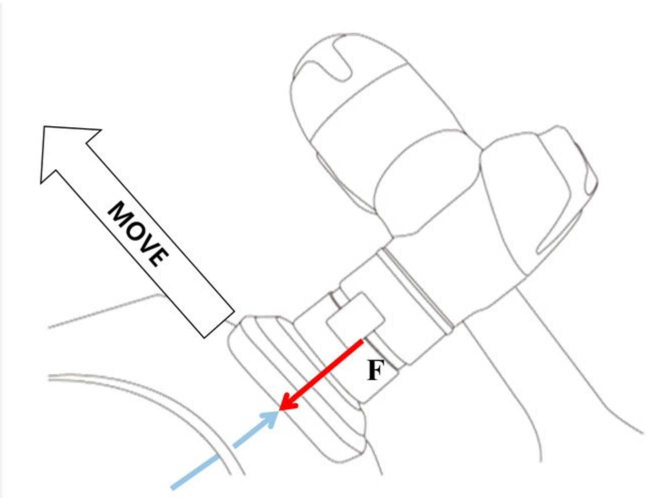
- Tool weight and TCP (Tool Center Point) must be accurately set. Inaccurate tool weight can cause the robot to detect the tool weight as external force, and setting the Compliance Command On will generate position error.
- Tension of the dress pack may generate external torque on the robot. Therefore, take caution when installing the dress pack.

- Compliance cannot be turned on or off while async motion or blending motion is being executed.
- During Compliance Command on, only linear motion is allowed. Joint motions, such as MoveJ and MoveSJ, are not allowed.
- During Compliance Command On, Tool Weight or TCP cannot be changed.
- During Compliance Command on, it is possible to not accurately reach the target point due to compliance of the torque generated during motion execution. Therefore, it is recommended to turn on compliance control near the target point. Or, it is possible to minimize position error by setting a large stiffness value.

Force Control

Force Control is a function that applies force in the force control direction until the set force and repelling force are balanced

- It moves the robot in the set force direction, and if contact with an object is made, it maintains the entered force (N)
- It is capable of motion control in a direction different from the force direction while applying a constant force
- The minimum setting is +/- 10N, and it can be fine-tuned with a resolution of 0.2N
- Force Control is unavailable in singularity zone
- In general, Compliance Control is used in conjunction with force control so that force control complies to external force



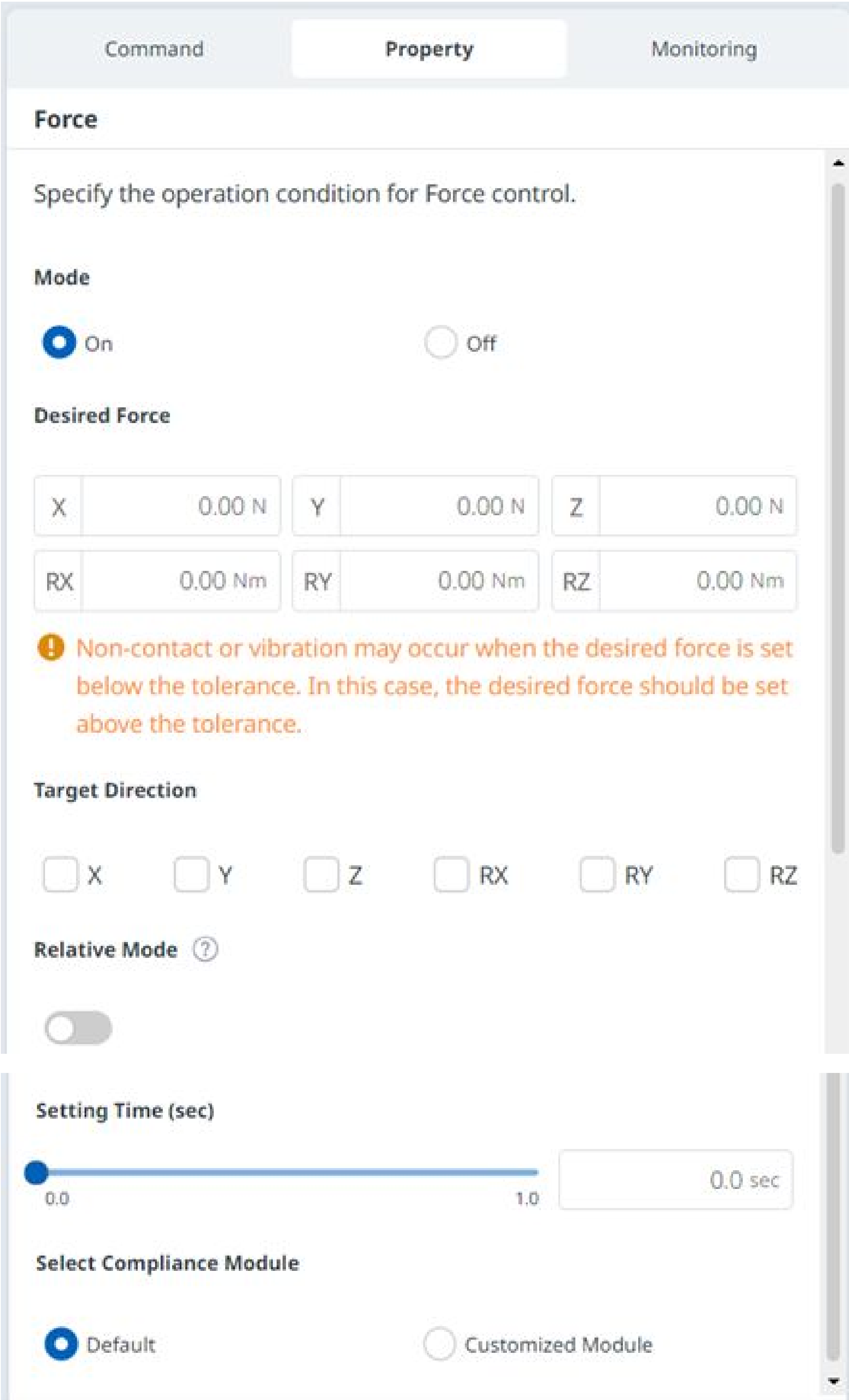
Note

From the property of Force Command, the following values can be set.

1. Mode
    - On: Enables Force Control

- Off: Disables Force Control

2. Desired Force Range
    - X, Y, Z: 10 - (each robot's maximum) N
    - A, B, C: 5 - (each robot's maximum) Nm
    - For more information about maximum force, refer to Upper/Lower Threshold Range and Default Value of Safety Parameters(p. 96).
3. Target Direction
    - It moves to the selected target value of each direction.
    - Multiple selections can be made.
    - Force control can only be executed with direction setting after force setting.
    - If one of the multiple selected directions reaches the target force, it will continue to move until the target value is reached for the other direction.
4. Relative Mode
    - If this mode is enabled, it calibrates the external force applied on the robot to 0 to improve the force control accuracy.
        i. When relative mode is disabled, the actual force applying on the target is equal to the sum of the set force and external force.
        ii. When relative mode is enabled, the actual force applying on the target is equal to the set force.
    - During force control, deviation can occur depending on the pose or external force.
    - During force control, it is possible not to reach the exact target point. Therefore, it is recommended to enable force control near the target point.
5. Setting Time
    - It is the time required for the current force value to reach the set force value (0-1s)


Command
Property
Monitoring
Force
Specify the operation condition for Force control.
Mode
On
Off
Desired Force
X 0.00 N
Y 0.00 N
Z 0.00 N
RX 0.00 Nm
RY 0.00 Nm
RZ 0.00 Nm
Non-contact or vibration may occur when the desired force is set below the tolerance. In this case, the desired force should be set above the tolerance.
Target Direction
X
Y
Z
RX
RY
RZ
Relative Mode
Setting Time (sec)
0.0
1.0
0.0 sec
Select Compliance Module
Default
Customized Module

Thread Command

Threads can be created and executed in the task editor.

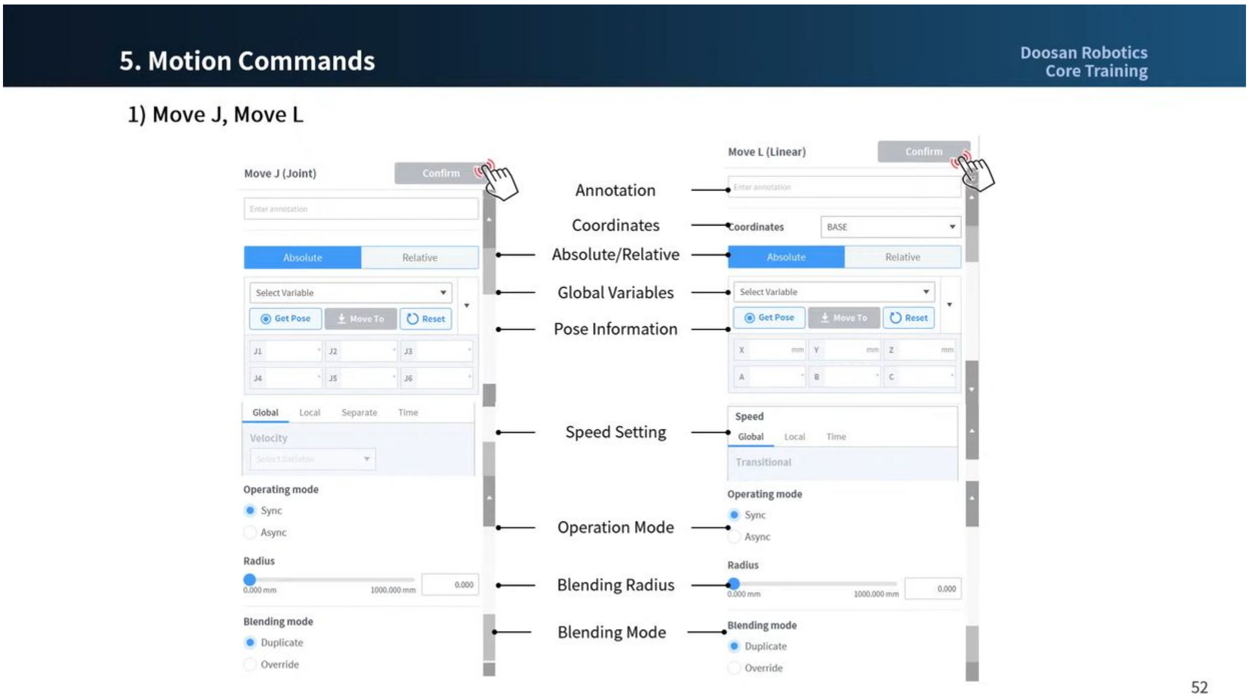
Note

The constraints for Threads are as follows:

- A Thread name cannot start with a number and can only contain lowercase letters, numbers, and underscores. The name must not exceed 30 characters or be duplicated with another Thread name.
- In the task editor screen, when you click the Thread command, both the Thread command and the end Thread command will be added to the task list panel. A maximum of four Threads is allowed per task.
- The following commands cannot be configured alone and must be implemented within conditional statements:
    - Move, Move L, Move J, Move SX,Move SJ, Move C, Move B, Move Spiral, Move Periodic, Move JX
    - Define, Set, Sub, Thread, Break, Weight Measure
    - Force Control Commands (Compliance, Force)
    - Signal Commands (Add Signal, Set Signal, Get Signal, Delete Signal)
    - Advanced Commands (Hand guide, Nudge)
    - User Commands

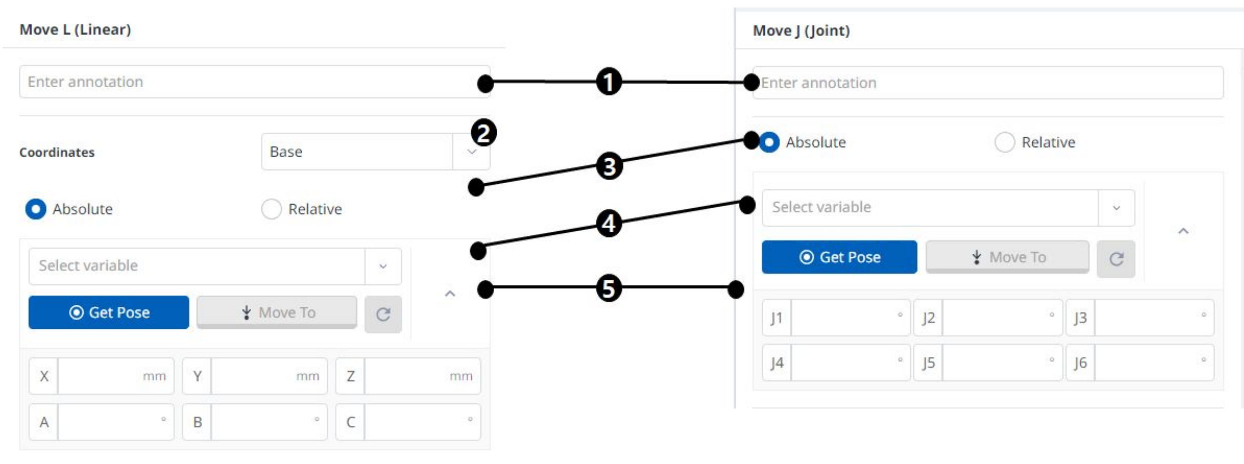
5.9.3 Overview of Robot Motion Properties of the Task Editor

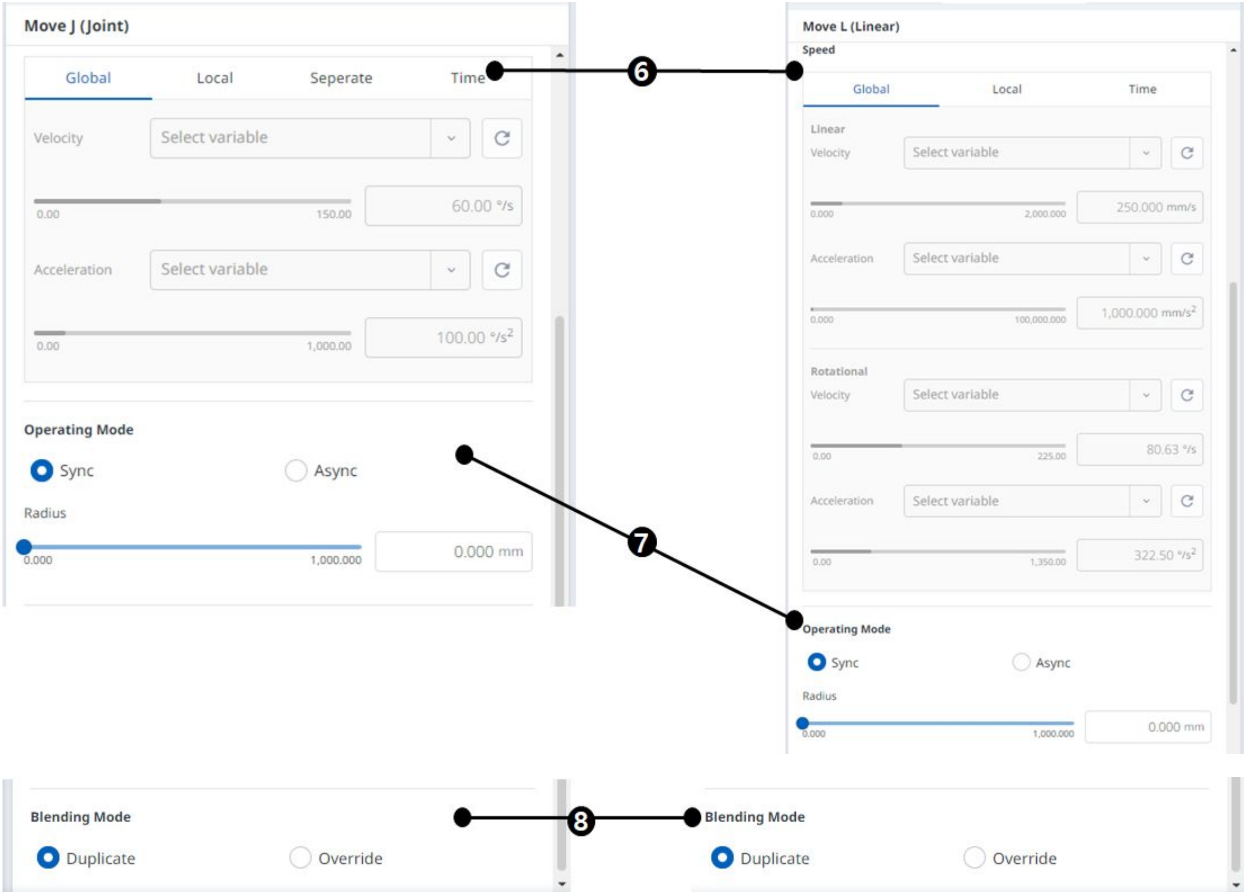
MANDATORY NORMAL 15 MIN



It is the property screen of the standard motions, MoveJ and MoveL commands. Other motions also have similar properties.

- If motion is created with minimum settings, only the pose information (5 in the figure below) needs to be entered.





	Name	Description
1	**Annotation**	Description or annotation of the command which can be found in the task window
2	**Coordinates**	• MoveJ: None • MoveL: Calculates the entered pose information based on the coordinates (BASE/WORLD/TOOL/USER)

3	**Select move type**	1. Absolute movement
		  • MoveJ: Each joint moves to the target angle
		  • MoveL: Performs absolute movement by the target value based on the origin of the selected coordinates
		2. Relative movement
		  • MoveJ: Each joint performs relative movement by the target angle from the current angle
		  • MoveL: Performs relative movement by set value based on the current point (relative movement based on the selected coordinates)

4	**Select variable**	Pose information registered as variables can be selected

5	**Pose information**	Pose information is entered • MoveJ: Angle of each axis ([J1, J2, J3, J4, J5, J6]) • MoveL: Position and rotation from coordinates ([X, Y, Z, A, B, C])

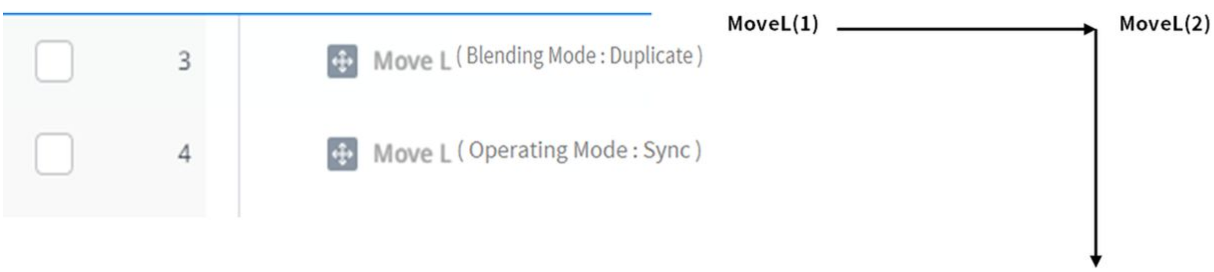
6	**Speed setting**	1. Global: Uses the speed designated as global in the property of MainSub
		2. Local: Each speed is designated
		3. Separate:
		  • MoveJ: Each joint speed is designated separately
		  • MoveL: None
		4. Time: Movement speed of the motion is set as time
		Caution
		• When considering the maximum payload condition in the payload diagram for each model, it is recommended to set the acceleration value to the same speed or less. (Speed:Acceleration Ratio = 1:1)
		• If a high acceleration is set, the robot may vibrate during acceleration/ deceleration.

7	**Operation mode**	1. Sync: The motion command in progress is done and the next command is executed 2. Async: The next command is done simultaneously when the motion command begins 3. Radius: The async function is activated in the radius section before the motion command reaches its target point
8	**Blending mode**	The option used to determine whether to ignore or overwrite the preceding motion according to the blending mode of the following motion when the radius is set as an option of the preceding motion

Operating mode

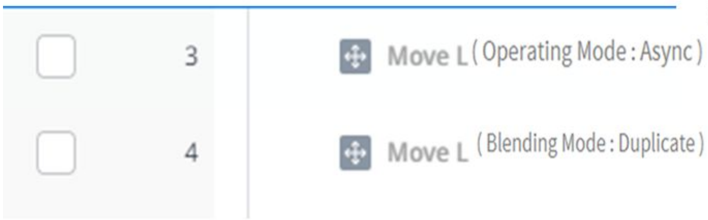
Sync

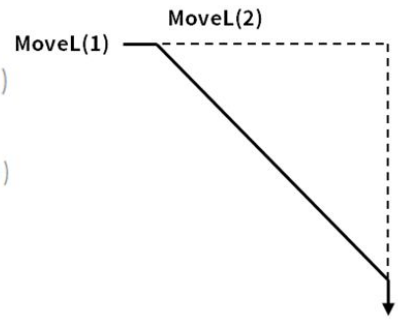
You can move to the next command with Sync when the command in progress is completed. It is set as default, and used in general situations.



Async

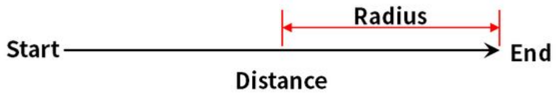
Async starts the next command simultaneously when the motion command begins. It is used to smoothly connect different motions, and it is also used when signal output is turned on/off simultaneously when the motion begins.

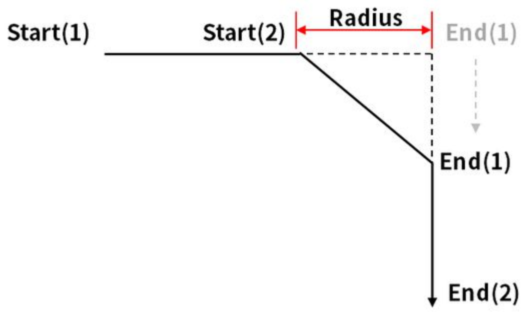




Radius

Radius option activates the async function in the radius section before the motion command reaches its target point. With this option, it is possible to smoothly connect to the next motion command without stopping the current motion command. The radius is set to 0 mm as default.





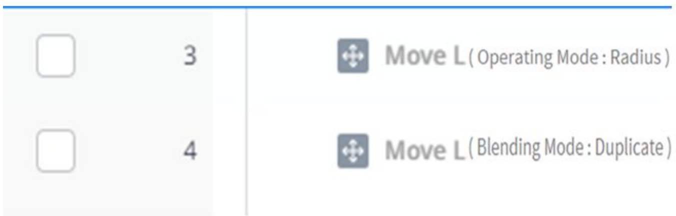
> **Caution**
>
> Radius option has following characteristics and limits:
> - Radius function can only be used in sync mode.
> - Conditions and calculations can be performed in the async section within the radius.
> - Radius cannot exceed 1/2 of the total distance between the current and target location before the motion is executed.
>   - ex. If the movement distance is 100 mm, the maximum radius available is 50 mm.
> - Motion commands which cannot apply Blending between motions are as follows: Blending is already applied in these commands, so applying radius to these commands and executing them causes errors. Utilizing commands, such as WaitMotion and StopMotion, can help avoid errors.
>   - MoveSX, MoveSJ, MovePeriodic, MoveSpiral, MoveB

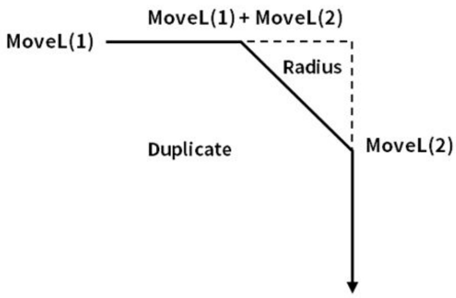
Blending mode

It is the option used to determine whether to ignore or overwrite the preceding motion according to the blending mode of the following motion when the radius is set as an option of the preceding motion.

