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INDY7
User Manual

neuromeka | 뉴로메카

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Indy7

neuromeka

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INDY7
User Manual

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Before installing and using the product, please read this user guide thoroughly and make sure you follow the instructions on how to install and use them. Users are responsible for any problems caused by lack of carefulness or understanding.

Also, the illustrations used in this user guide are for your understanding only and may differ from actual ones and Neuromeka is not responsible for any errors or inaccuracies that may appear in the documentation.

All information is based on the time of writing, and all information provided in this manual is subject to change without notice. For more information, please visit and check the Neuromeka website at https://www.neuromeka.com/.

The user guide can be accompanied by video contents by YouTube using the QR code below.

YouTube Video Manual

Written on Aug 23, 2019

Comments or questions should be addressed to : sales@neuromeka.com

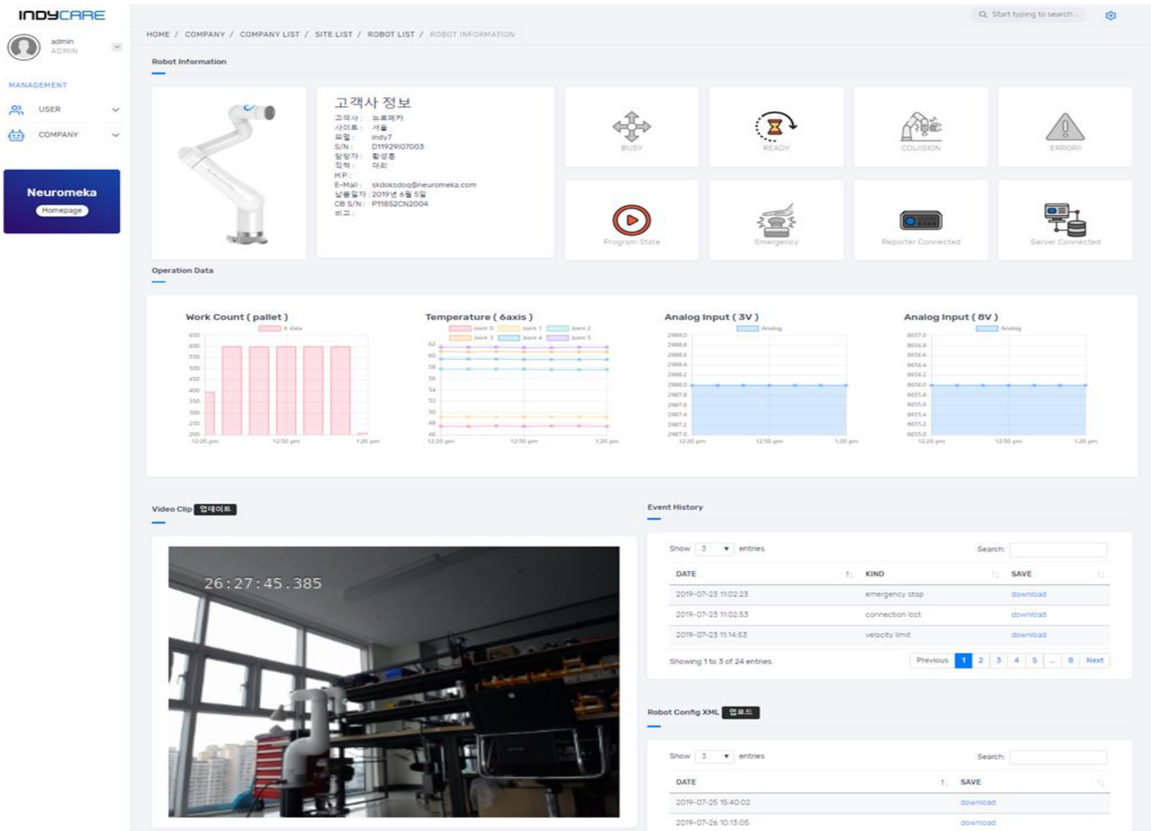
New Features

The following features are newly available in S/W 2.3.0.
Enjoy the Indy with these improved features.

IndyCARE

IndyCARE represents a cloud-based integrated management system providing a variety of information facilitating realtime online monitoring of remotely installed robots via internet as well as analysis of troubles which have already happened or are likely to happen for possible prevention of future failures. IndyCARE provides the following functionalities:

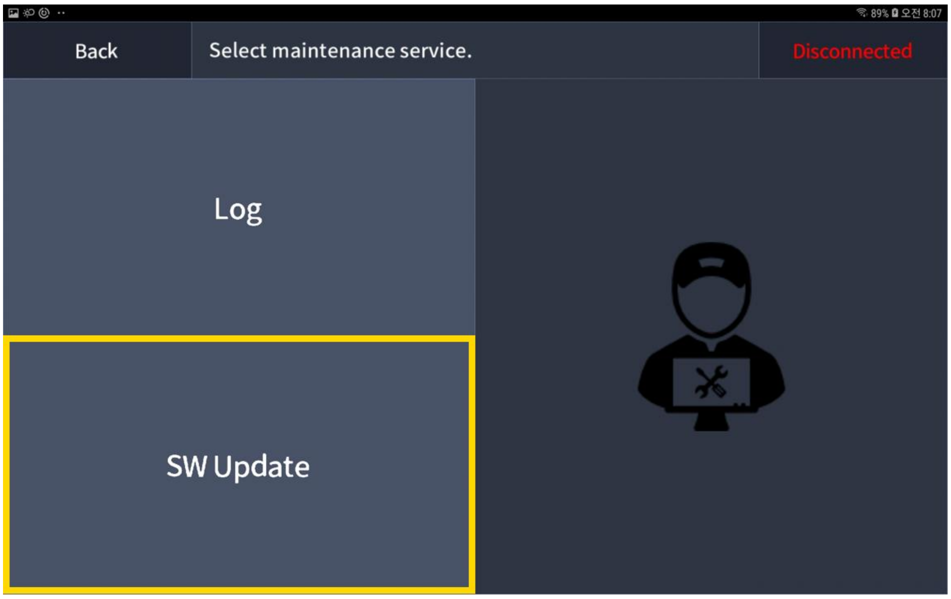
- Realtime robot status monitoring: one can monitor online the status information of the Indy installed in a remote client sitevia internet.
- Process data monitoring: As the data is always collected for management of the process which Indy is involved in, one can monitor and report the process progress.
- Blackbox: Everytime Indy encounters a trouble signaling alarm during operation the video snapshot and the log data are transferred to the server for fastest diagnosis and recovery of the robot.
- Predictive maintenance: Periodic evaluation of the accumulated data could help prevent any potential failures or malfunction in advance.



Conty now has a set of IndyCARE-related setting and commands to enable IndyCARE service. Detailed explanation of them can be found in **Sec. 5.5 Configuration** and **Sec. 5.9 IndyCARE Commands**. Also, the updated guide for IndyCARE service can be checked out in our website https://www.neuromeka.com/.

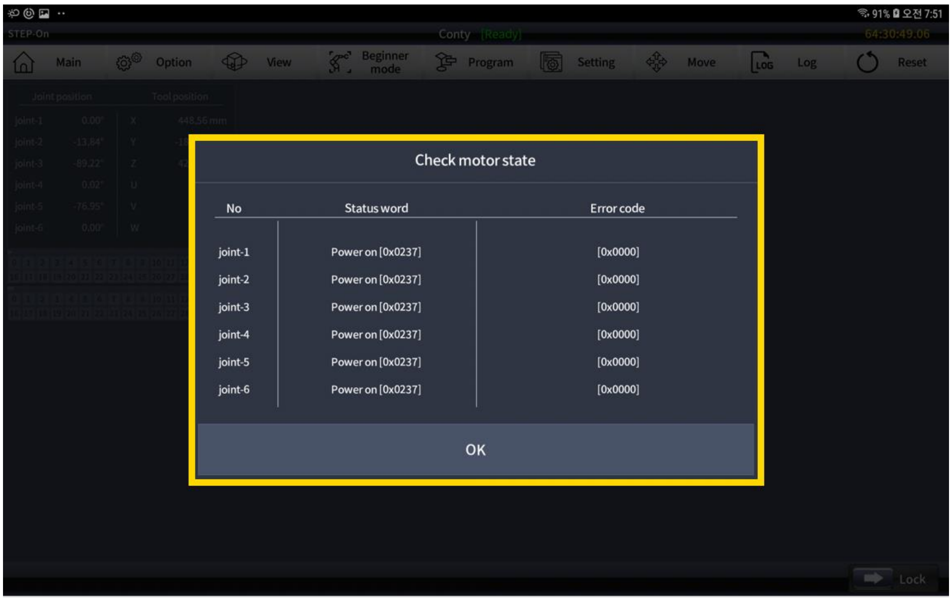
Software update

The software update procedure becomes more convenient. You can find the detailed information in **Sec. 4.1 Getting Started**.



Motor Status

Motor status can be checked by **Motor Status** in the option on the upper menu bar. Now you can check the current status and the error code of every joint motor. For detailed information see **Sec. 6.2 Options**.