Duplicate

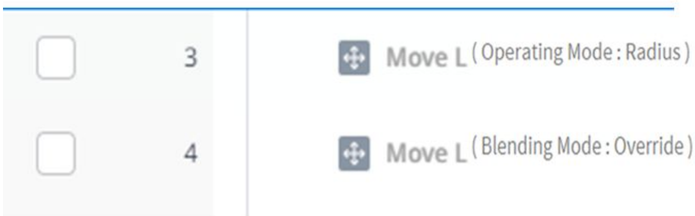
Duplicate is a mode that maintains the preceding motion to allow the following motion to overlap with the preceding motion.

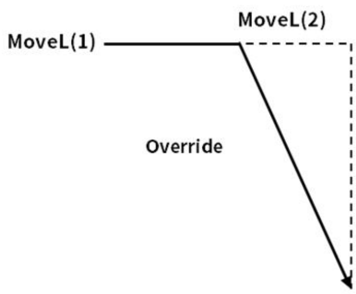




Override

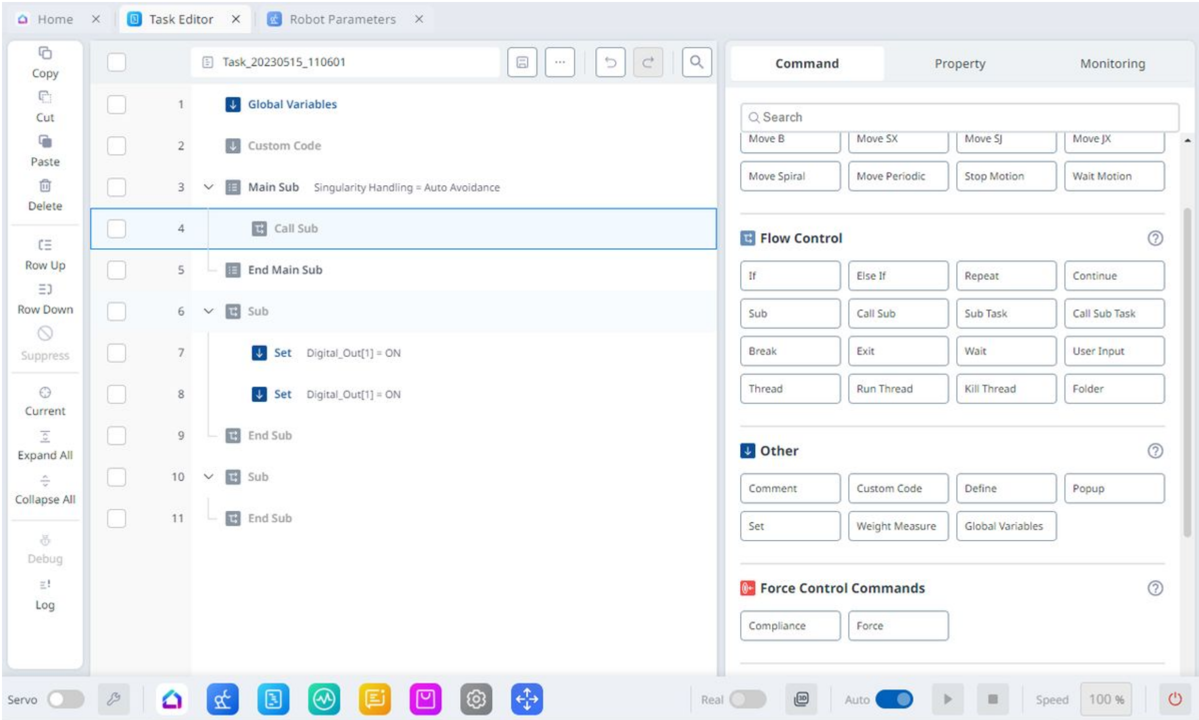
Override ignores and overwrites the preceding motion to execute the following motion.





5.9.4 Overview of Sub/Call Sub

OPTIONAL NORMAL 5 MIN

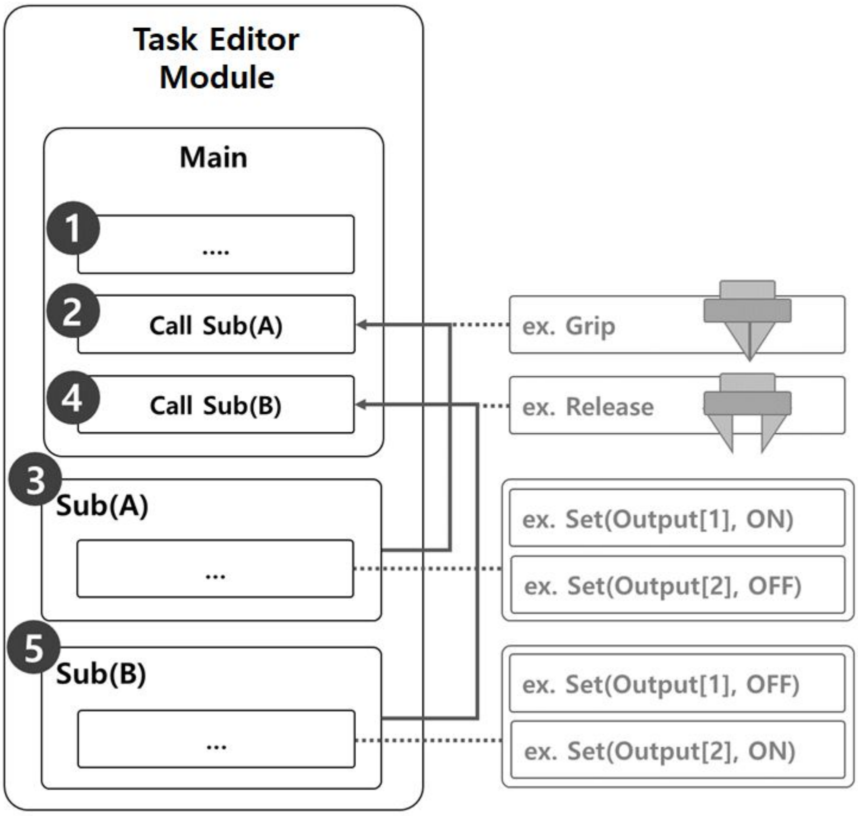


Sub is an abbreviation of Subroutine. A subroutine refers to a process that minimizes the number of steps in a program by calling necessary parts when two or more duplicate parts are present.

- Doosan Robotics robots provide a CallSub command to call Sub commands and the corresponding Sub paragraph.
- The Sub command functions as defined in Python.

Note

- Sub paragraph must be added in MainSub, the start of a Main paragraph, and EndMainSub, the end of a Main paragraph.
- In addition to repetition, the Sub command is also used to simplify a Main paragraph. Utilizing a Sub command will allow intuitive identification of what task of a Main paragraph is being performed at the moment.
- Utilizing a Sub command allows Sub paragraph unit testing.



The sample where a Sub command is used to execute grip and release motions of a robot gripper consists of the following.

1. Lines of the Main paragraph execute the task program in sequential order starting from the first line.

2. Move to Sub(A) called by Call Sub.
    - Sample
        - Program: Call the Grip subroutine.
        - Robot: No motion.

3. Sub(A) is executed. All Sub paragraph lines are executed in sequential order, returns to the Main paragraph, and executes the next line.
    - Sample
        - Program: Execute the Grip subroutine lines in sequential order. Use the Set command to set Output [1] as ON and Output [2] as OFF.
        - Robot: The robot gripper executes Grip motion.

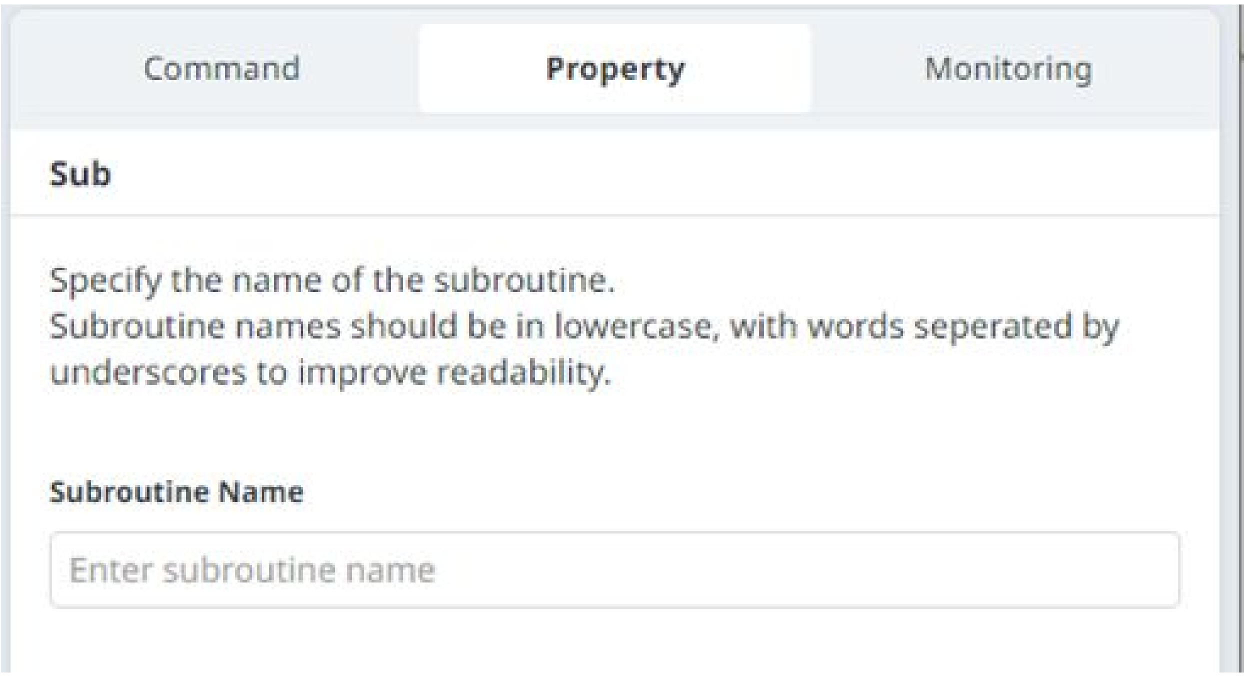
4. Move to Sub(B) called by Call Sub.
    - Sample
        - Program: Call the Release subroutine.

        - Robot: No motion.

5. Sub(B) is executed. All Sub paragraph lines are executed in sequential order, returns to the Main paragraph, and executes the next line.
    - Sample
        - Program: Execute the Grip subroutine lines in sequential order. Use the Set command to set Output [1] as OFF and Output [2] as ON.
        - Robot: The robot gripper executes Release motion.

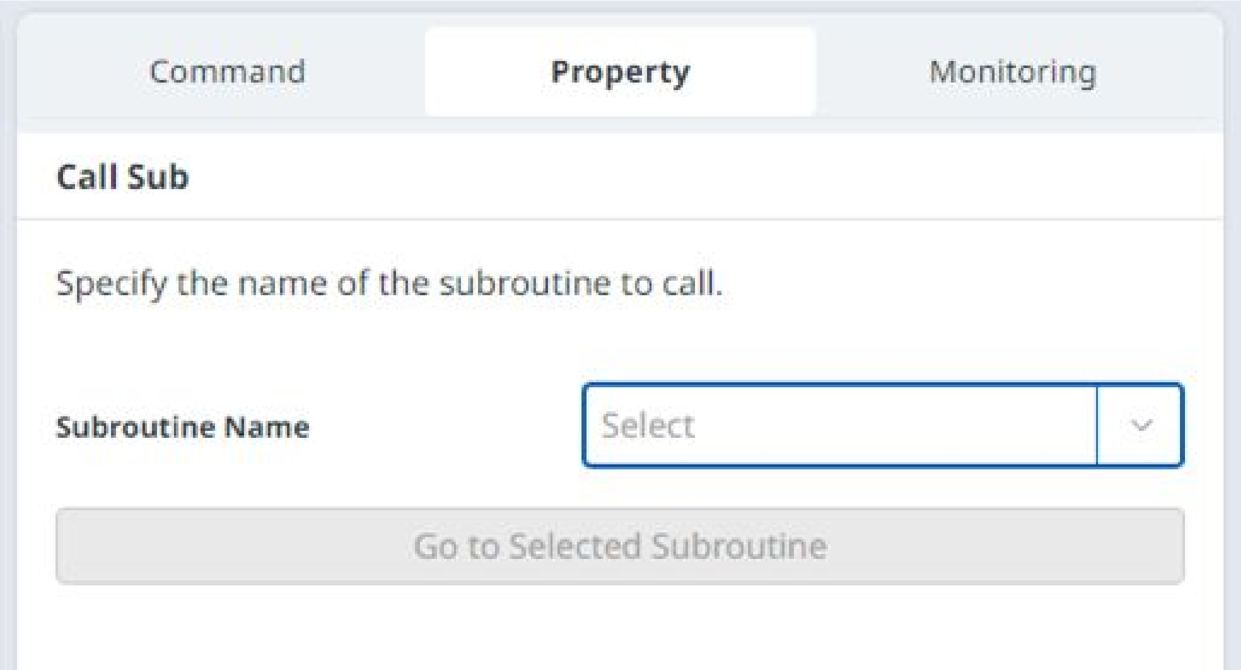
Add Sub command

1. In the Task Editor module, under the Flow Control section of the right-hand Command menu, add a Sub command.
2. Enter the subroutine name.



Add CallSub command

1. In the Task Editor module, under the Flow Control section of the right-hand Command menu, add a Call Sub command.
2. Select the subroutine name registered with Sub command.

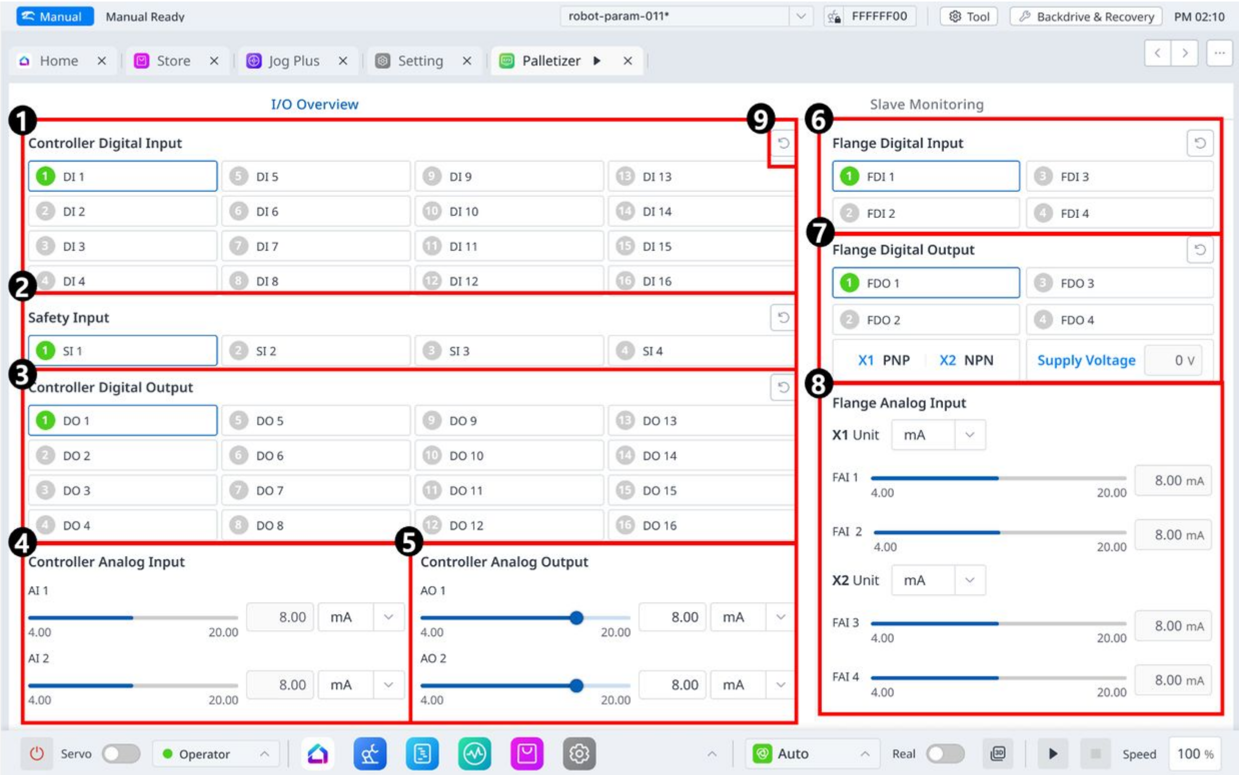


Note

- If the number of lines increases in the task program, it may become difficult to find subroutines. In such case, touch the Go to selected Subroutine in the Property of CallSub command to move the focus to the corresponding Sub command line.

5.10 Status Module

5.10.1 Screen layout for the Status module



Menu Items

	Item	Description
1	Controller Digital Input	This section is where the controller digital input is set.
2	Safety Input	This section is where the safety input is set
3	Controller Digital Output	This section is where the controller digital output is set.
4	Controller Analog Input	This section is where the controller analog input is set.
5	Controller Analog Output	This section is where the controller analog output is set.

	Item	Description
6	Flange Digital Input	This section is where the flange digital input is set.
7	Flange Digital Output	This section is where the flange digital output is set.
8	Flange Analog Input	This section is where displays the flange analog input status.
9	Refresh	This button allows you to change the settings to the defaults.

Controller I/O

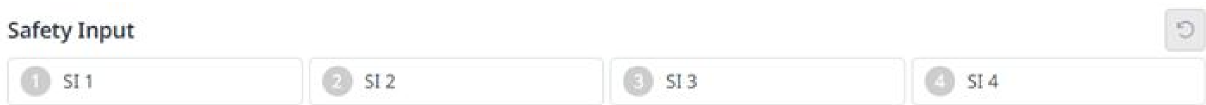
Controller Digital Input

1. Check the port number of the device connected to the controller.
2. The following is displayed depending on the digital input status of the corresponding number.
   - If the digital signal is a high signal, the icon is displayed in light green.
   - If the digital signal is a low signal, the icon is displayed in gray.

Note

- The same is true when the digital input is set as a safety input, the icon is displayed in blue when the digital signal is high, and gray when it is low.

Safety input



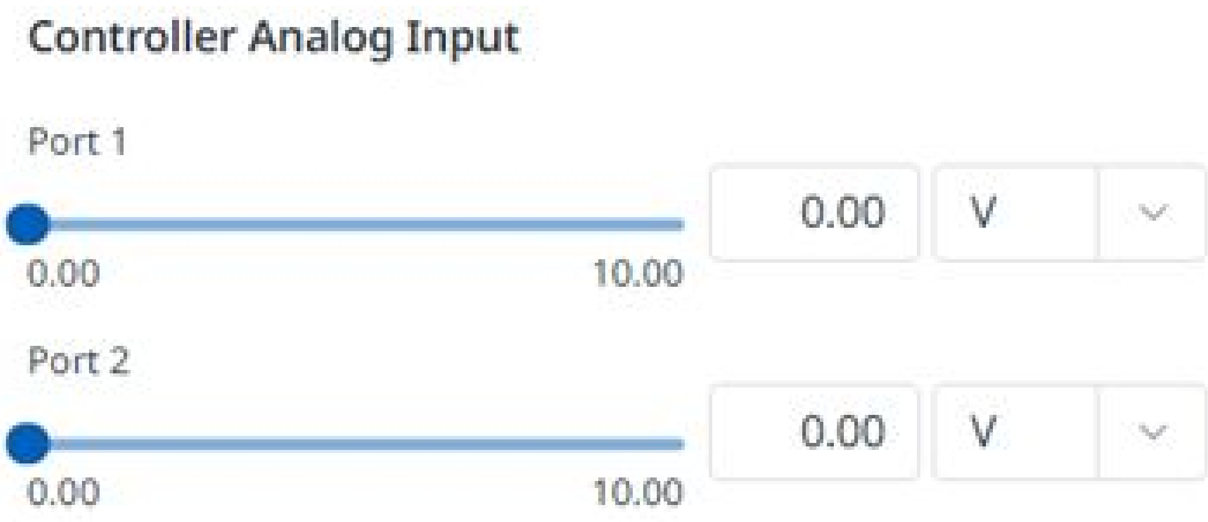
1. Check the port number of the device connected to the controller.

2. Depending on the digital input status of the number, it is displayed as follows.
    - When the digital signal is high, the icon color is light green.
    - When the digital signal is low, the icon color is gray.

Controller Digital Output

1. Check the port number of the device connected to the controller or flange.
2. Press the On/Off icon corresponding to the port number to activate or deactivate digital output.
    - When the **On** icon is pressed, the icon changes to light green and the corresponding port is enabled.
    - When the **Off** icon is pressed, the icon changes to light green and the corresponding port is disabled.

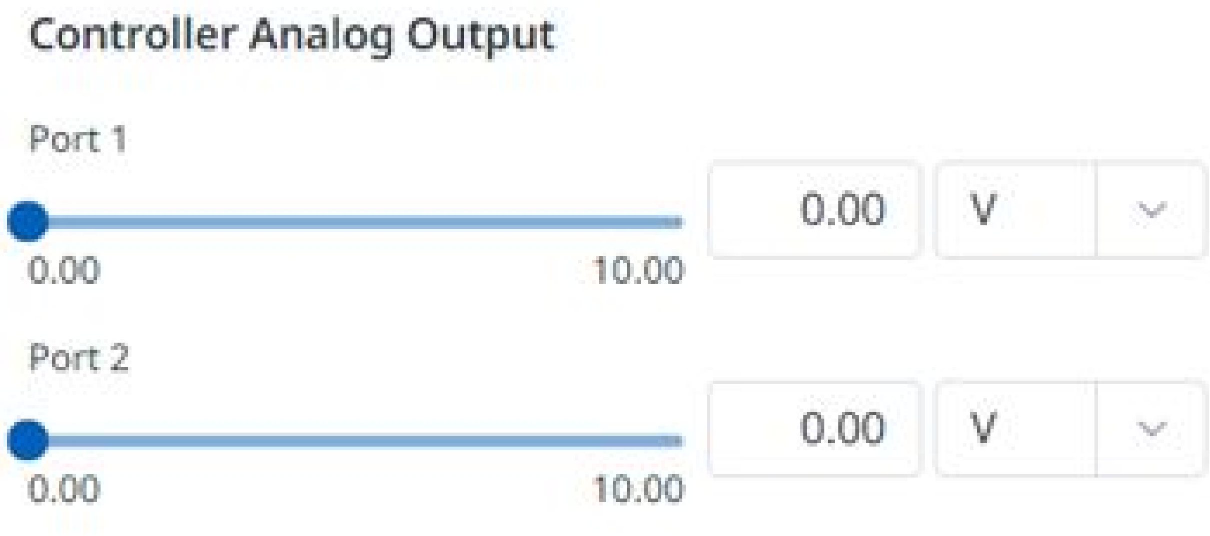
Controller Analog Input



1. Press the drop-down list on the analog input of the controller to select the item to check.
2. Check the analog input information of the selected item displayed on the screen.