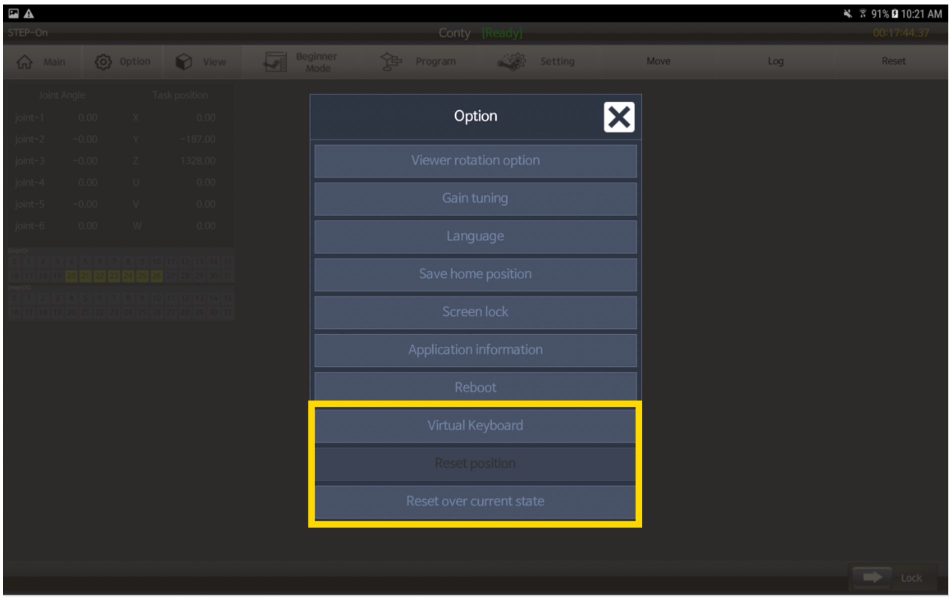


Obsolete Features

The following features become obsolete from ver 2.3.0.

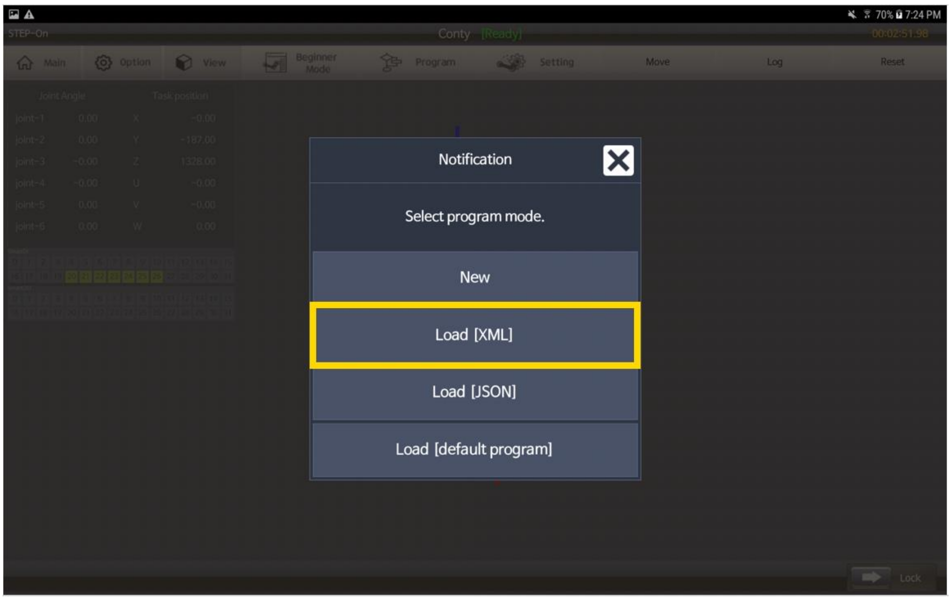
Option Menu

In option menu, list virtual keyboard, reset position, and reset over-current state have been eliminated.



Program Menu

In program menu, Load [XML] has been eliminated.



Contents

1 Safety Information

1.1 Overview

This chapter contains important safety information that must be read and understood by any user of Neuromeka's robots and by the system integrator using them. Be sure to read these instructions thoroughly before installing the product. You should also follow all instructions on how to install and use them. In particular, particular attention should be paid to the contents with safety marks.

1.2 Validation and Responsibility

The information contained in this manual does not cover exhaustively the design, installation, and operation of systems using Neuromeka's robots or any peripherals that may affect the safety of the entire system. The overall system design and installation must comply with the safety standards and regulations of the country in which you are using it, and system integrators must understand the safety laws and regulations of their countries and ensure that major risks do not occur.

This includes, but is not limited to, the following:

- Risk assessment for the entire system
- Addition of other machines and additional safety devices according to the results of the risk assessment
- Setting the safety function appropriate for the software
- Prevention of users from changing safety measures
- Validation of the entire system design and installation
- Clear specification of user instructions
- Appropriate information on robot installation and contact information on system integrator
- Collection of all documents, including technical manuals, risk assessments reports and user guides

1.3 Limitation on Liability

The safety information provided in this manual should not be interpreted as Neuromeka's warranty that no operators will suffer from injury or property loss even in the case that they follow every instruction.

1.4 Safety Symbols

The following are definitions of safety-related indications used in this manual. If you find any of these signs in the manual, please read them carefully to prevent personal injury or damage to the product or peripheral devices.