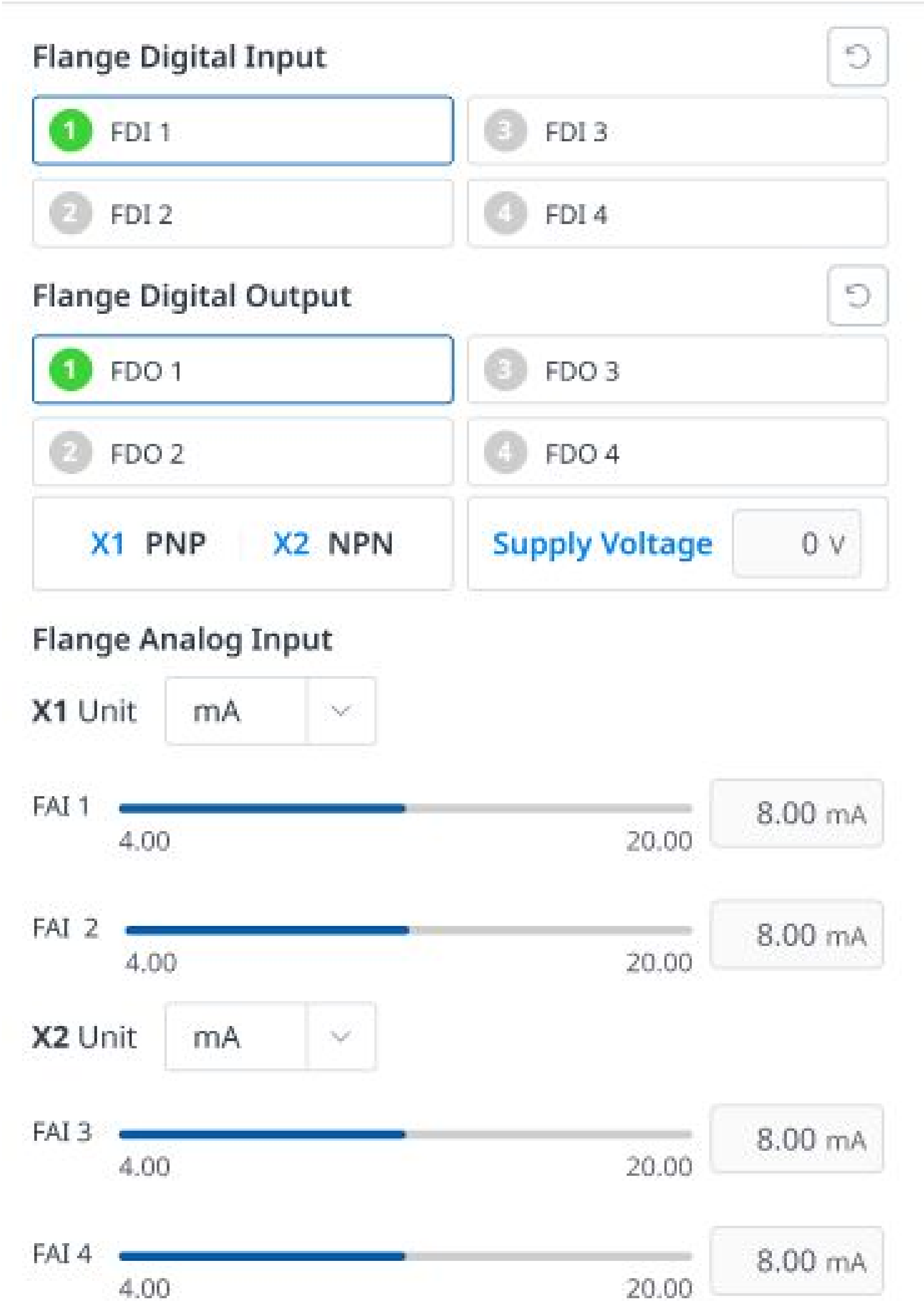
> **Note**
>
> - The analog input value cannot set the input value in the status window.

Controller Analog Output



1. Check the analog input information displayed on the screen according to the selected item.
    - Analog output information of the selected item is displayed on the right side of the drop-down list.
    - The default value for analog output signal type is voltage.
2. Modify the analog output value.

Flange I/O Port Setting


Flange Digital Input
FDI 1
FDI 3
FDI 2
FDI 4
Flange Digital Output
FDO 1
FDO 3
FDO 2
FDO 4
X1 PNP
X2 NPN
Supply Voltage
0 V
Flange Analog Input
X1 Unit
mA
FAI 1
4.00
20.00
8.00 mA
FAI 2
4.00
20.00
8.00 mA
X2 Unit
mA
FAI 3
4.00
20.00
8.00 mA
FAI 4
4.00
20.00
8.00 mA

Flange Digital Input

1. Check the port number of the device connected to the flange.
2. The following is displayed depending on the digital input status of the corresponding number.
    - If the digital signal is a high signal, the icon is displayed in light green.
    - If the digital signal is a low signal, the icon is displayed in gray.

Note

- If the digital signal is High even when the digital input is set as the safety input, the icon is displayed in blue, and if it is Low, it is displayed in gray.

Flange Digital Output

1. Check the port number of the device connected to the flange.
2. Press the On/Off icon corresponding to the port number to activate or deactivate digital output.
    - When the **On** icon is pressed, the icon changes to light green and the corresponding port is enabled.
    - When the **Off** icon is pressed, the icon changes to light green and the corresponding port is disabled.

Flange Analog Input

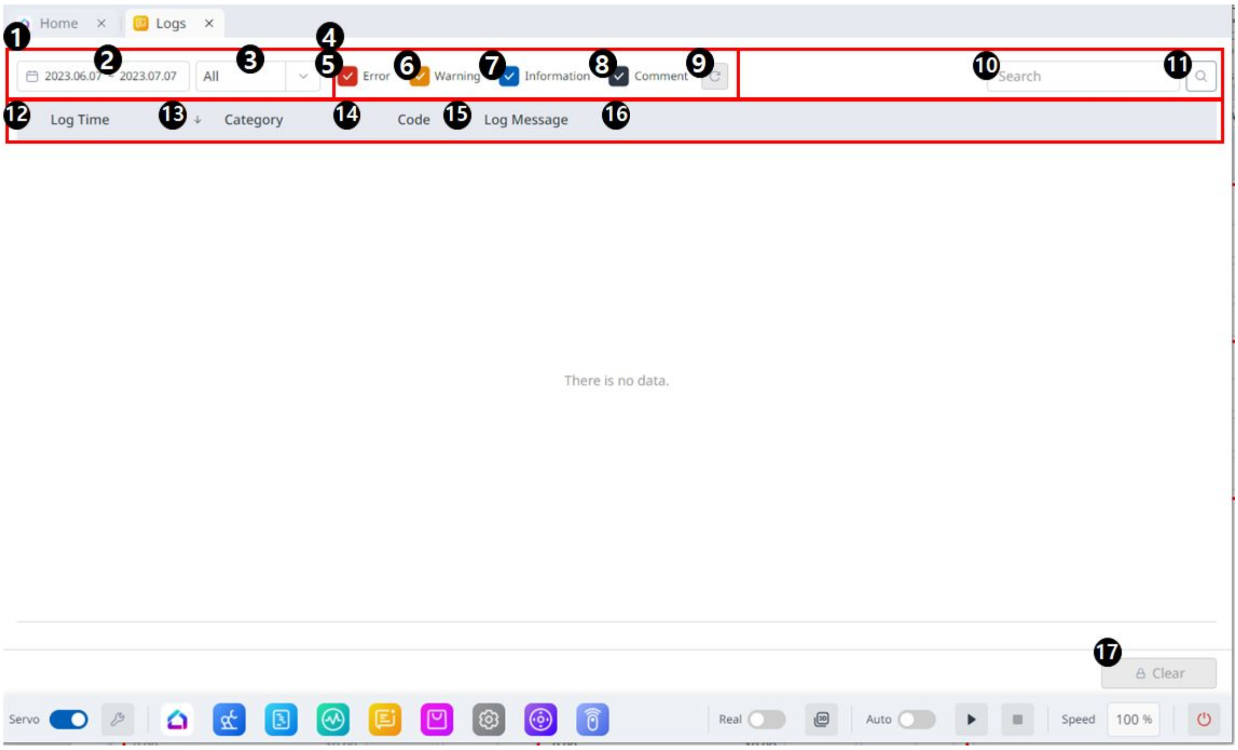
1. Press the drop-down list on the flange analog input of the controller to select the item to check.
2. Check the flange analog input information of the selected item displayed on the screen.

Note

- The flange analog input value cannot set the input value in the status window.

5.11 Logs Module

With this module, logs can be managed by any criteria and dates.



Menu Layout

	Item	Description
1	Section for Search	Allows you to search by any criteria.
2	Date Filter	Allows you to view logs for a period of up to a month.
3	Category	Allows you to view logs by selecting a category. The categories are: • **All** • Control System • Control Algorithm • Inverter • Safety Controller • Modbus Communication • System Message
4	Level	This is where you can select the type of log.
5	Error	If checked, error logs are seen.

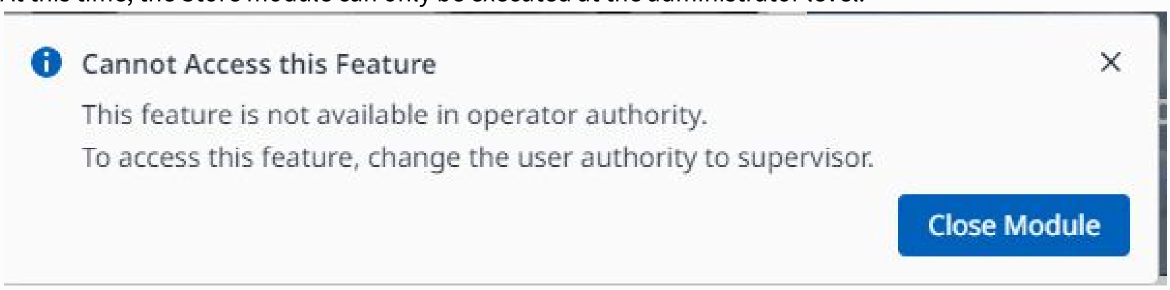
	Item	Description
6	Warning	If checked, warning logs are seen.
7	Information	If checked, information logs are seen.
8	Comment	If checked, comment logs are seen.
9	Filter Reset	This button allows you to initialize the selected log type.
10	Code or Keyword	This field is where you search for the desired code or keyword.
11	Search	This button allows you to search for what you need.
12	Log Table header	Header of the log table
13	Log Time	The time of each log is seen.
14	Category	The category of each log is seen.
15	Code	The code of each log is seen.
16	Log Message	Log messages are seen.
17	Clear	This button allows you to delete the log.

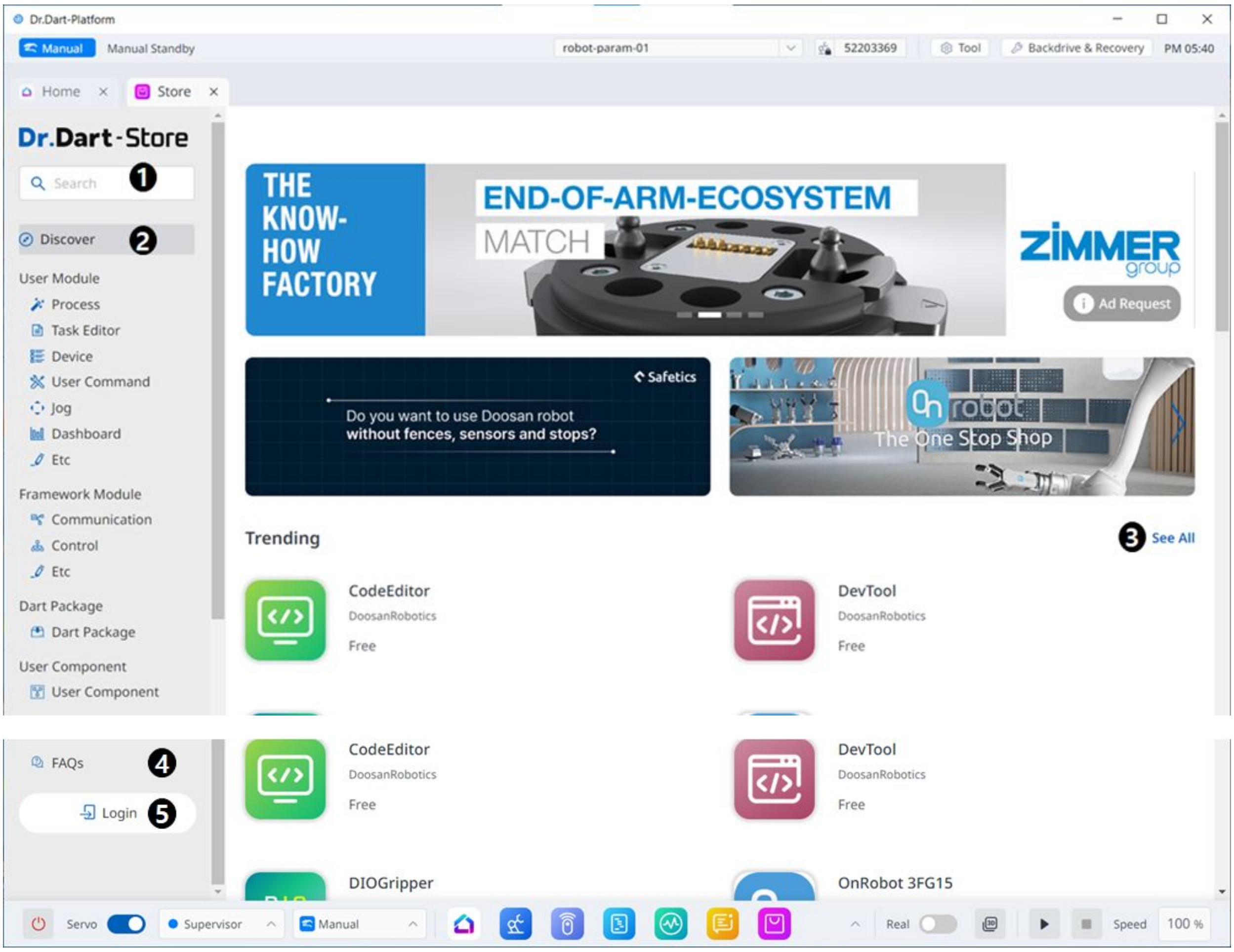
5.12 Store Module

Tapping the Store module redirects you to the Dr.Dart-Store link.

Note

At this time, the Store module can only be executed at the administrator level.



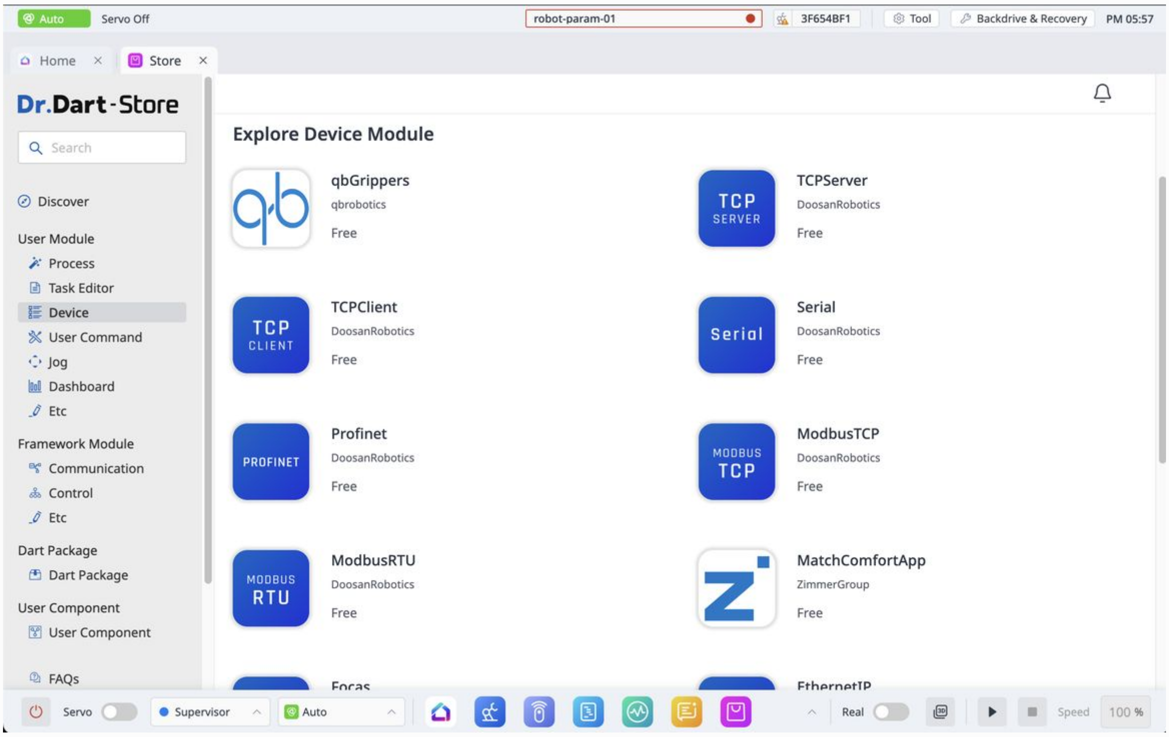


Menu Items

	Item	Description
1	Search	This field is where you search for any module.
2	Menu Bar	The categorization is based on the features of the module.
3	Trending	This is the Home screen, where the currently popular modules are seen.
4	FAQs	This is where you can find the frequently asked questions regarding the Store.
5	Account	This is your account, which you can tap to manage your account settings and upload/download modules.

알아두기

In the existing legacy Dart-Platform, communication modules were installed as standard, but in the current Dr.Dart-Platform 3, there are communication modules that must be downloaded through the Store separately from the basic modules.



The list below is modules that are installed as standard in Dr.Dart-Platform3.

- TCPModbusSlave
- ModbusMaster
- Serial
- TCP
- AdmittanceControl
- ImpedanceControl

You can download the modules below from the User Module > Device section of the Store.

- Focas Master
- Digital IO TEST
- ModbusTCP Master
- ModbusRTU Master
- TCP Client
- TCP Server
- Serial
- IndustrialEthernet GPR Test

5.12.1 Activate or deactivate modules

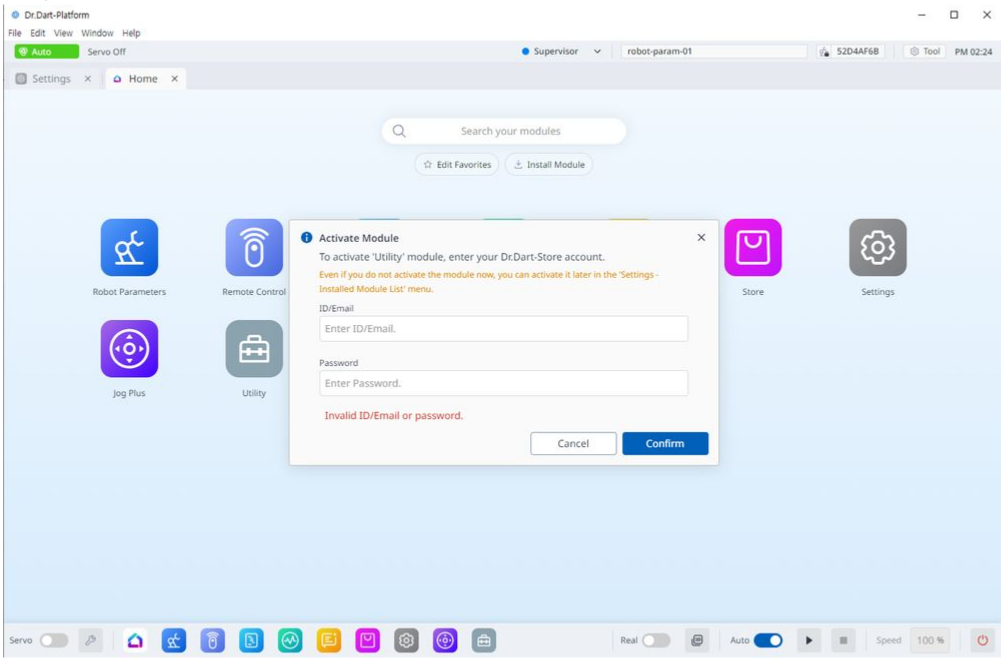
After purchasing a paid module through Dr. Dart-Store, it must go through an activation process when executing the module.

In the case of a paid module, it cannot be executed in the inactive state, and when the module is deleted or refunded, the module must be in the inactive state.

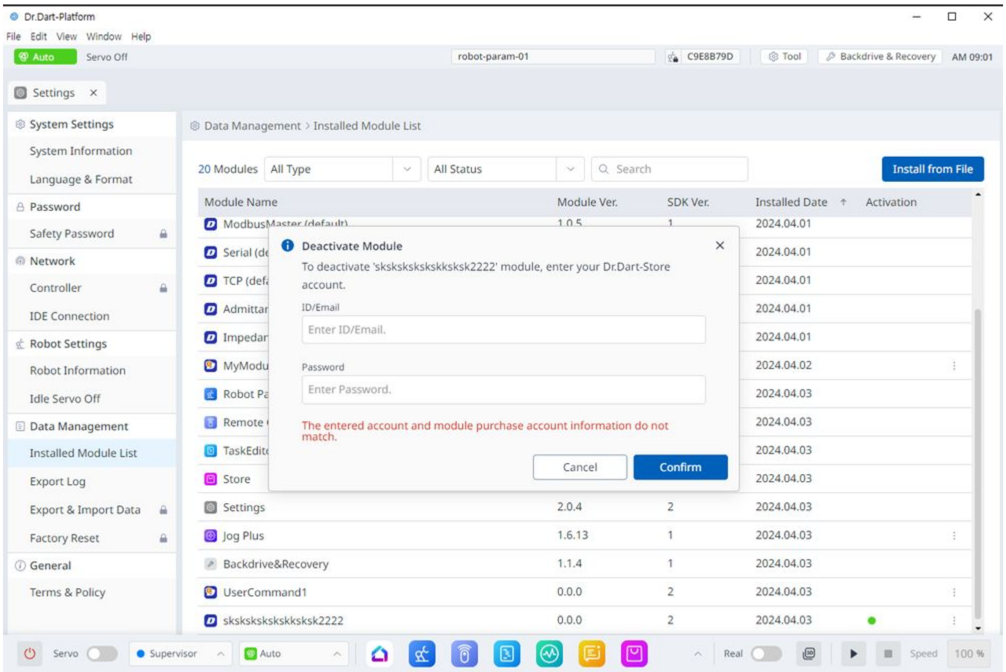
Activation

When online:

If you are logged in to Dr. Dart-Store, it will be automatically activated if the paid module information you are trying to run matches the store login ID. If you are not logged in to the store or if your credentials do not match, a log-in pop-up will occur.