Danger

Failure to follow the instructions with this mark may result in serious accidents and death or serious injury to the operator may be caused.

Warning

Failure to follow the instructions with this mark may result in accidents and serious injury to the operator may be caused.

Caution

Failure to follow the directions with this mark may result in damage to the product or injury to the operator.

1.5 General Warnings and Cautions

The following describes general warnings and cautions. These warnings and cautions may be displayed or repeated in the remainder of the manual, so be careful when you see them.

Danger

1. Before installing, using, maintaining and repairing the product, read carefully the product's specifications and operation instructions. Ensure that all conditions meet specifications and requirements to prevent unexpected accidents that could result in operator injury and/or product damage during its operation.
2. Before installing and using the product, the installation manager must perform an essential risk assessment based on the conditions of actual use to prevent serious personal injury and product damage during operation caused by improper parameter settings. Also, it is absolutely necessary to perform an essential risk assessment if the robot's work space is shared by human operators.
3. All electrical work must be done after turning off the robot and disconnecting the power plug from the power socket to prevent personal injury or damage to the product due to electric shock.
4. The robot and all electrical equipment must be installed according to the specifications and warnings in Chapters 2, 3 and 4 of this manual.

Warning

1. Users must understand the contents of the manual and complete the training necessary for their use. No one is allowed to operate this product unless you have been trained and have understood the manual. Users are responsible for any problems caused by lack of carefulness or understanding.
2. Before using the product, make sure that there is at least one emergency stop device that stops the robot operation. Also make sure that the emergency stop device always works properly.
3. Do not install or operate this product in a hazardous environment (e.g. near strong magnetic field or combustible material) that may cause explosion or malfunction of the robot due to external conditions. Exposure to very strong magnetic fields can damage the product.
4. Provide enough space for the robot to move freely and secure the robot base to the floor.
5. Tighten the tool to the proper position.
6. Do not wear loose clothing or jewelry to prevent it from getting caught in the robot's joints before using the robot. Long hair should be tied back.
7. Before starting the robot, make sure that there are no people or obstacles in the work area.
8. Never use a robot which is out of order or broken.

9. In presence of any fatal error in the software, immediately stop operation and contact the product supplier.
10. Make sure that the robot settings (robot installation inclination angle, tool weight and center-of-mass, tool offset, safety settings, etc.) are entered correctly. If these settings are not entered correctly, direct teaching or collision detection may not function properly.
11. Direct teaching function should be used only if permitted by the risk assessment and it should not be used when there is a sharp part or a crevice in the tool or work area. Also, everybody should keep their head and face out of the working range of the robot.
12. Direct teaching function should be activated with correct tool settings. Entering information different from the specifications of the actual tool will cause a malfunction in using direct teaching function.
13. During direct teaching of the robot, emergency stop can happen for your safety if you move joints faster than a certain speed.
14. When moving the robot using the Smart Teach Pendant, pay attention to the movement of the robot.
15. Do not approach nor contact the robot while it is in motion.
16. Physical collision against the robot transfers a significant amount of kinetic energy, proportional linearly to the payload and quadratically to the speed. (Kinetic energy = 1/2·mass·velocity^2)
17. Movement in the task space is limited in some portion of the workspace due to the property of singularity, unlike joint space movement where no such limitation exists in all configuration space.
18. In occurrence of any product malfunctions, please resolve the issues subject to the proper procedure and expert guidance or contact our service channel for troubleshooting. Users are strictly prohibited from attempting to repair the product by themselves to prevent damage due to improper disassembly. If this is the case, Neuromeka will not be held responsible and the product may not be repaired.
19. Combination of different devices and machines can increase risk or create new risks. In this case, the entire risk assessment must be performed again.
20. Never modify the robot nor open it at will. Neuromeka assumes no responsibility for any problems arising from any changes or modifications to the product by the user.

Caution

1. The robot and control box accumulate heat when used for a long time. Therefore, the robot should be powered off and cooled long enough before touching the robot after long-term operation.
2. All electrical work related with interfaces to peripherals must be performed by an expert with relevant knowledge. The manufacturer is not responsible for any failure due to incorrect connection or misuse.

3. It is recommended that all functions and programs be tested separately before use with machines or other robots that may damage the robot. Neuromeka assumes no responsibility for any safety accidents or injury to property resulting from hardware or software errors or malfunctions of the product itself.
4. Neuromeka is not responsible for any errors or inaccuracies that may appear in the documentation. The illustrations used in this manual are for your understanding only and may differ from actual ones. All information is based on the time of writing, and all information provided in this manual is subject to change without notice. For more information, please visit the Neuromeka website at https://www.neuromeka.com/.

1.6 Intended Use

Neuromeka's robot is a cooperative robot equipped with collision detection and direct teaching function. It can be used for transporting and assembling objects using the tool under the operating conditions of the robot specified in the specification or the manual.

It is possible to work collaboratively with a person without a physical safety fence by preconfigured safety function. However, if it is to be integrated with other devices, it should be used after performing a risk assessment of the final whole system.

It is also prohibited to use the robot for any other purpose outside of its intended use, and any attempt to misuse away from its intended environment and use is considered improper. Neuromeka will not be liable for damage or loss of the robot caused by this. These improper uses include, but are not limited to:

- Use in potentially hazardous environments
- Medical and life related uses
- Transport of people and animals
- Use without a risk assessment or before its completion
- Over-use beyond the robot's performance specification
- Use in places where the performance of the safety measure is insufficient
- Use with inaccurate or inappropriate parameters
- Use in applications that may cause direct damage to the robot itself

1.7 Risk Assessment

All users must perform a necessary risk assessment subject to their operation environment and conditions before installation and use of the product. The purpose of the risk assessment is to predict or evaluate possible accidents during robot operation and to prevent accidents effectively and to reduce the severity of injuries through appropriate protective measures and safety settings.

Refer to ISO 10218-2, ISO 12100, and ISO / TS 15066 for detailed descriptions of risk assessments.

Danger

The manufacturer is not responsible for any accidents that occur due to failure to comply with the relevant regulations of the international standards and domestic regulations in the installation and use, or the improper performance of the risk assessment.

1.8 Potential Hazards

Users should be prepared for potential hazards even if the risk assessment performed by the final system manufacturer applying the robot results in a significant reduction in risk. This includes, but is not limited to, the potential risks that may occur with the final system.

- Injury caused by fingers jammed in the robot joint area
- Injury due to tool's sharp edges
- Injury caused by an object located near the robot
- Injury that may occur when working with toxic and hazardous materials
- Injury caused by collision against robot
- Injury due to insecure fastening
- Injury due to a detached object from the tool or free-falling objects

1.9 Emergency Stop

The user can immediately stop all operations of the robot by pressing the emergency stop button. If the robot is stopped due to an emergency stop, the user must remove all dangerous conditions and start the robot again. The pressed emergency stop button can be released by turning clockwise.

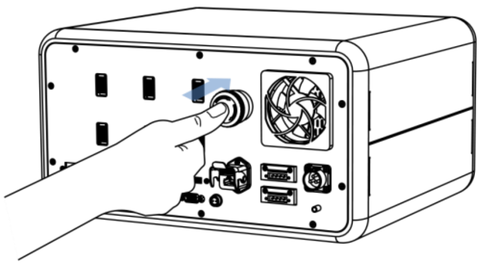
Emergency stop should not be used as a risk reduction method and should only be used in an emergency situation. To stop the robot in normal operation, use the stop button of Smart Teach Pendant application. Neuromeka provides two emergencies stop buttons, and these emergencies stop buttons comply with the requirements of ISO 60204-1.

Caution

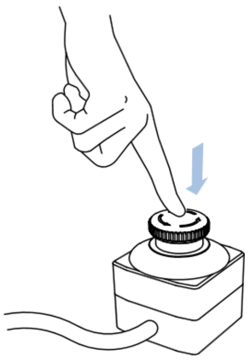
As soon as the emergency stop button is pressed, the control system of the control box transmits the stop command to the robot, and the power of the motor is shut off, and the magnetic brake of each joint is automatically activated at the same time. However, it takes some time to fully brake down each joint to a complete stop, which can cause the robot to fall in gravity for a while. As the falling distance may vary depending on the weight of the tool, be careful not to cause the nearby operators to get stuck in the joints or the robot to collide against nearby objects or operators.

Using Emergency Stop

You can stop the robot immediately by pressing the emergency stop button attached to the back panel of the control box.

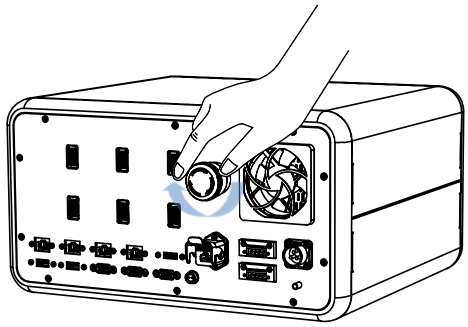


You can stop the robot immediately by pressing the emergency stop button connected to the emergency stop cable.



Releasing Emergency Stop

Turning the emergency stop button on the back panel of the control box clockwise will release it.



Turning the emergency stop button connected to the emergency stop cable clockwise will release it.

1.10 Movement without Drive Power

One can move the robot forcefully even when the power of each joint of the robot cannot be used or is not used. In the non-powered state, pushing or pulling hard on the joint you want to move can force the joint to move.

Caution

Caution

Too much force in the non-motorized state may cause overstress in actuator components inside while the joint is moving. The manufacturer is not responsible for any trouble caused by excessive force.