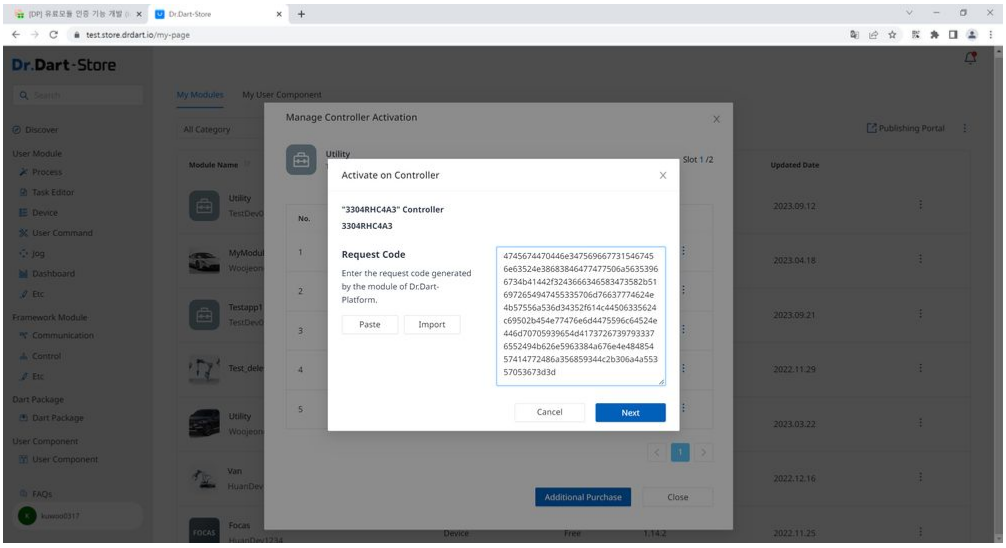
You can also activate it from the Installed Module List menu of the Setting module using the option button of the module you want to activate.



When offline:

It can be activated using the option button of the module you want to activate from the Installed Module List menu of the Setting module.

A module activation code must be issued and authenticated online through Dr. Dart-Store.

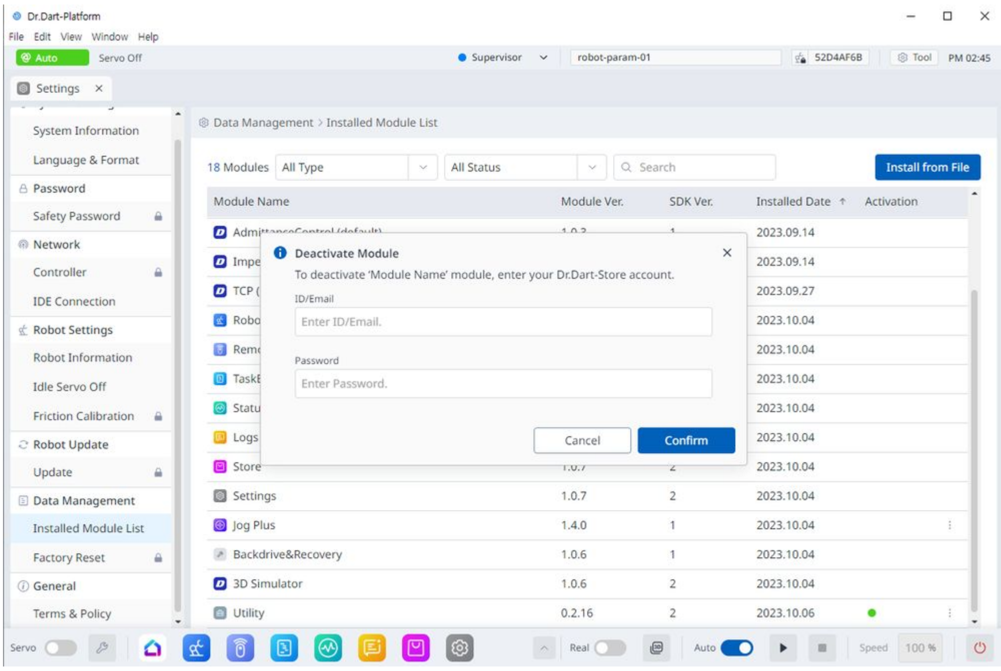


Deactivation

When online:

You can deactivate it using the option button of the module you want to deactivate in the Installed Module List menu of the Setting module.

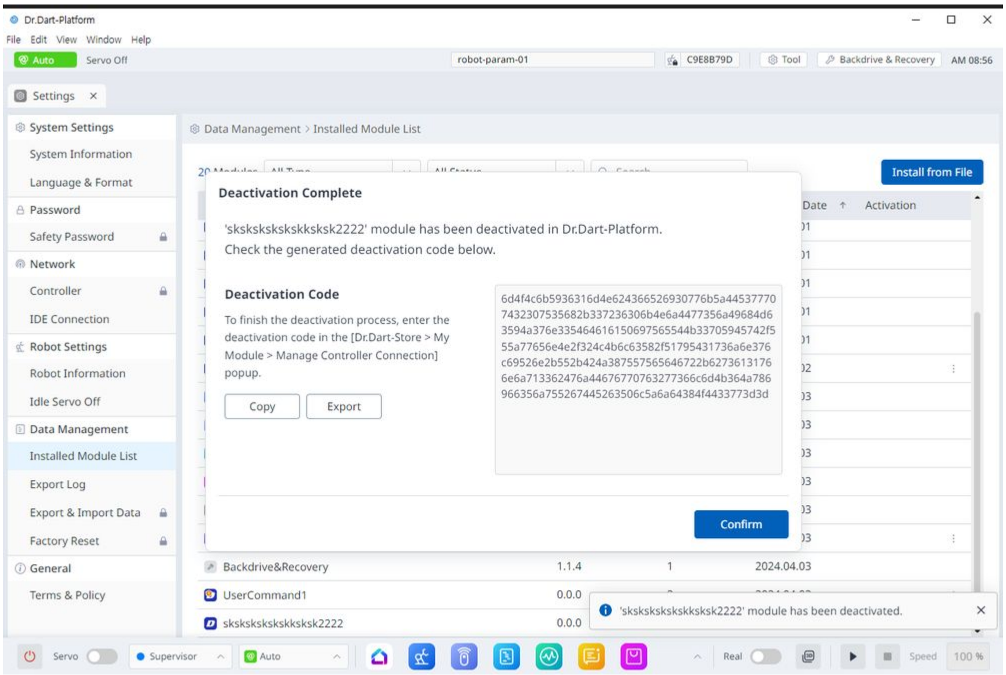
The paid module information that you want to deactivate and the store login ID must match when this operation is executed. If you are not logged in to the store or if your credentials do not match, a login pop-up will occur.



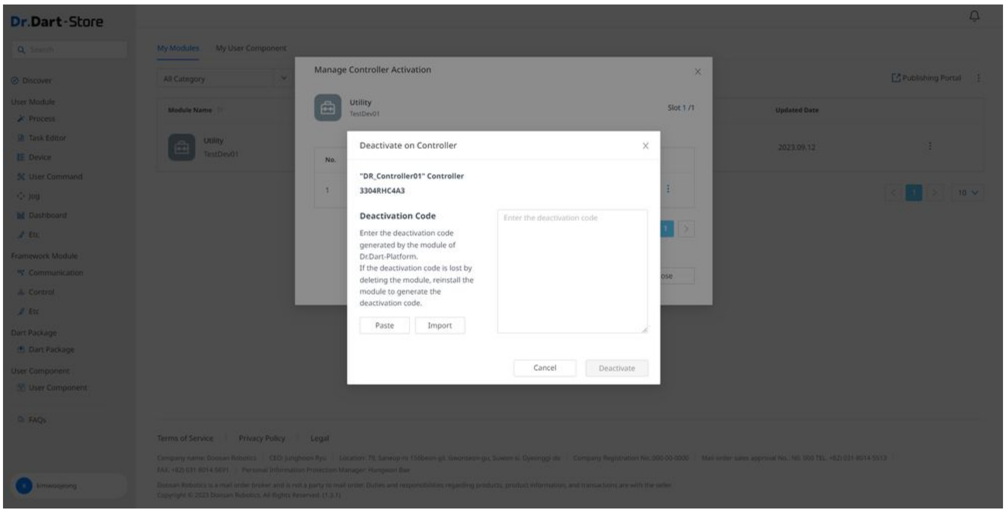
When offline:

You can deactivate it using the option button of the module you want to deactivate in the Installed Module List menu of the Setting module.

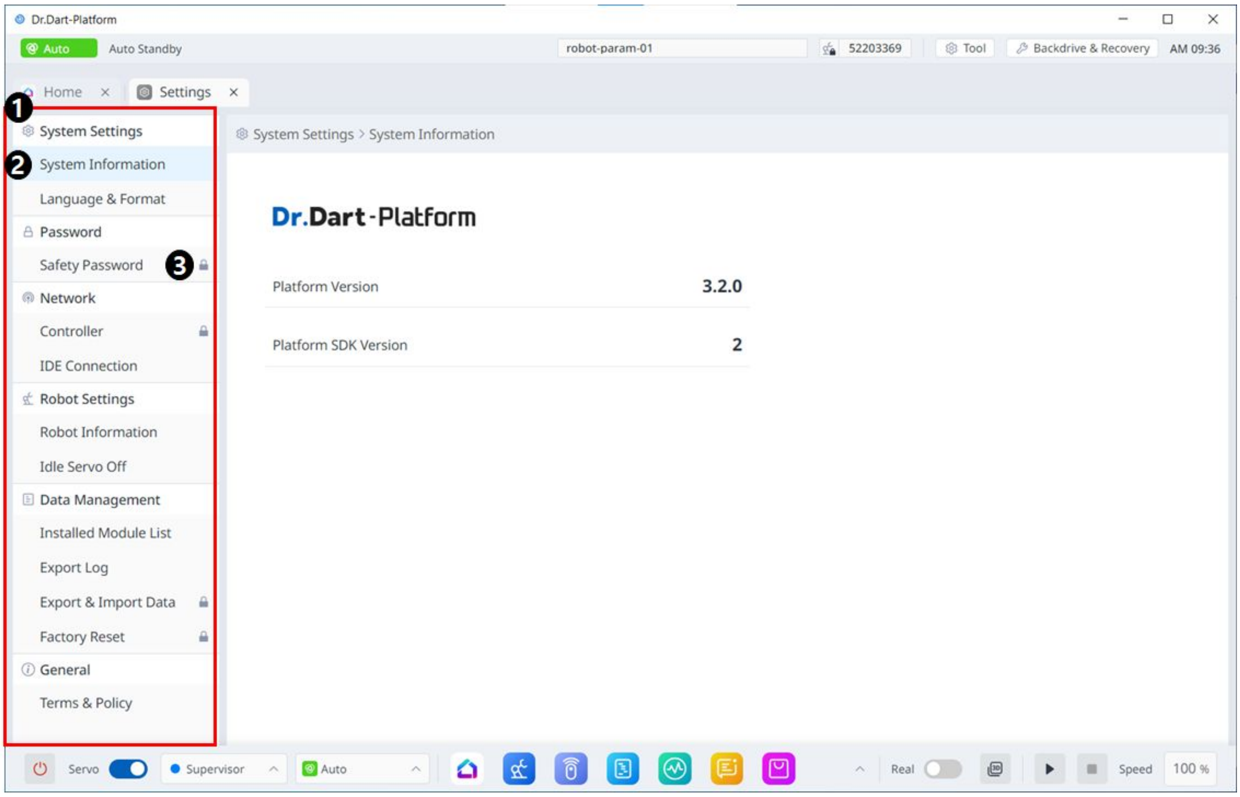
When a module deactivation code is issued, the module is immediately deactivated.



You must copy the corresponding deactivation code and switch it from online to deactivated on the Store via Dr. Dart-Store.



5.13 Settings Module



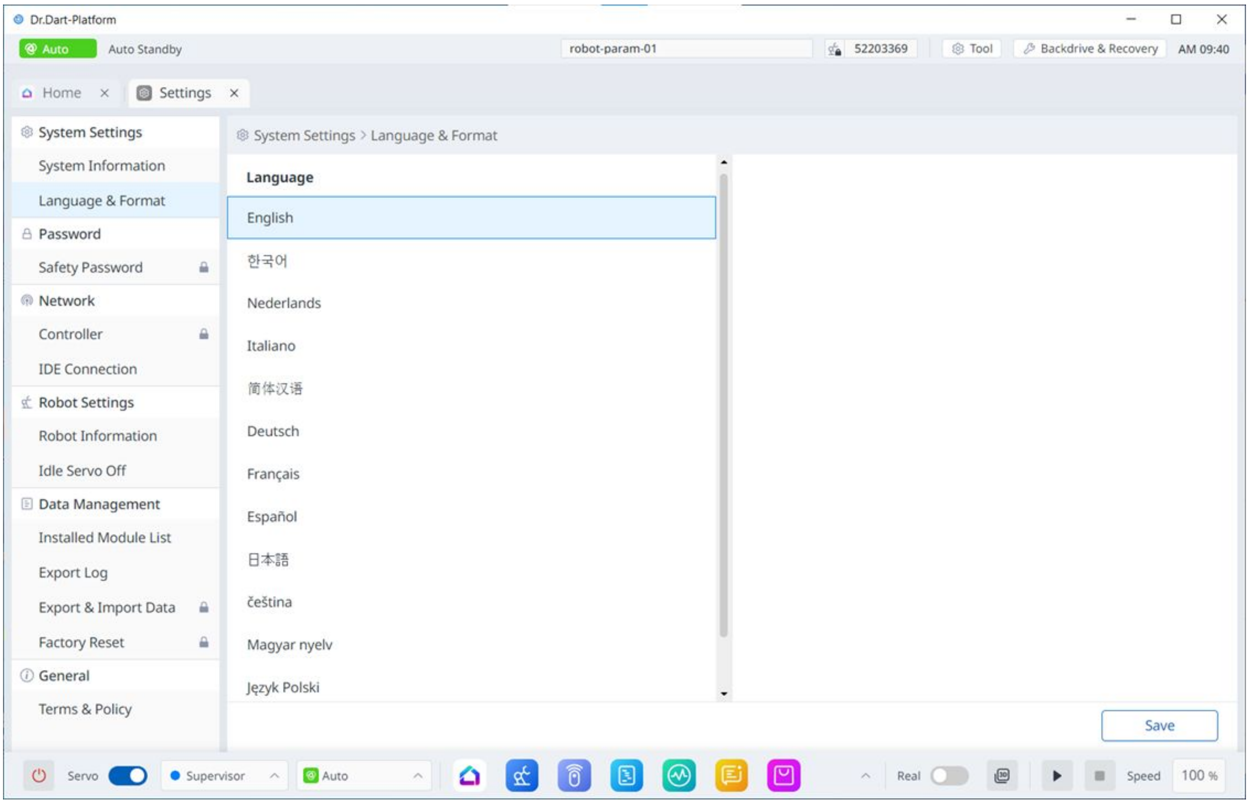
Menu Description

	Item	Description
1	List	This section shows the entire menu list of System Settings.
2	Current location	The currently selected menu is displayed in blue.
3	Lock	This function requires an administrator password.

5.13.1 Setting language in system settings.

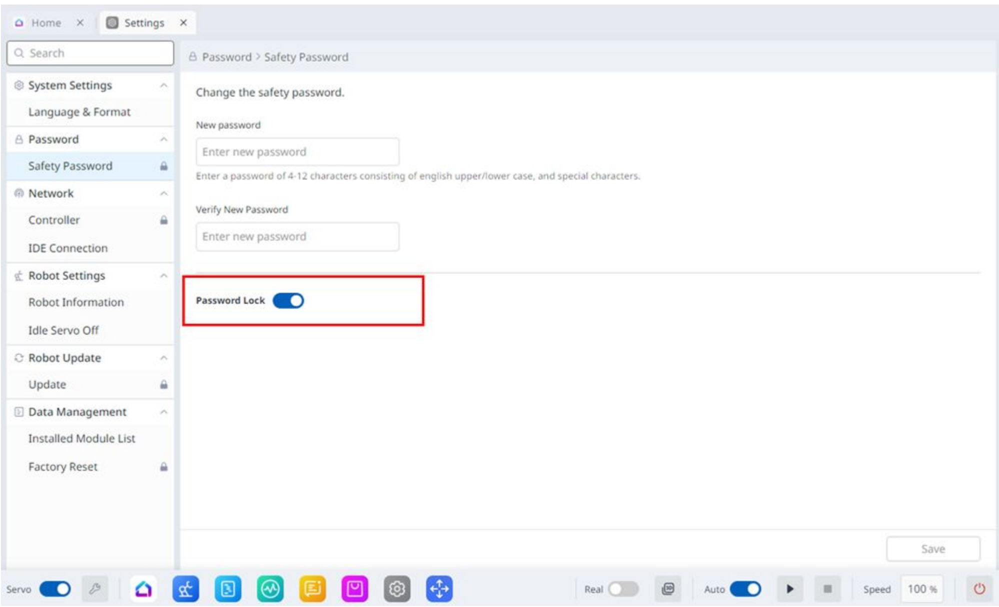
To set the UI language of the operation program, follow these steps:

1. Tap the **Settings Module** button on the main menu, and under **System Settings**, select **Language & Format**.
2. Select the language to set from the language list and tap the Save button.



5.13.2 Setting and disabling Password Lock.

MANDATORY **EASY** **1 MIN**



When changing various settings after robot installation, the process can be troublesome as the system constantly requests the password to be entered.

In this case, enter the password in **Setting > Safety Password**. If the system requests the password when the password is not changed, enter the following password.

- admin

Touch the Password Lock toggle switch to disable the Password Lock function. Then all password lock functions will be disabled until the controller is rebooted.

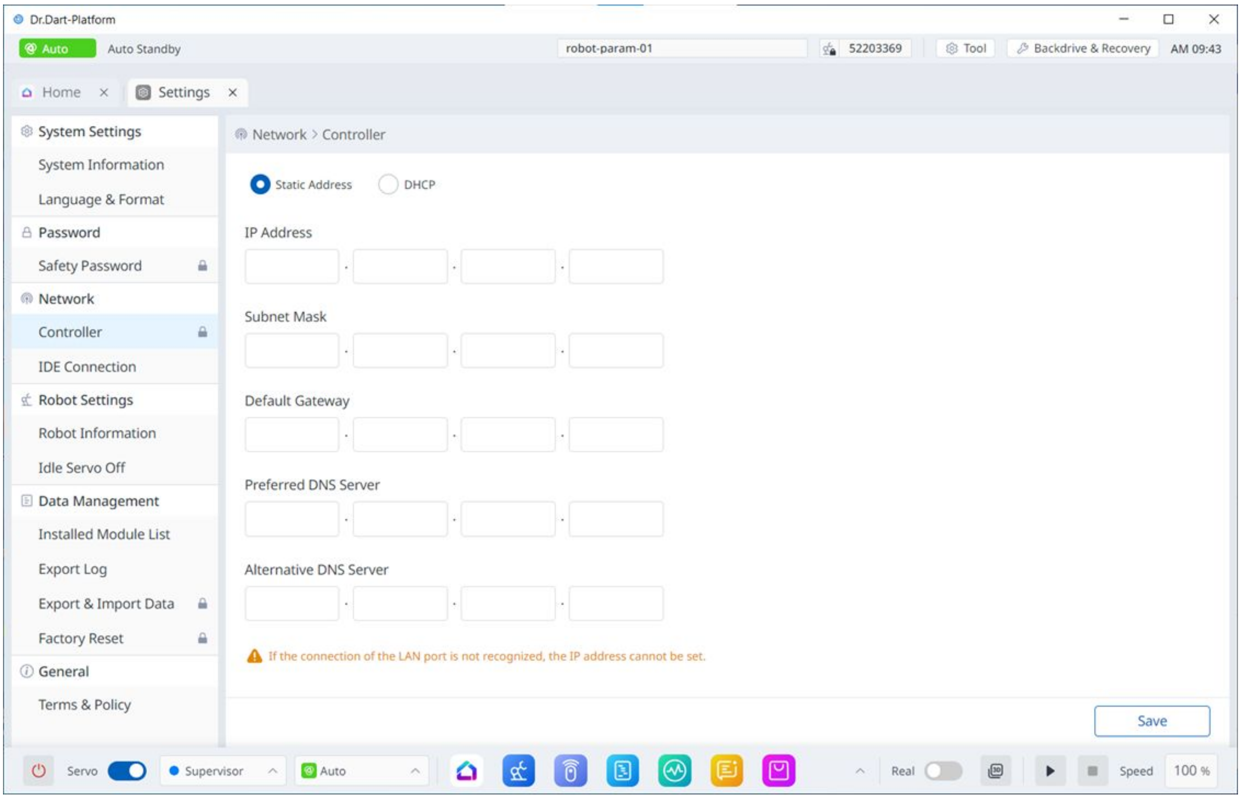
Caution

- Once the administrator finishes setting up the system, the password lock function must be enabled again before the user starts operating the system.