2 Transportation and Installation

2.1 Transportation

The Neuromeka product is composed of the default components delivered in two dedicated boxes: The long rectangular box contains one robot arm and six screws for fixing the robot base, and the square box contains one control box and three cables (the robot communication cable, the emergency stop cable, and the power cable).

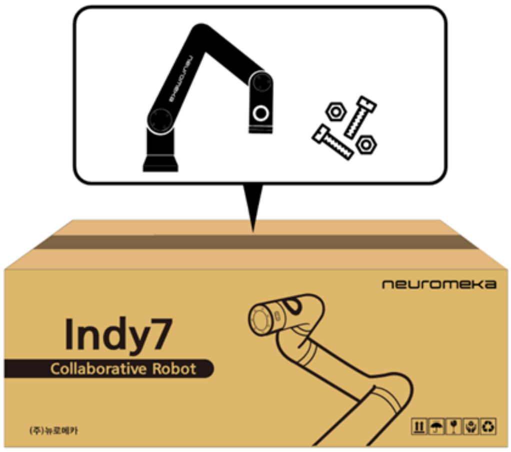
After unpacking, store the packaging boxes in a dry place in case you need to transport the robot again. Additional components are carried separately from the default components.

Warning

The body of Indy7 weighs about 29kg and the control box weighs about 15.5kg. Therefore, at least two people are required during shipping and transportation to avoid excessive strain on the musculoskeletal system. Also, be sure to support the robot arm so that the product will not be damaged during transportation or while the robot base is being fixed by fastening the screws. Neuromeka is not responsible for damage caused during shipping and transportation.

Caution

Be sure to follow the instructions in the manual regarding fixing the robot base.



[Product box 1]

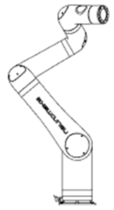
[Product box 2]

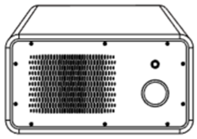
2.2 System Components

The Neuromeka product consists of the default components and additional components. The additional components can be purchased separately.

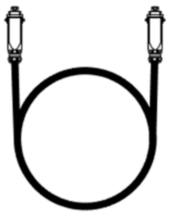
Default Components

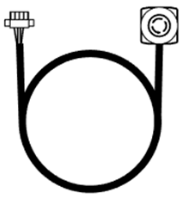
The default components are provided as follows.


Robot arm


Control box


Screws for fixing robot (6EA)

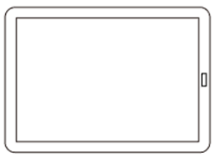

Robot communication cable

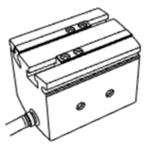

Emergency stop Cable

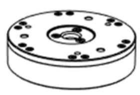

Power cable

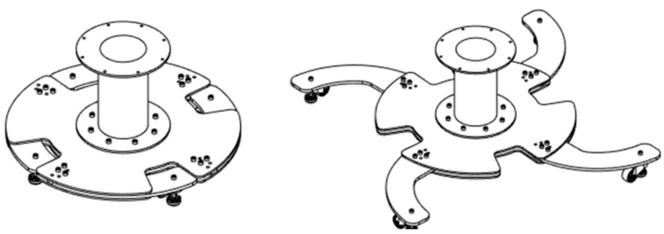
Additional Components

Additional components currently available separately include the Android Tablet PC (with Smart Teach Pendant application installed), a foldable mobile base, electric grippers and a six-axes force/torque sensor (hereafter referred to as the FT sensor). Among these, the FT sensor is available for research purposes only. For exact list of additional tools please refer to the website http://www.neuromeka.com.


Android Tablet PC


Electric gripper

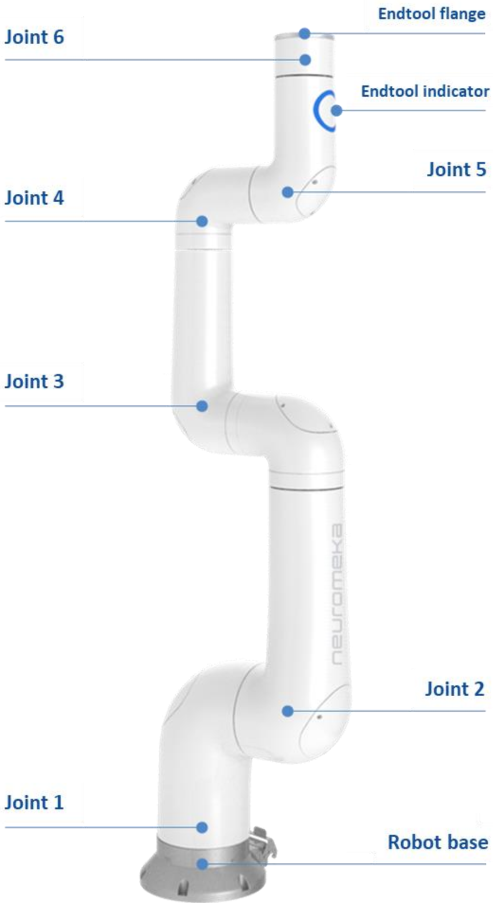

Six-axes force/torque sensor (for research purpose)


Foldable mobile base

2.3 System Overview

Robot Arm (Indy7)

It is composed of six revolute joints, which allow arbitrary motion in three-dimensional space in order to carry objects or assemble parts. To do this, you can attach various tools such as grippers to the endtool flange of the robot, and you can check the status of the robot through the light of the endtool indicator.



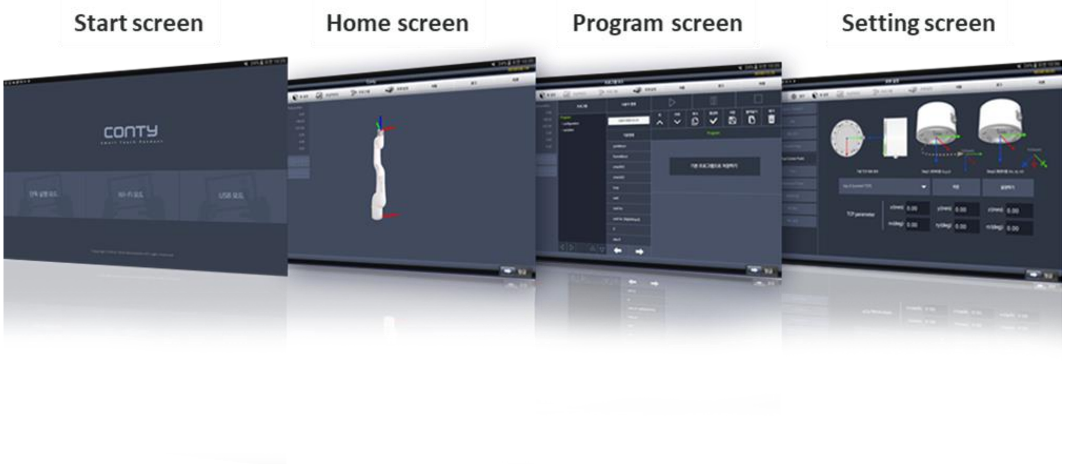
Control Box (IndyCB)

It controls the power of the robot and transmits all the control signals necessary for robot operation and/or all the interface signal inputs and outputs with peripheral devices. It can also turn off the power in case of emergency.

[Front] [Rear]

Smart Teach Pendant (Conty)

Android-based Smart Teach Pendant application (hereinafter referred to as Conty) provides control and monitoring of the robot and various interface signals and provides a graphical user interface (GUI) for setting the robot and programming motion for specific tasks.



2.4 Installation

The installer must install and operate the robot in accordance with ISO 10218-2 and ISO 12100 guidelines and must comply with relevant requirements of international standards such as ISO / TS 15066 and the national regulations.

Caution

Caution

The manufacturer is not responsible for any accidents that do not comply with the relevant requirements of international standards and national regulations, or that occur without reviewing the risk assessment described in Section 1.7.

Installation Locations

It is recommended to install the robot in a place that meets the following conditions.

- no flammable or explosive material
- no leakage
- solid flat floor bearing the weight of the robot and the loads that occur during operation
- temperature and humidity kept within the operating range of the robot and the control box
- little dust inflow

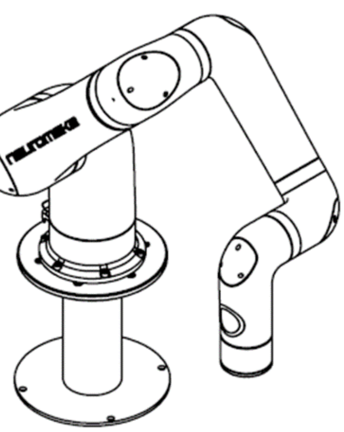
Caution

Caution

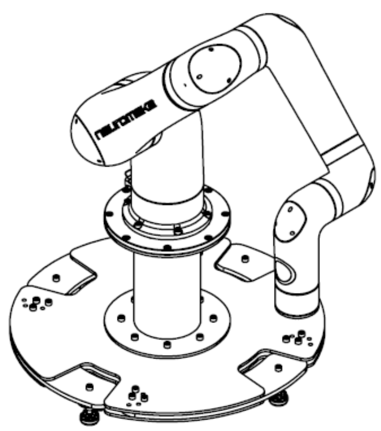
Failure to install the product in the recommended location may affect performance and lifetime.

Installation Type

Robots can be installed on the floor in various forms.