5.13.3 Making Settings in Network Section

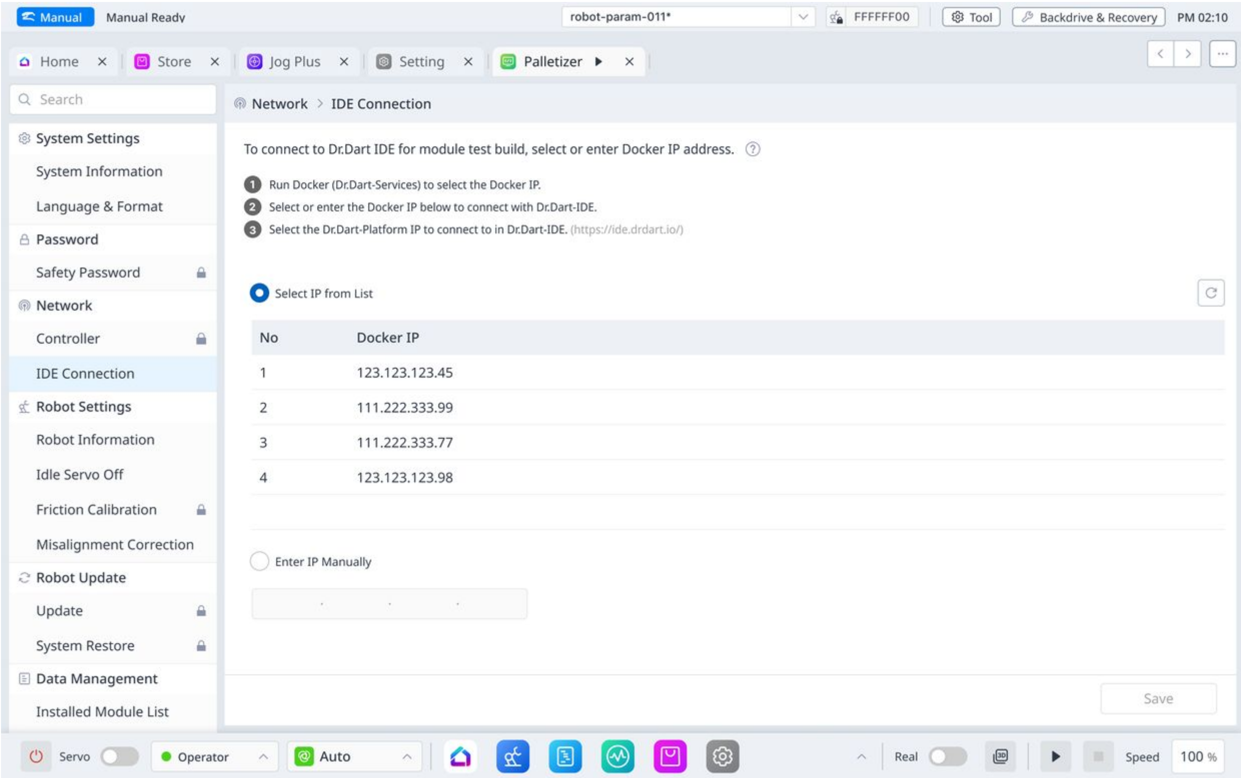
The Network section is where you can make settings related to the connection between the controller and the IDE.

When configuring the controller, you can select either a static address or DHCP.



In the IDE Connection item, you can select an IP to connect to Dr. Dart-IDE.

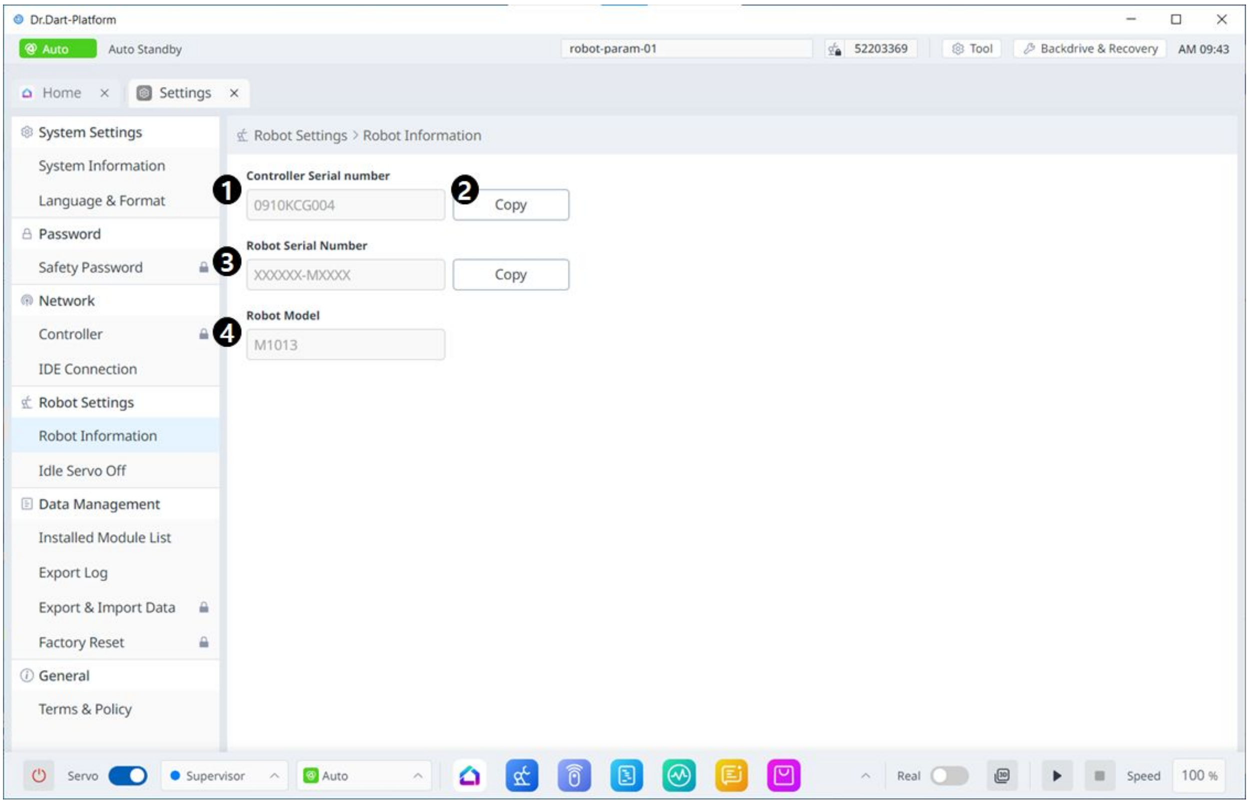
You can select a connectable IP from the list or enter a direct IP.



- To save the settings, the Save button at the bottom must be pressed.
- If you are using industrial communications, use Static Address.

5.13.4 Setting the Robot

Setting the Robot Information

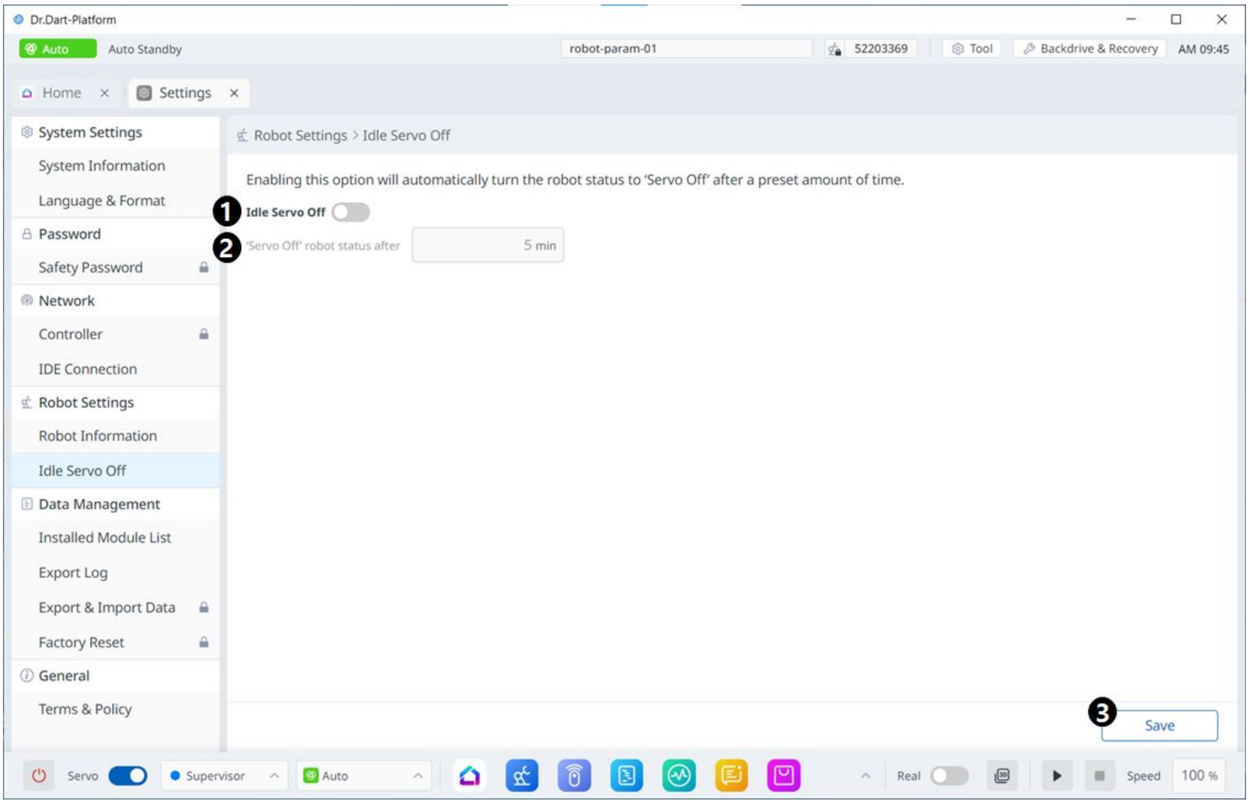


Menu Items

	Item	Description
1	Controller Serial Number	This is where the serial number of the controller is seen.
2	Copy Controller Serial Number	This button allows you to copy the serial number.
3	Robot Serial Number	This is where the serial number of the robot is seen.
4	Robot Model	This is where the robot model name is seen.

Robot Idle Servo Off

If the robot is idle for a certain amount of time, the robot is automatically set to the Safety Off state. The default value is 5 minutes, but the time can be changed to a time the user prefers.

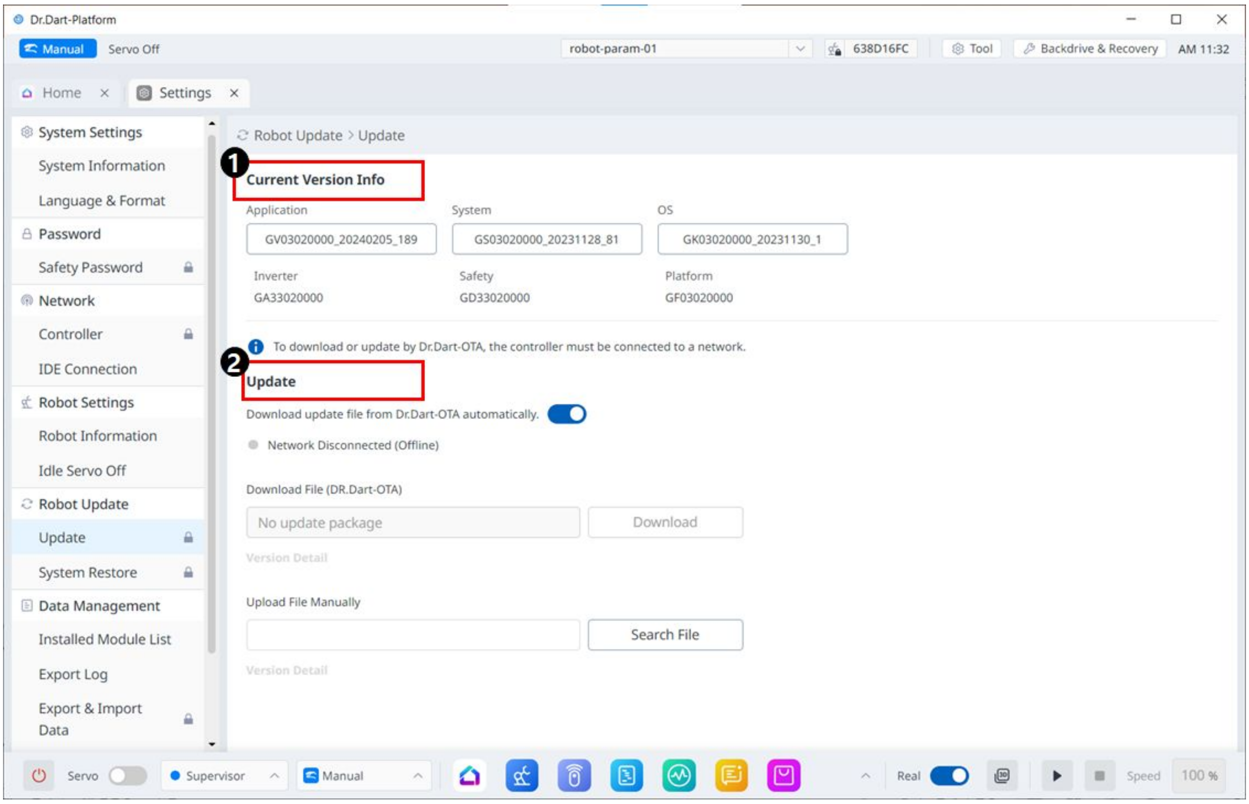


	Item	Description
1	Enable Idle Servo Off	This button allows you to enable idle servo off.
2	Servo Off Setting	This field is where you set the idle servo off in minutes.
3	Save	This button allows you to save the changed settings.

5.13.5 Robot update

Updating and managing the Robot.

After entering the Safety Password, you can select the desired update file from the Update section, on your PC to initiate the update.



Menu Layout

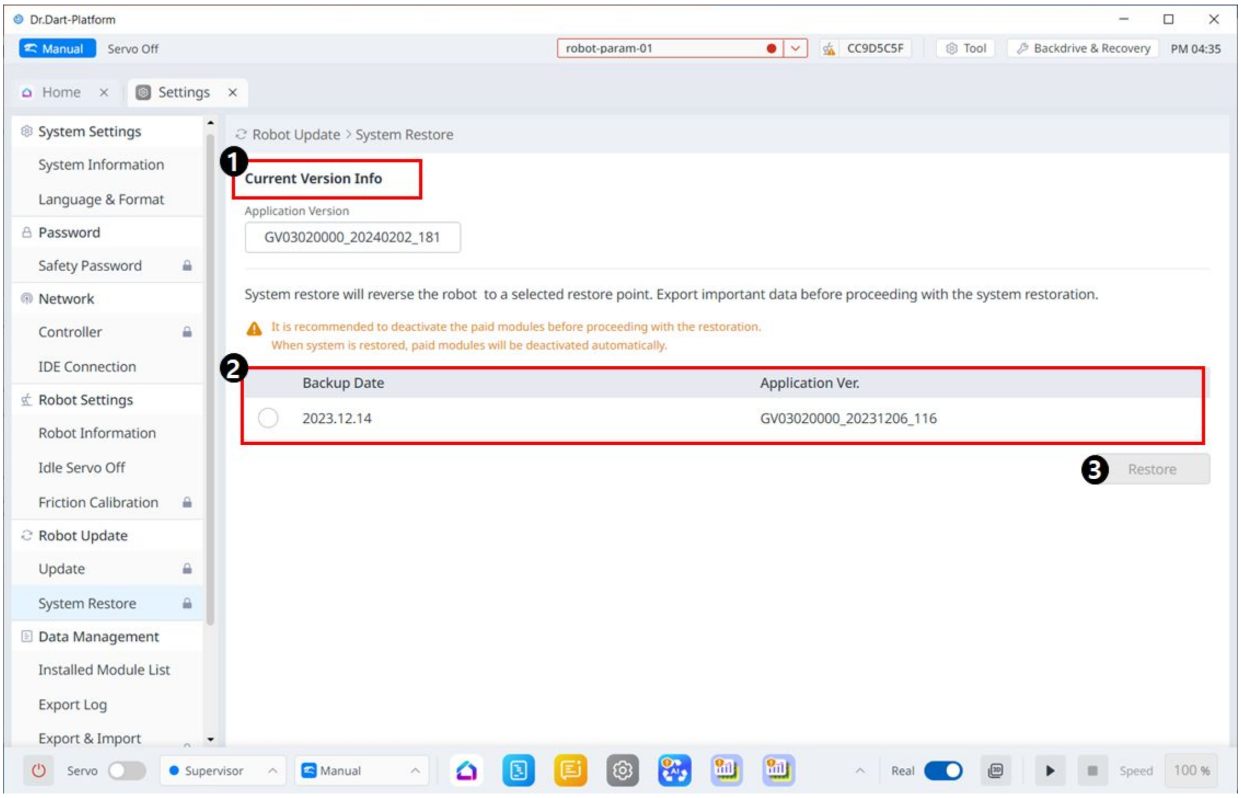
	Item	Description
1	Current Version Info	Displays the current application/system/OS version information.
2	Update	You can download update files automatically or manually.

Note

For JTS models, the JTS information is also displayed.

System restore

After entering the Safety Password, you can restore by selecting the desired restoration version from the restoration list.



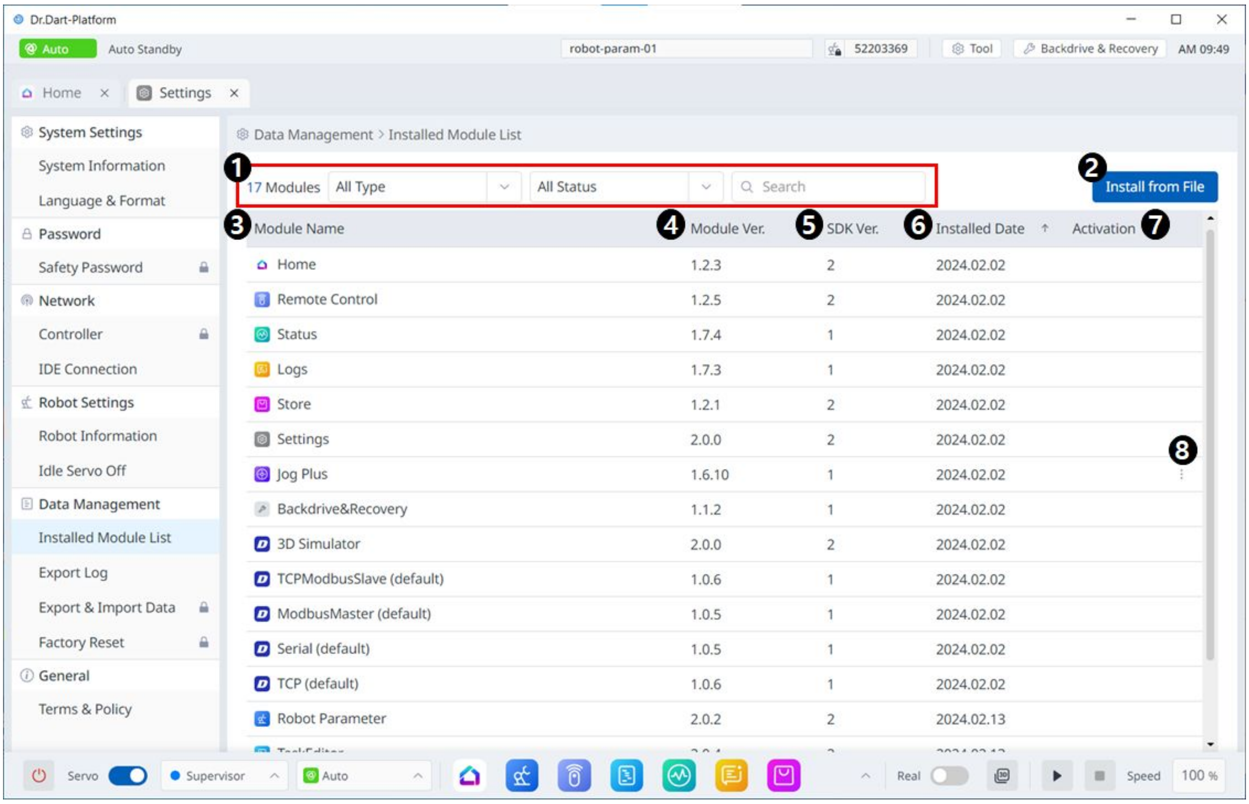
메뉴 구성

	Item	Description
1	Current Version Info	Shows current application/system/OS version information.
2	Backup List	It shows a list of restore versions that can be backed up. Items on the list are created when updated using the update function.
3	Restore	When you select the restore version list, the restore button becomes activated.

5.13.6 Managing Data

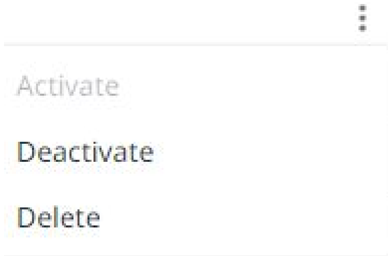
List of installed modules

This menu is where you can view and manage the installed modules.



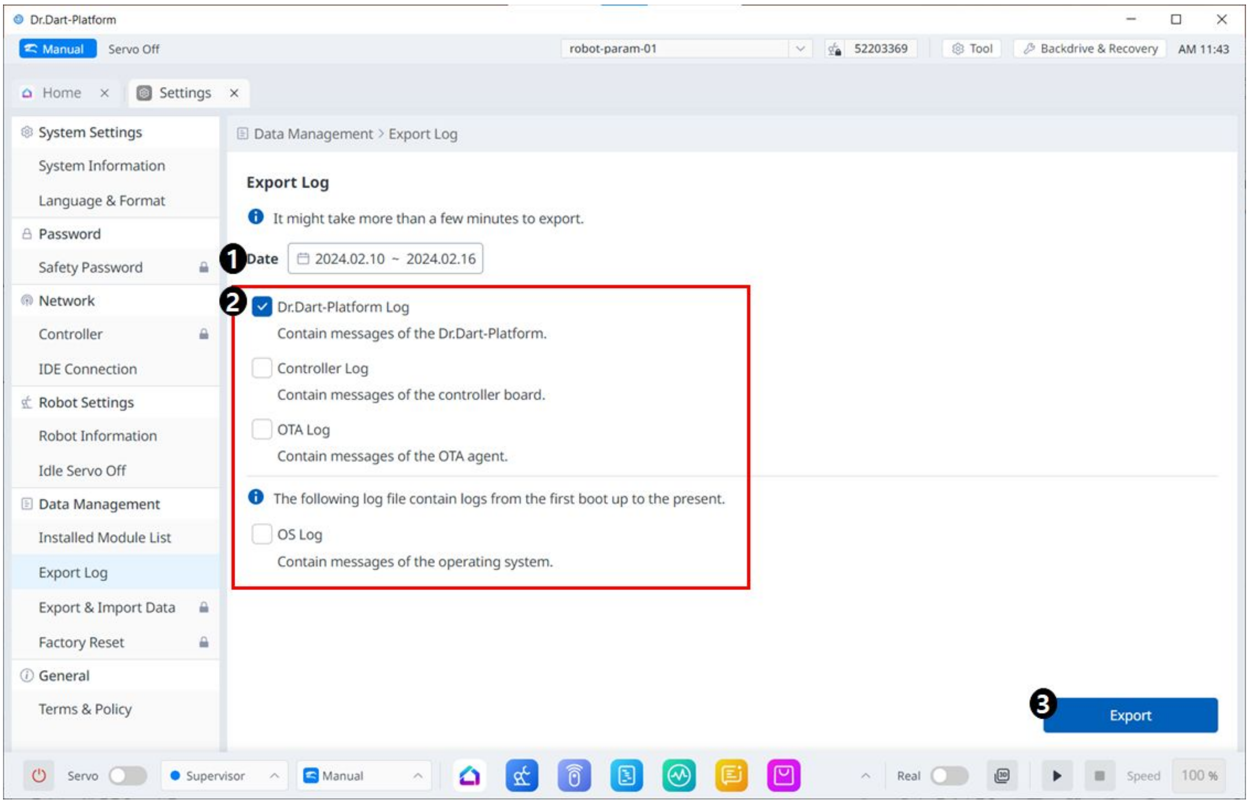
Menu Items

	Item	Description
1	Category	On the module list, you can select the type of module or status category you want to view, as well as search for them.
2	Install from File	This button allows you to add your files to install the module.
3	Module Name	The names of the installed modules are seen.
4	Module Ver.	The versions of the installed modules are seen.
5	SDK Ver.	The SDK versions of the installed modules are seen.
6	Installed Date	The dates each module was installed are seen.
7	Activation	Whether each is enabled is seen.

	Item	Description
8	3 dot button	If it is enabled, 3 dots are seen, and tapping the 3 dots brings up the menu below.  • Deactivate: Disables the enabled module. • Delete: Deletes the enabled module.

Export log

In this menu, you can export Dr.Dart-Platform, Controller, OTA, and OS logs.

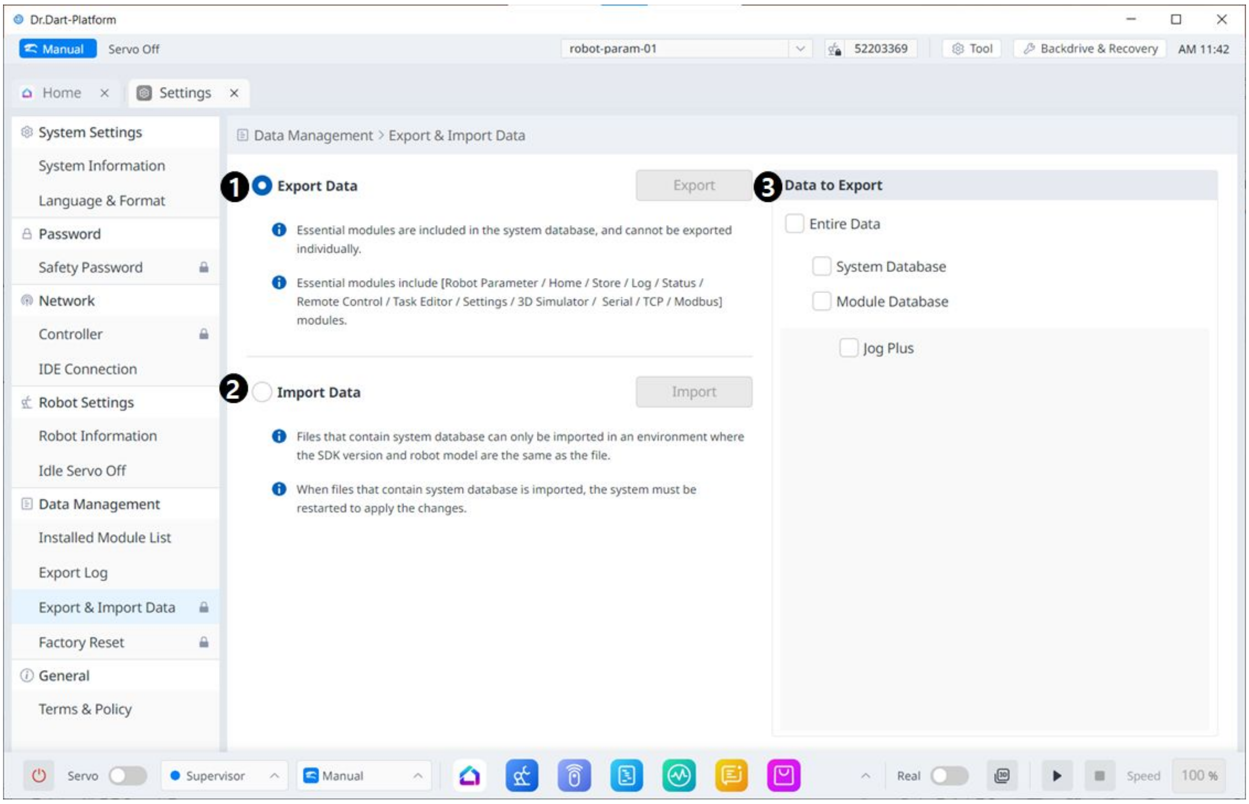


Menu item

	item	explanation
1	Select log period	You can select the period of logs to be exported.
2	Select log type	Check the objects you want to export.
3	Export log button	Activated when there is more than one selected log.

Export & Import Data

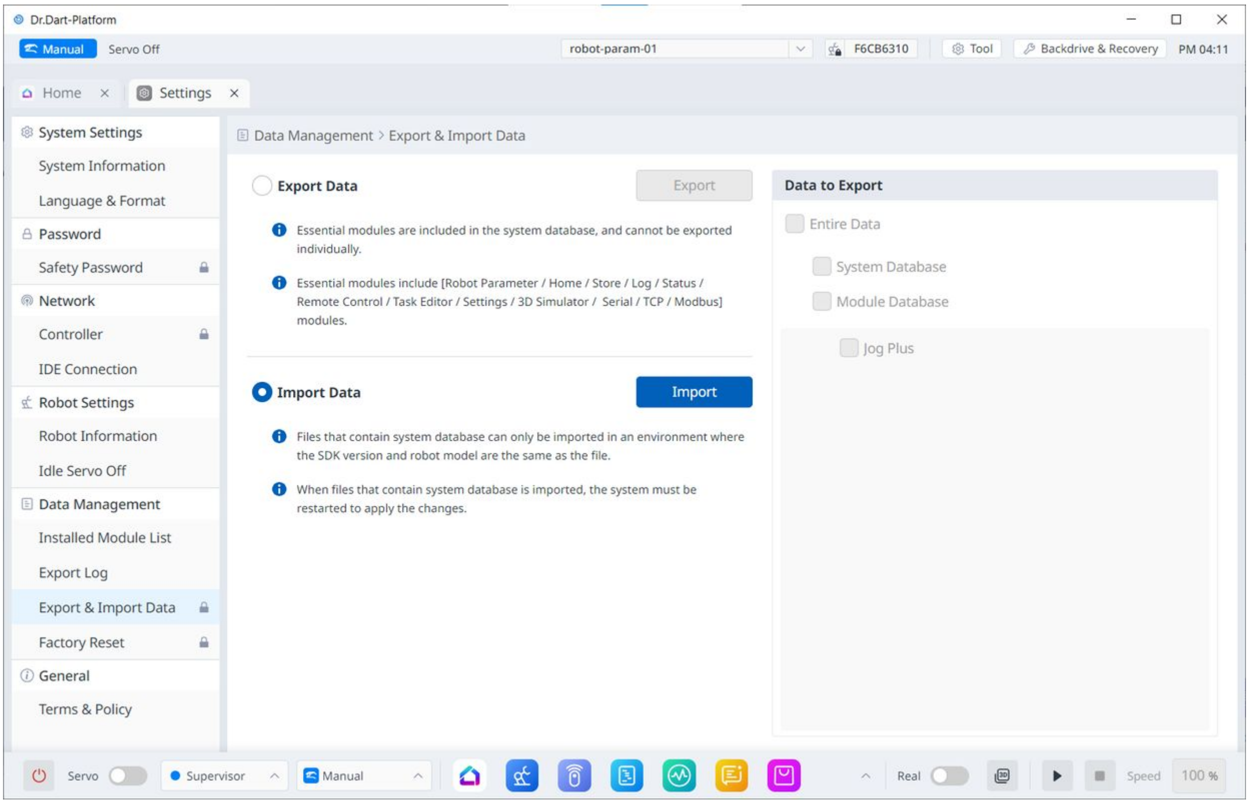
This menu allows you to export and import data from your Dart-platform.



Menu item

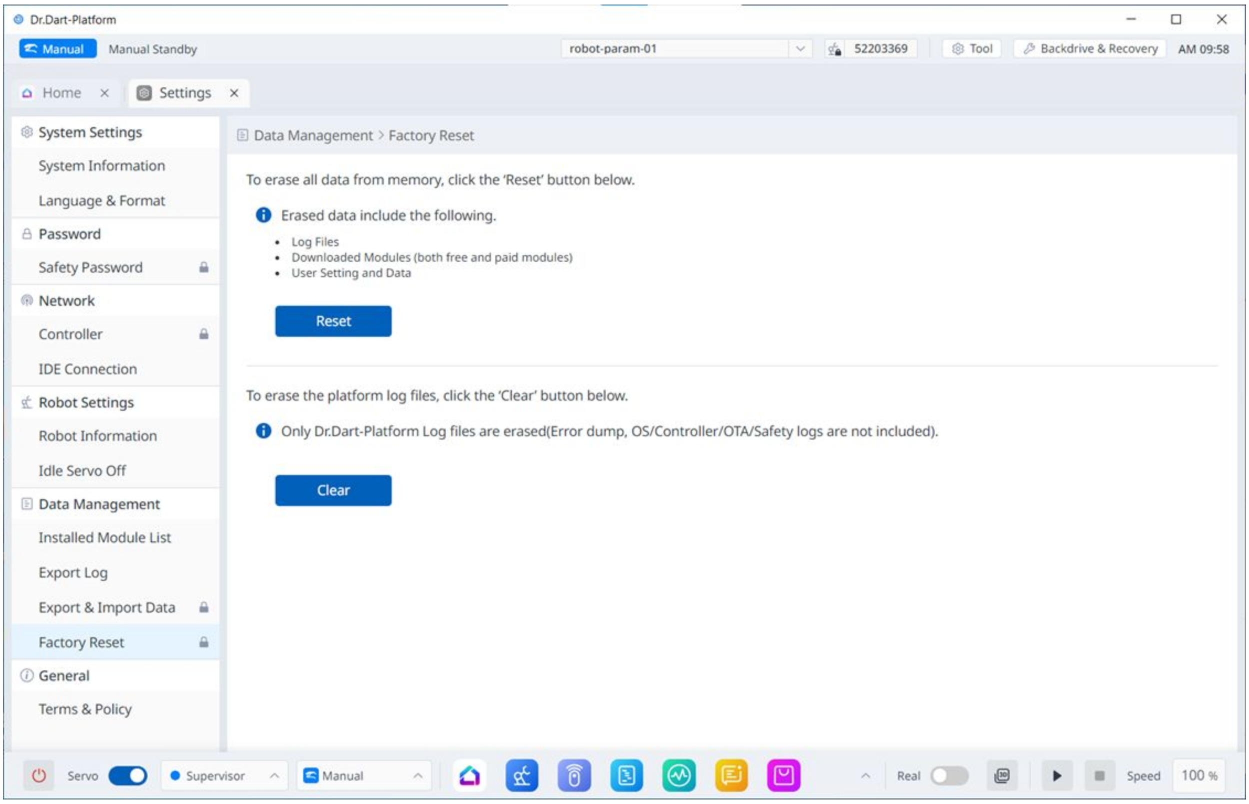
	Item	Explanation
1	Export Data	After selecting the corresponding radio button, the export button will be activated when you select the data to export on the right.
2	Import Data	When you select the corresponding radio button, the Import button becomes activated.

	Item	Explanation
3	Data to Export	You can select the data to export.



When the Import radio button is selected, the data selection screen on the right is disabled.

Factory Reset



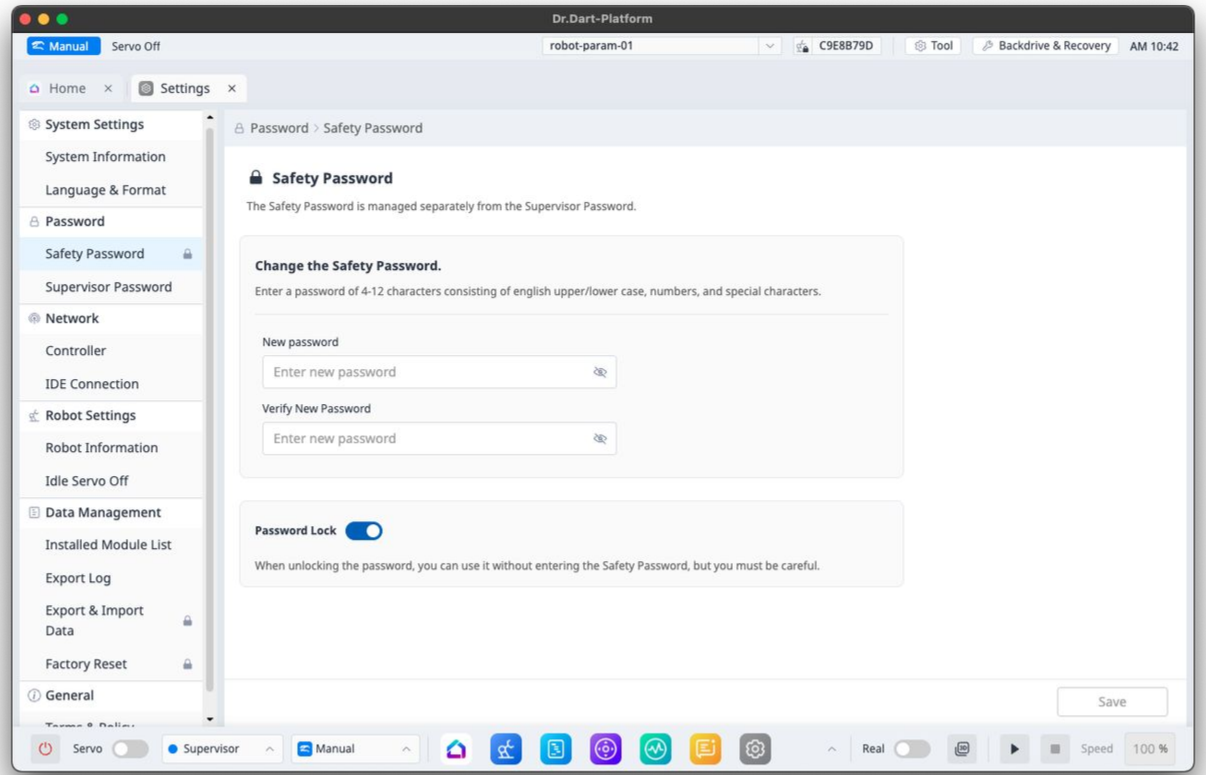
The Factory Reset function can be used to delete all user data and logs saved on the robot. Once the factory reset is in progress, the database, log files, Workcell Items and task files are deleted.

1. Tap the **Settings Module** button on the main menu and select **Factory Reset**.
2. **To delete all data, tap the Reset** button. To selectively delete log files, tap the **Clear** button.
3. Once the factory reset is complete, a restart of the system is required.

5.13.7 Changing Safety Password

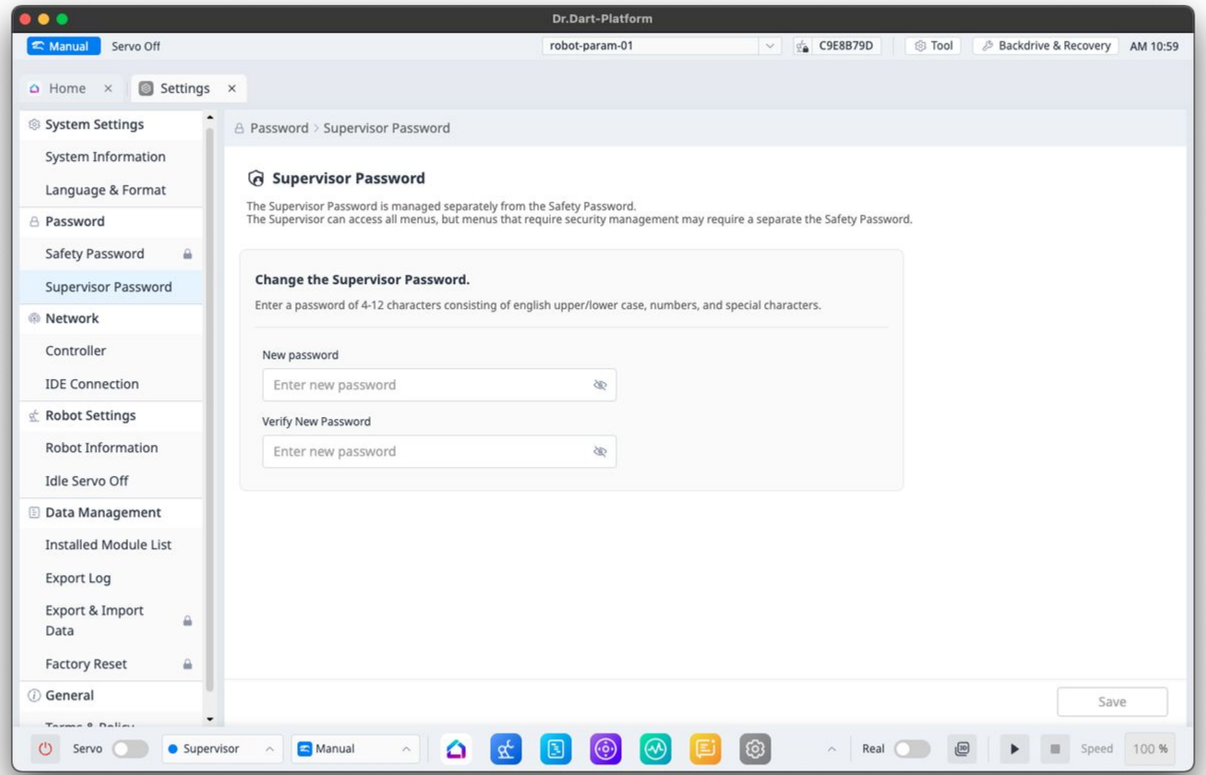
You can change your safety password to a new one.

This function is only available unless a Safety Password is set.



5.13.8 Changing Supervisor Password

You can manage the supervisor password used when changing from Operator level to Supervisor level.



> The default supervisor password is **admin**.

5.14 Jog Plus Module

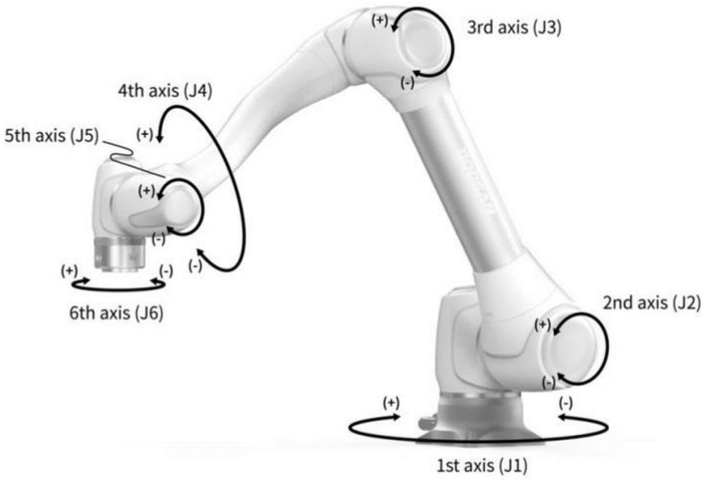
The user can select a manual movement method from the Jog tab.

- **Jog**: It moves the robot joint or TCP to the joint axis or coordinate axis the user selected
- **Move**: It moves the robot joint or TCP to the target point the user entered

Robot movement consists of two types.

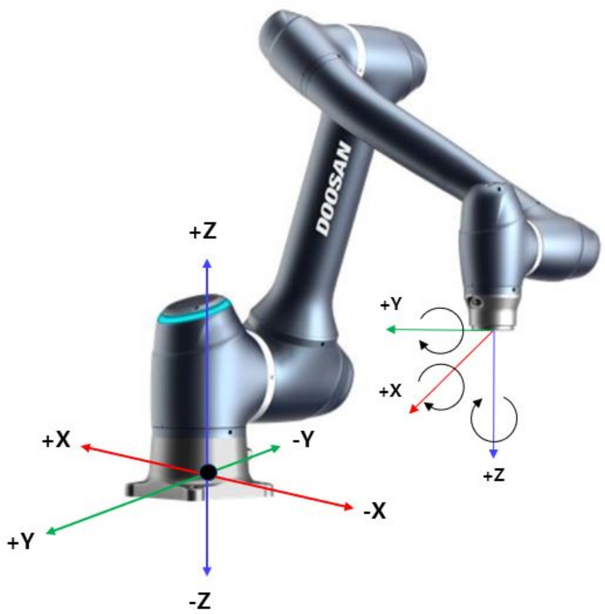
1. Joint Motion: It moves each joint linearly with a rotating motion
2. Task Motion: It moves the end linearly to the target point

The following is the method how to move the robot using joint motion from the jog screen:



1. Select the Joint tab.
2. Select the axis to move. For example, You can select J1.
3. Press the +/- button to move the robot. The robot moves while the +/- button is pressed, and the current location is displayed on the screen in real-time.

The following is the method how to move the robot using task motion on the jog screen:



1. Select the base coordinates. The robot can be moved according to the BASE coordinates or the TOOL coordinates.
2. Select the direction to move. For example, X-axis can be selected.
3. Press the +/- button to move the robot. The robot moves while the +/- button is pressed, and the current location is displayed on the screen in real-time.

For more information about jog movement, move and align, refer to Jog Screen(p. 382), and Move Panel(p. 387) respectively.

> **Note**
>
> - If the toggle switch of the actual mode on the top left of the Jog screen is turned off, the robot moves only on the virtual screen on the left of the Jog screen. The actual robot moves if the actual mode toggle switch is turned on.

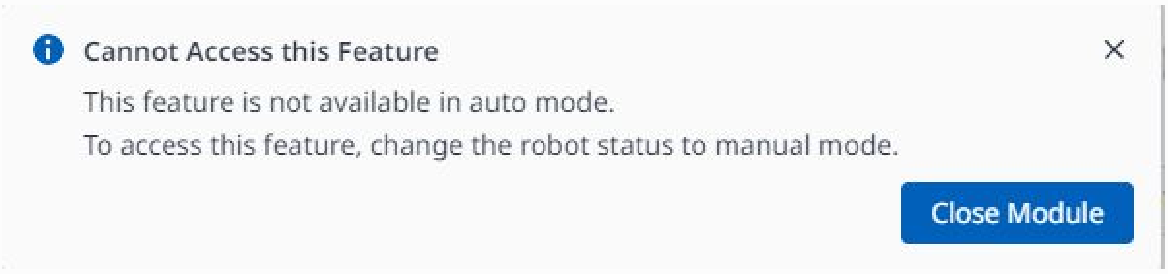
With the Jog Plus module, the user can explore the entire work space in manual mode or set the Operation Space as the robot operation space. The movement angle of each axis can be limited according to the selected operation space and joint angle limit of the safety setting.

To use the Jog Plus function, tap the **Jog** Plus Module on the main menu.

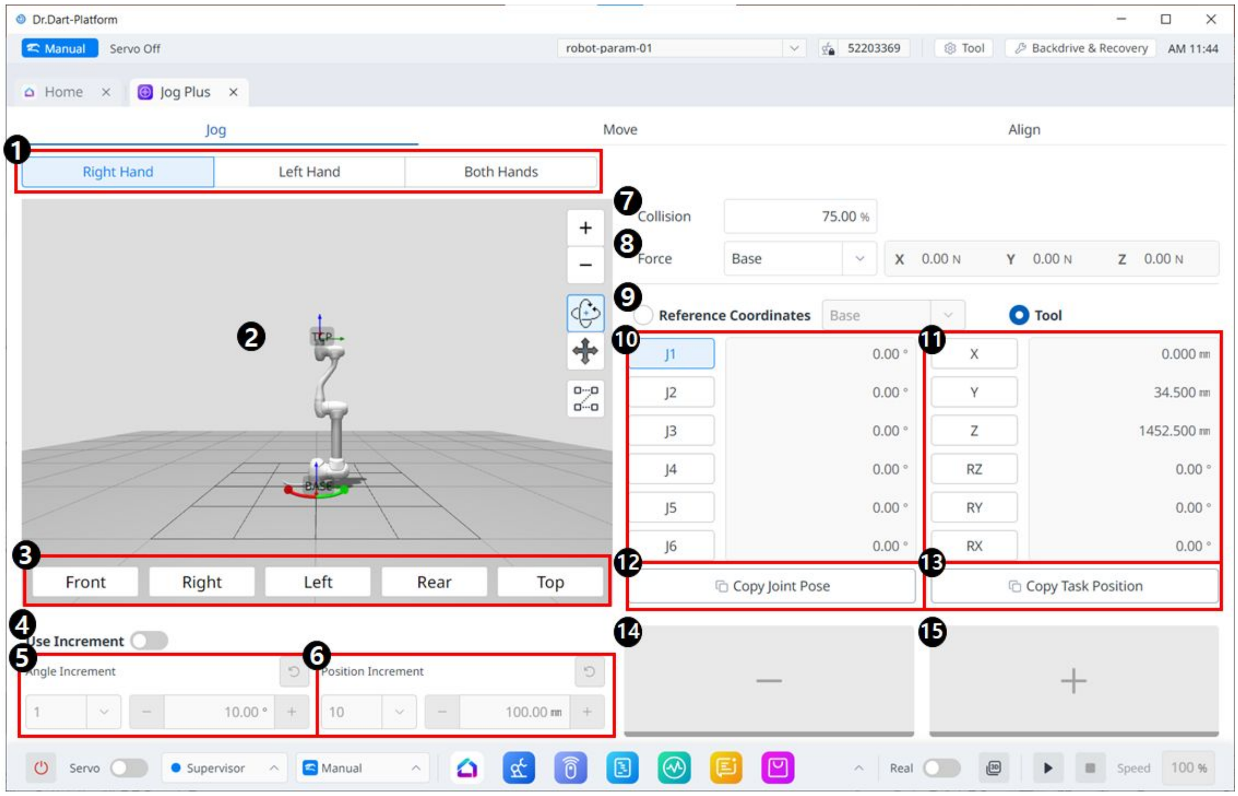
- **The Jog function** cannot be used during Servo Off.
- **The robot** is operated manually in the Jog Plus screen, so the robot only moves when the Jog button is pressed.
- **It is** possible to move the robot based on the current position on the Jog Plus tab screen.
- **The** robot can be moved by configuring the target angle/coordinates on the Move tab screen.
- **It is** possible to **configure** the reference coordinates on the Jog Plus tab screen and Move tab screen as a joint or task.

> **Note**
>
> - **If the** robot cannot be navigated due to being located in a space other than the operation space of the Jog Plus mode, set the robot operation space to “None”to allow the robot to be navigated.

> **Note**
>
> This module is not available in Auto mode. Tapping the toggle button in the bottom right makes it available in Manual mode.



Using Job Plus (Jog+) allows you to use the jog feature simultaneously while performing different work. This can be utilized when manual control is required to move the robot to the target point during teaching.

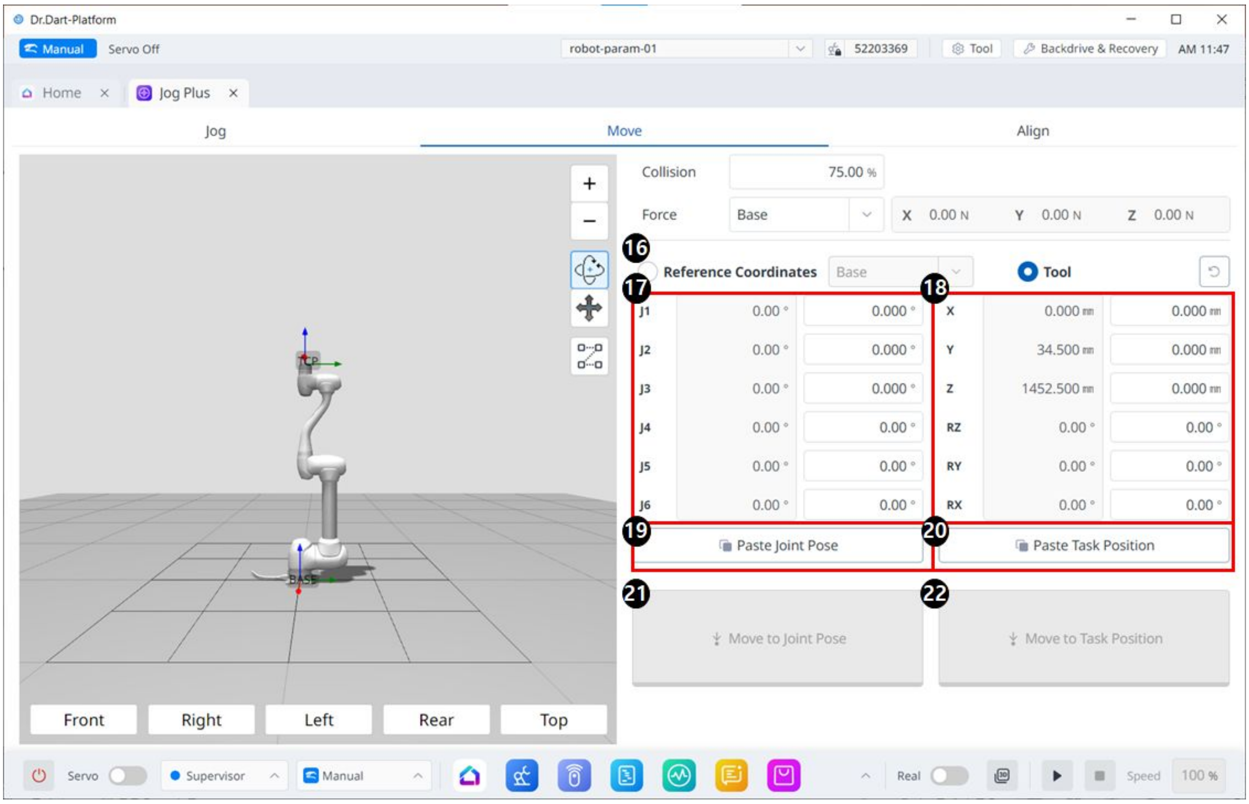


Jog Menu Layout

	Item	Description
1	Select panel type	You can choose the location of the move button.
2	3D simulation	This is the 3D viewer, where you can see how the robot looks.
3	Simulator Alignment	You can utilize this section to steer the simulator.
4	Use Increment	This button allows you to enable angle or position increments.
5	Angle Increment	This section is where the angle increment on the selected axis is set.
6	Position Increment	This section is where the position increment on the selected axis is set.
7	Collision	This field is where you set the Robot Collision.

	Item	Description
8	Force Monitoring	This section is where you set the forces in the X, Y, and Z axes based on Base, Tool, World, Reference and among others.
9	Select reference coordinate system	Select a reference coordinate system to display or jog the task coordinates in Figure 11. It can be Base, World, or User coordinates.
10	Joint panel	You can select the joint axis to jog.
11	Task panel	You can select the task axis to jog.
12	Copy Pose J button	This button allows you to copy Pose J.
13	Copy Pose X button	This button allows you to copy Pose X.
14	Move - Button	You can have the robot move in the - direction based on each axis. At this time, you can figure out the direction of the - and + on the 3D simulation on the left-hand side.
15	Move + Button	You can have the robot move in the + direction based on each axis. At this time, you can figure out the direction of the - and + on the 3D simulation on the left-hand side.

Move

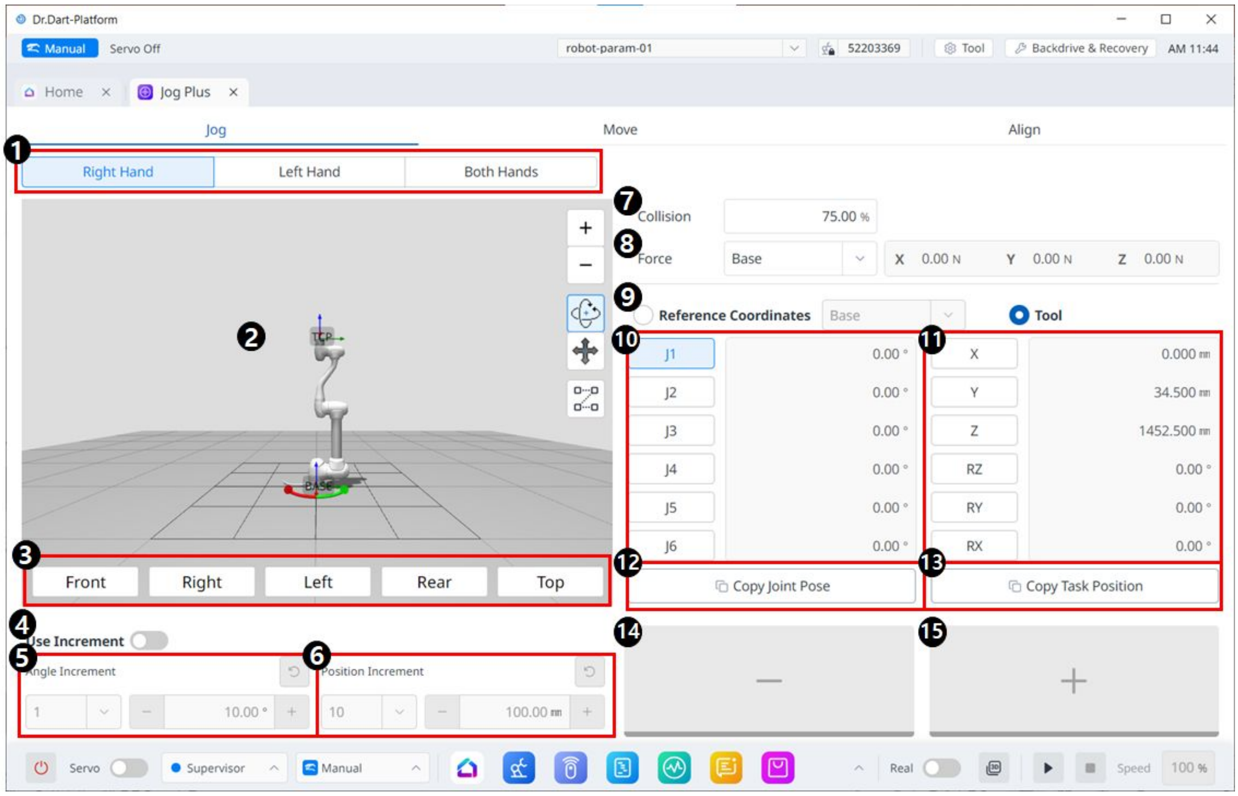


Move Menu Layout

	Item	Description
16	Reference Coordinates	Select the reference coordinate system to be used for the task coordinates in Figure 18. You can choose Base, World, or User coordinates.
17	Joint Posture	Displays the current robot posture and the target joint posture.
18	Task Posture	Displays the current robot posture and the target task posture that fit the selected reference coordinate system.
19	Paste Joint Posture	Paste the posture value copied to the clipboard into the joint posture panel.
20	Paste Task Posture	Paste the posture value copied to the clipboard into the task posture panel.
21	Joint Move button	This button causes the robot to move to the target joint posture.

	Item	Description
22	Task Move button	This button causes the robot to move to the target task posture.

5.14.1 Jog Screen

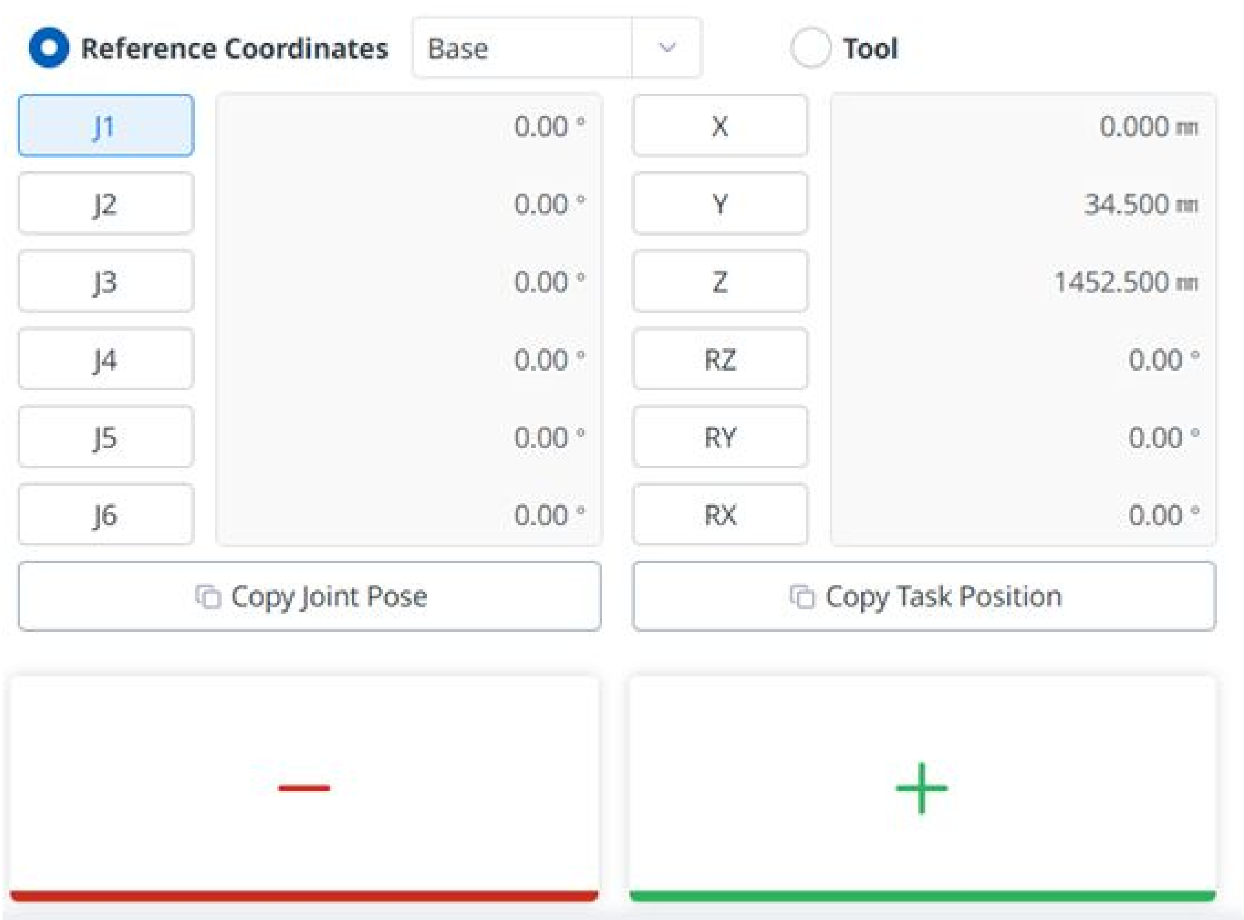


Jog Menu Layout

	Item	Description
1	Select panel type	You can choose the location of the move button.
2	3D simulation	This is the 3D viewer, where you can see how the robot looks.
3	Simulator Alignment	You can utilize this section to steer the simulator.
4	Use Increment	This button allows you to enable angle or position increments.

	Item	Description
5	Angle Increment	This section is where the angle increment on the selected axis is set.
6	Position Increment	This section is where the position increment on the selected axis is set.
7	Collision	This field is where you set the Robot Collision.
8	Force Monitoring	This section is where you set the forces in the X, Y, and Z axes based on Base, Tool, World, Reference and among others.
9	Select reference coordinate system	Select a reference coordinate system to display or jog the task coordinates in Figure 11. It can be Base, World, or User coordinates.
10	Joint panel	You can select the joint axis to jog.
11	Task panel	You can select the task axis to jog.
12	Copy Pose J button	This button allows you to copy Pose J.
13	Copy Pose X button	This button allows you to copy Pose X.
14	Move - Button	You can have the robot move in the - direction based on each axis. At this time, you can figure out the direction of the - and + on the 3D simulation on the left-hand side.
15	Move + Button	You can have the robot move in the + direction based on each axis. At this time, you can figure out the direction of the - and + on the 3D simulation on the left-hand side.

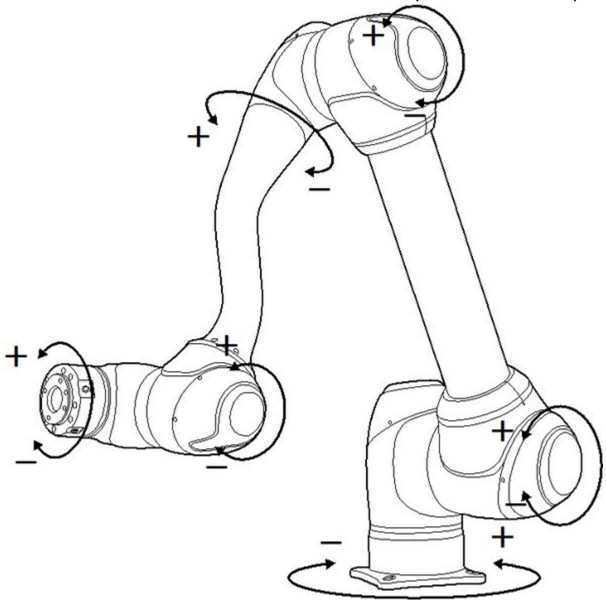
Execute based on Robot Joint



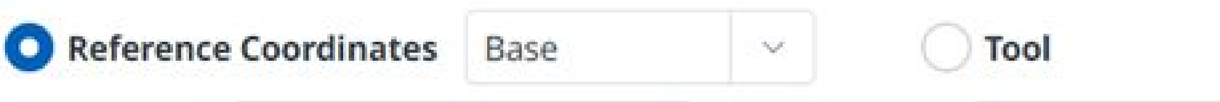
To adjust the angle based on the robot joint, follow these steps:

1. Select the axis (J1-J6) to adjust the angle on the **Joint Panel.**

2. Press and hold the Direction Buttons (+ and −) to adjust the angle of the corresponding axis.



Executing based on Robot Base



To move the robot based on base coordinates, follow these steps:

1. Select the Base as a reference coordinate system.
2. In the task panel, select the axis (X~RX) for which you want to adjust the angle.
3. Press and hold a direction button (+,_) to move the corresponding axis.

Executing based on World Coordinates

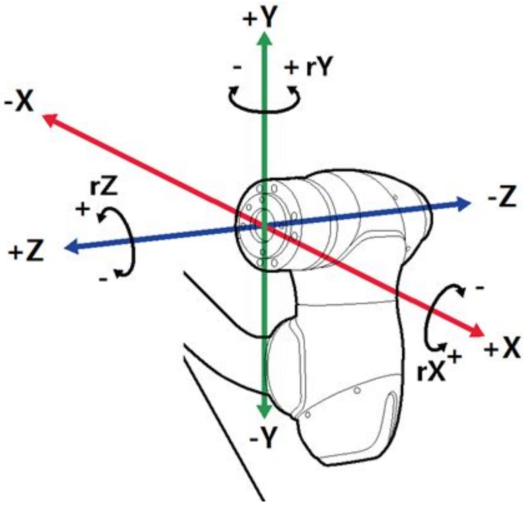
To move the robot based on World Coordinates, follow these steps:

1. Select the World as a reference coordinate system.
2. In the task panel, select the axis (X~RX) for which you want to adjust the angle.
3. Press and hold a direction button (+,_) to move the corresponding axis.

Executing based on Robot Tool

To move the robot based on the robot tool, follow these steps:

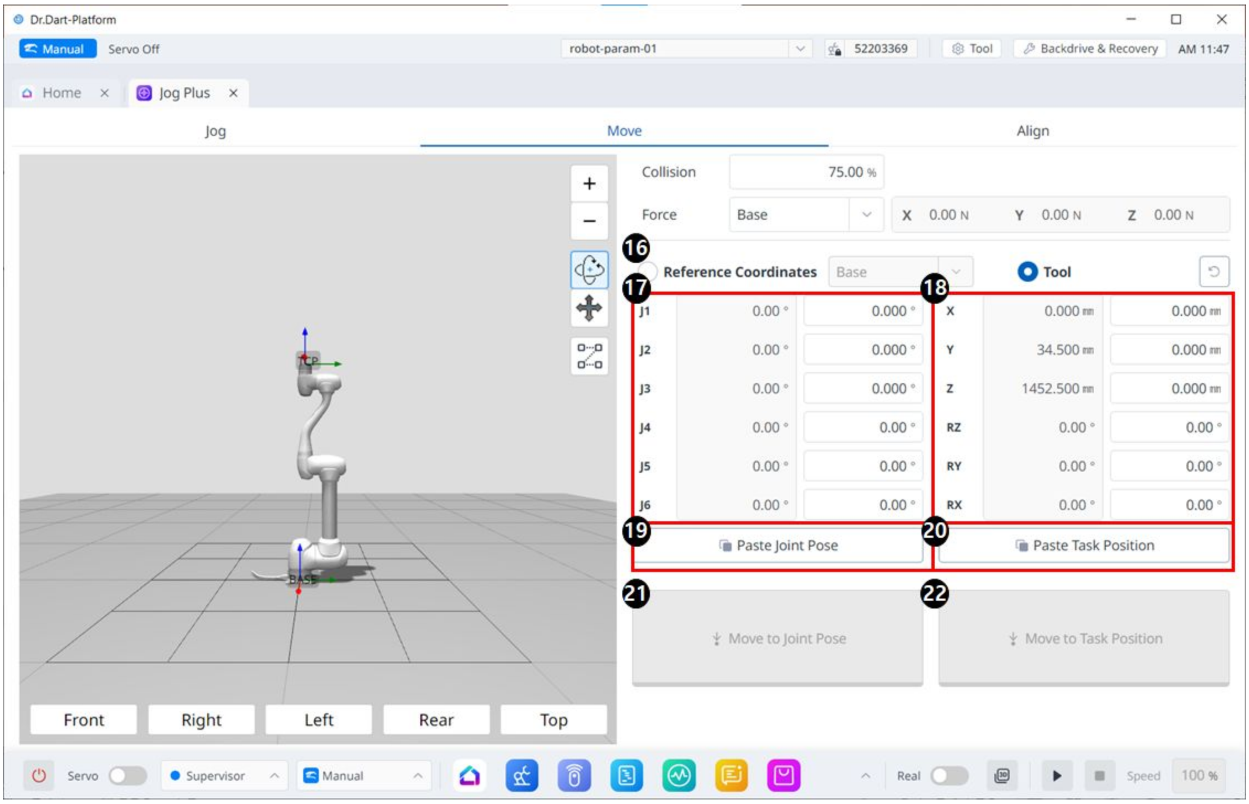
1. Select the tool as a reference coordinate system.
2. In the task panel, select the axis (X~RX) for which you want to adjust the angle.
3. Press and hold the Direction button (+,_) to move the corresponding axis.



Note

- Safety area does not apply in virtual mode.
- Rx, Ry and Rz are executed according to TCP (tool center position).

5.14.2 Move Panel

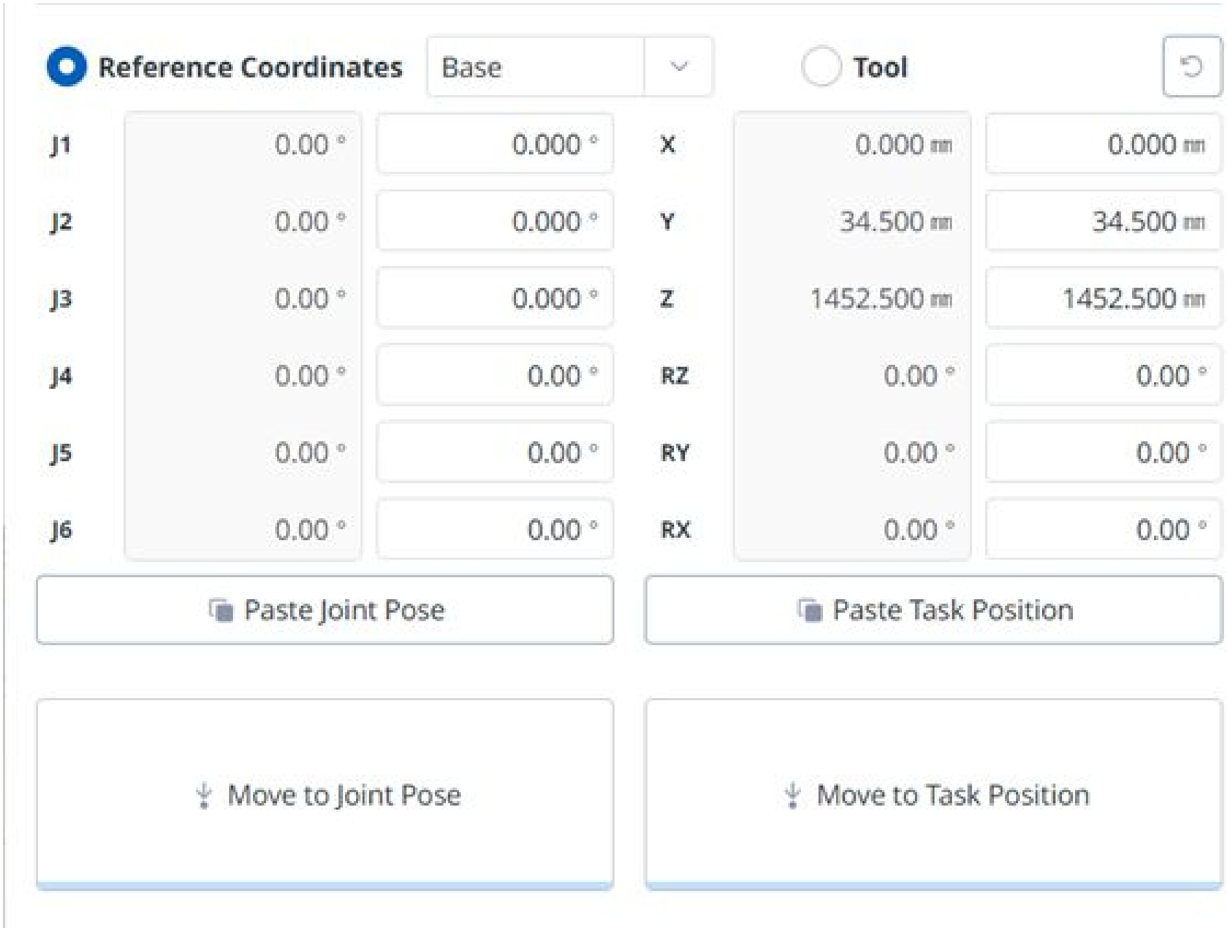


Move Menu Layout

	Item	Description
16	Reference Coordinates	Select the reference coordinate system to be used for the task coordinates in Figure 18. You can choose Base, World, or User coordinates.
17	Joint Posture	Displays the current robot posture and the target joint posture.
18	Task Posture	Displays the current robot posture and the target task posture that fit the selected reference coordinate system.
19	Paste Joint Posture	Paste the posture value copied to the clipboard into the joint posture panel.
20	Paste Task Posture	Paste the posture value copied to the clipboard into the task posture panel.
21	Joint Move button	This button causes the robot to move to the target joint posture.

	Item	Description
2 2	Task Move button	This button causes the robot to move to the target task posture.

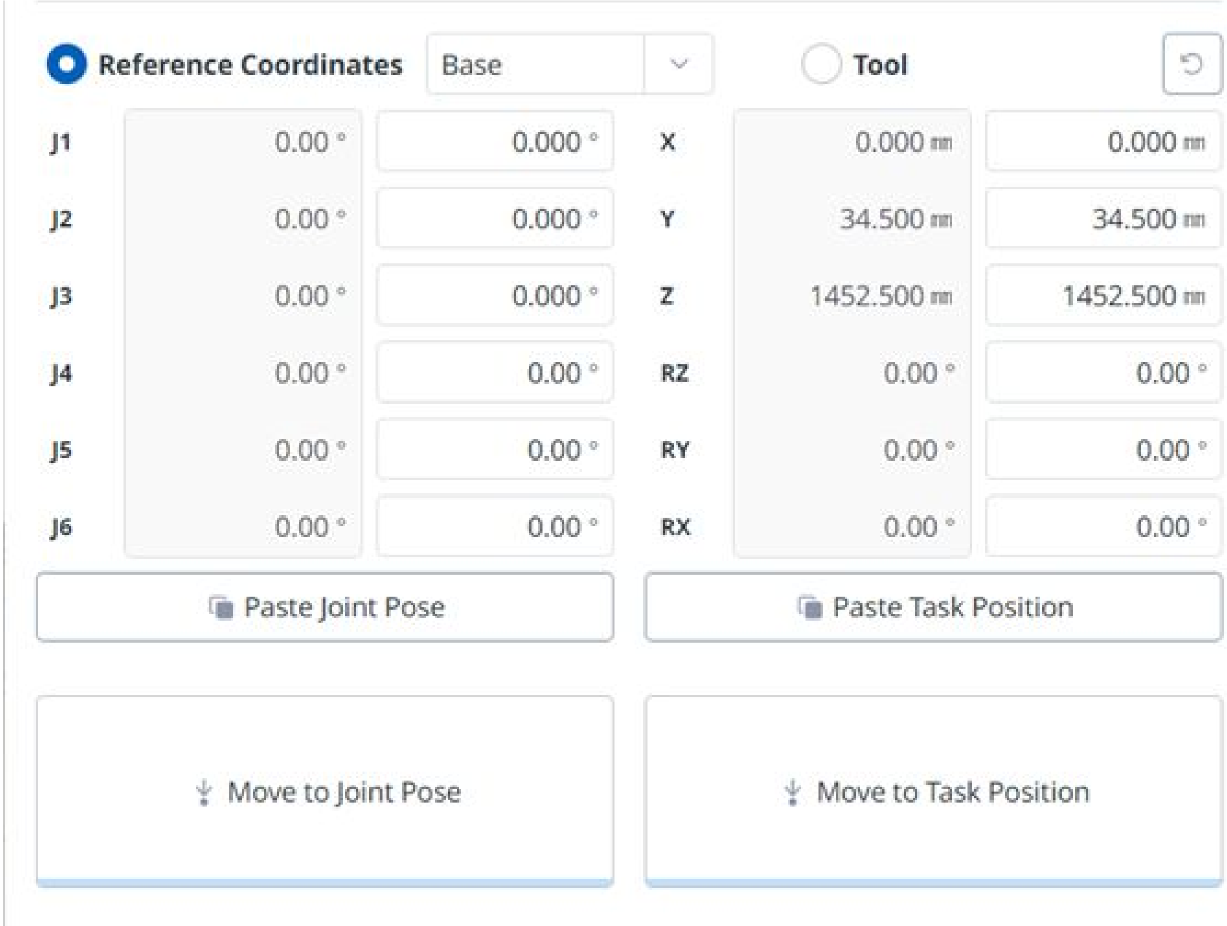
Setting Angle to Move



To move the robot at a specific angle, follow these steps:

1. Select the **Move** tab
2. Enter the target angle of the robot joint.
3. Enable the **Real Mode**.
4. Tap and hold the **Move to Corresponding Pose** button to adjust the robot joint angle.

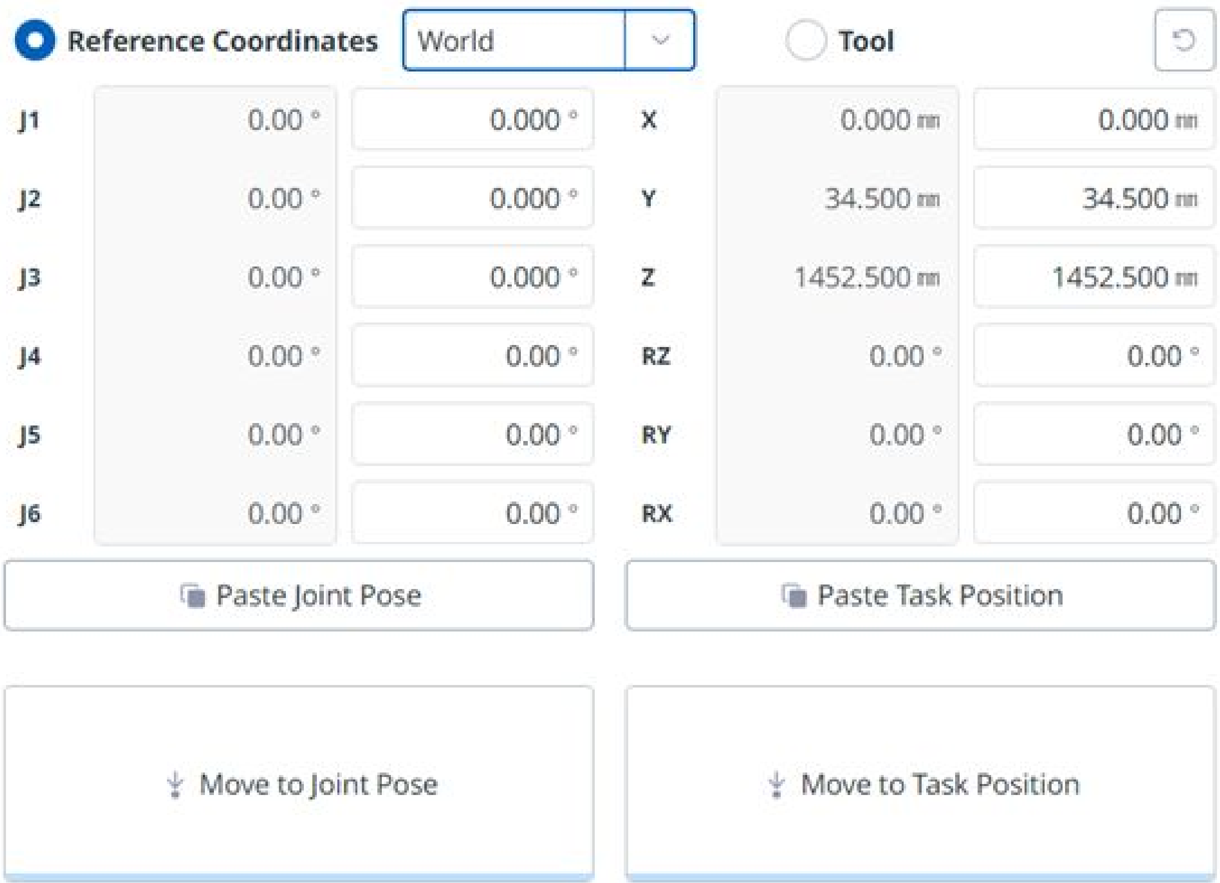
Setting Base Reference Coordinates to Move



To move the robot based on its base coordinates:

1. Select the **Move** tab and then select the **Reference Coordinate** item.
2. Select the display coordinate as the base.
3. Tap and hold the button to **move to the corresponding task position** to move to the set coordinates.

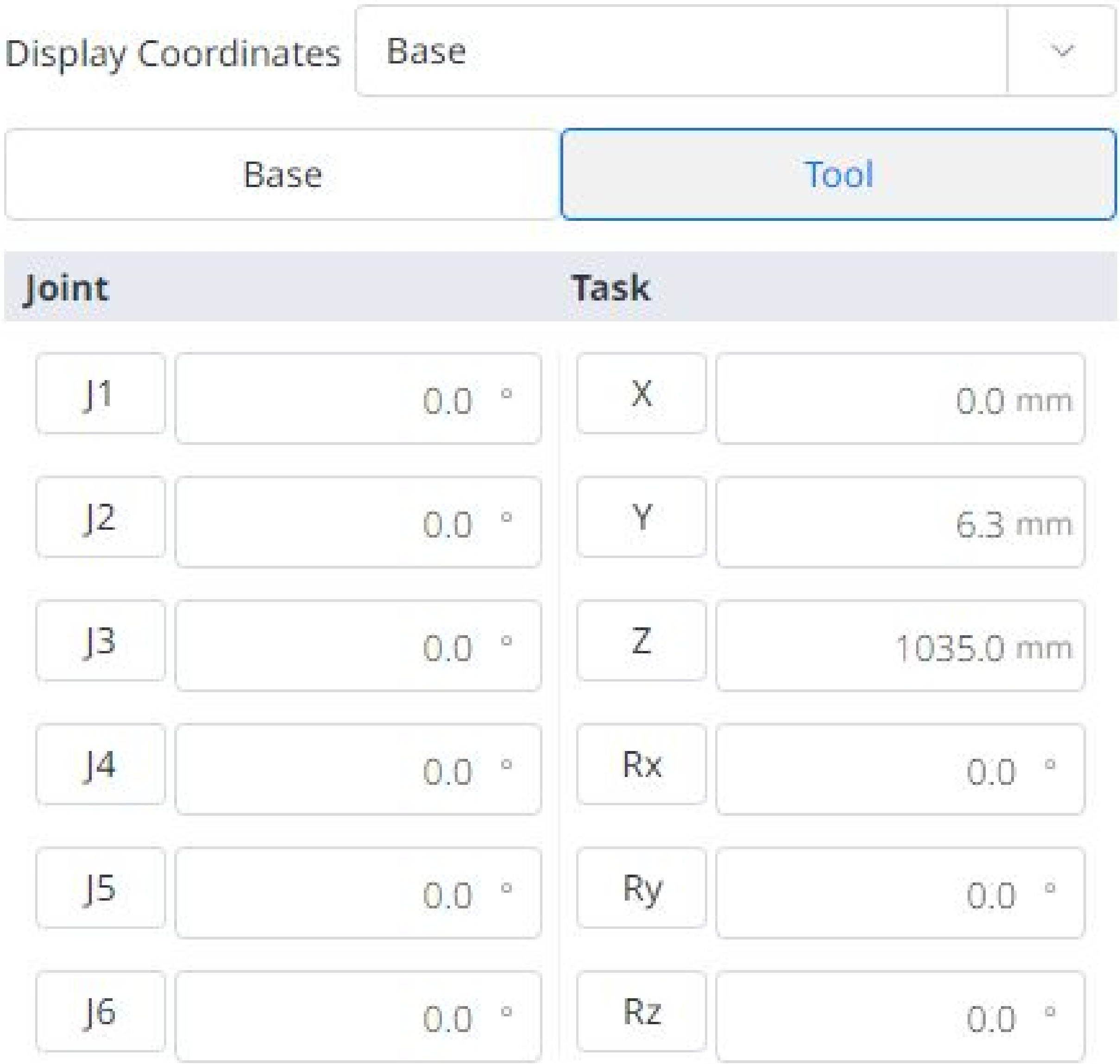
Setting World Coordinates Reference Coordinates to move



To move the robot based on World Coordinates, follow these steps:

1. Select the **Move tab and Reference Coordinates.**
2. Select World as the display coordinates and select the **World** tab.
3. Configure the pose to move with reference to the World Coordinates.
4. Tap and hold the **Move to Corresponding Pose** button to go to the set coordinates.

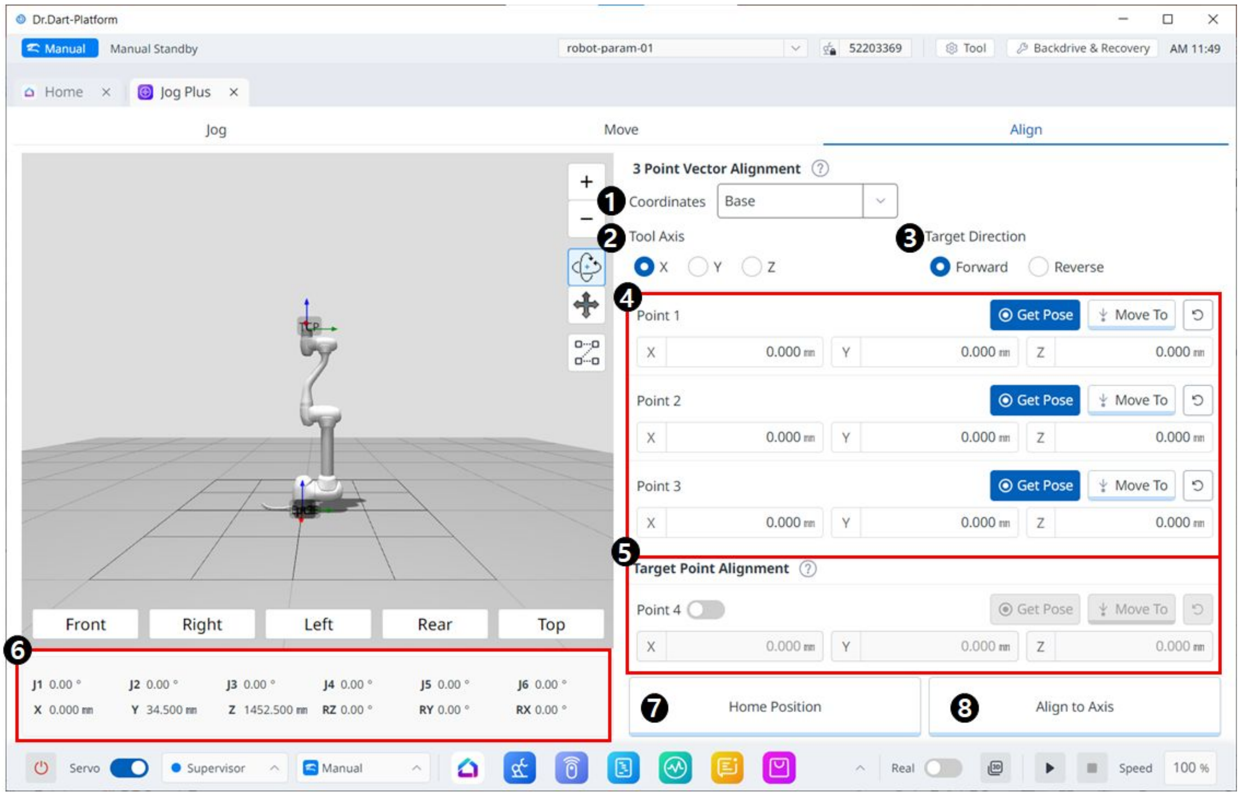
Setting Coordinates to Move Based on the Tool



To move the robot based on the tool coordinates, follow these steps:

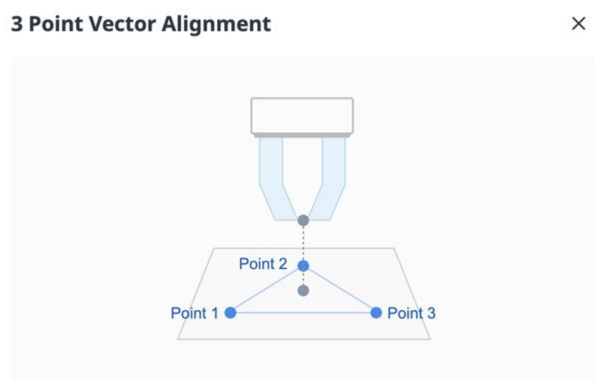
1. Select the **Move** tab and select the **Task** tab.
2. Select the **Tool** tab.
3. Configure the pose to move with reference to the tool.
4. Tap and hold the **Move to Corresponding Pose** button to go to the set coordinates.

5.14.3 Align Panel



Align Menu

	Item	Description
1	Coordinates	Select the reference coordinate system for positions in Figures 4 and 5.
2	Tool Axis	Select which axis of TCP to align.
3	Target direction	Select forward/reverse direction

	Item	Description
4	Pick points on a plane	Pick three points to define the plane. The definitions are as follows: 
5	Target Point Alignment	Select a point to place TCP. This is optional and if unchecked, only the orientation will be sorted from the current location.
6	Robot Posture	Displays the current robot's joint posture and task posture. For task posture, it follows the reference coordinate system selected in Figure 1.
7	Home Position	When you click the button, it moves to the home position.
8	Align to Axis	When you click the button, it algins.

5.15 Appendix, DART Platform installation environment (recommended)

1. Windows OS: Windows 10 Enterprise (64bit)

1. CPU : 2.80GHz
2. GPU : GMA 4500,GMA HD (Intel)
3. Memory : 16GB
4. Java SDK : jdk1.8.0_152 (64bit)
5. Screen resolution: 1280 x 800

2. Mac OS: Ventura 13

1. CPU: M1

2. Memory : 8GB

3. Android OS: Android 13

1. CPU: Snapdragon8 Gen2
2. Memory: 8GB