[Example of fixed post]



[Example of folding mobile base]

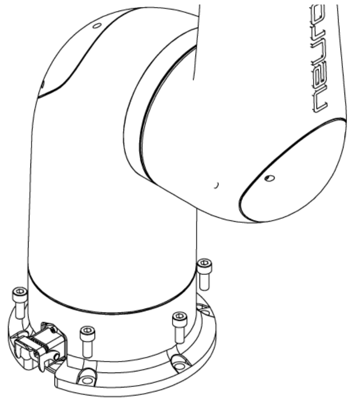
Warning

Warning

If the base can be selectively moved or fixed, such as the foldable mobile base, it must be fixed to the ground before the robot operates.

Fixing Robot

The robot can be fixed to the floor with six screws of the M8 bolts (with 20mm hex socket head size) contained in the same box as the robot arm. It is recommended to tighten these bolts with 34 Nm torque. If the fastening bolts are lost, bolts that meet ISO 898-1 class 10.9 or class 12.9 of the same standard may be used instead.

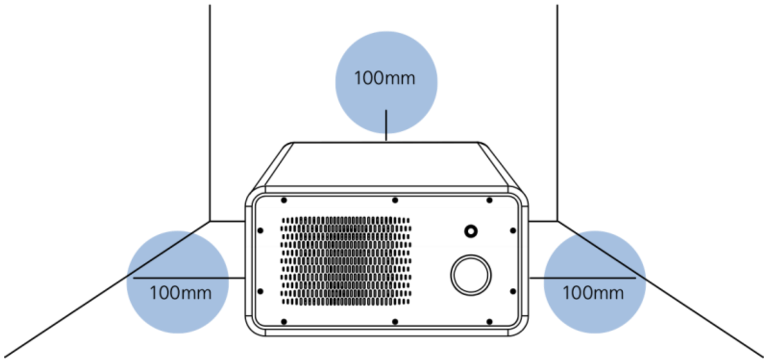


Warning

Securely fasten the fixing bolts so that they will not loosen. Also, check the tightening status of the bolts periodically as the environment is subject to frequent vibration.

Fixing Control Box

The control box should be installed in an upright position with a minimum clearance of 100 mm to avoid interference with the internal air flow.



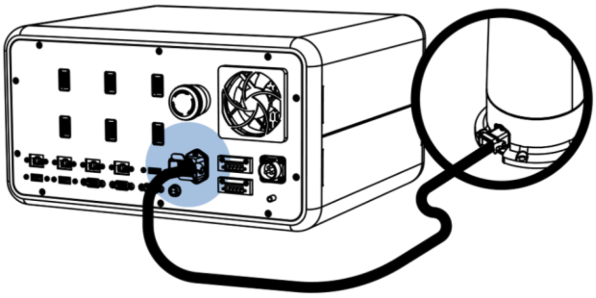
Caution

Installing the control box upside down may violate safety guidance. In this case, please contact the manufacturer separately.

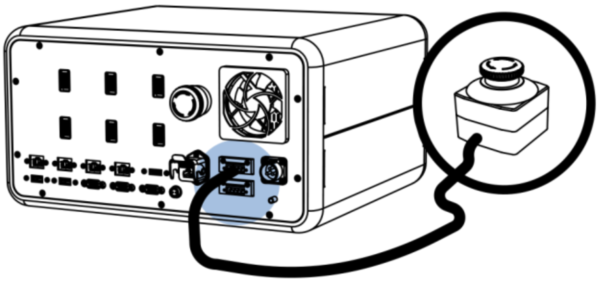
Connecting Cables

The cables are contained in the same box as the control box, that is a robot communication cable, an emergency stop cable, and a power cable, respectively.

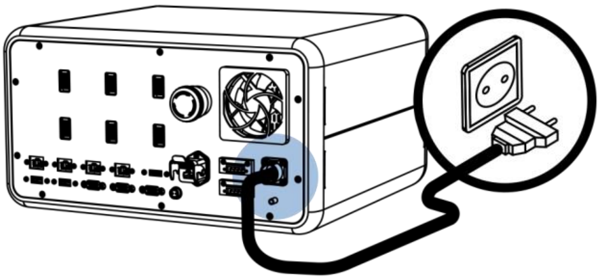
Connect the connectors on both ends of the robot communication cable to the **ROBOT** terminal on the back panel of the control box and the robot base terminal respectively. After connection, fasten the latch down so that the cable does not get unplugged.



Connect the emergency stop cable to the **EMERGENCY** terminal on the back panel of the control box. There are two EMERGENCY terminals on the control box, but any terminal works.



Connect the power cable to the **AC INPUT** terminal located on the back panel of the control box. Finally, plug the power plug into the power socket to complete the installation. Connection to the power socket must be made at the last stage of the installation.



Electrical specifications of the power are shown in the following table.

Item	Specification
Input power	100 ~ 240 VAC
Main fuse	12 A
Input power frequency	50 ~ 60 Hz

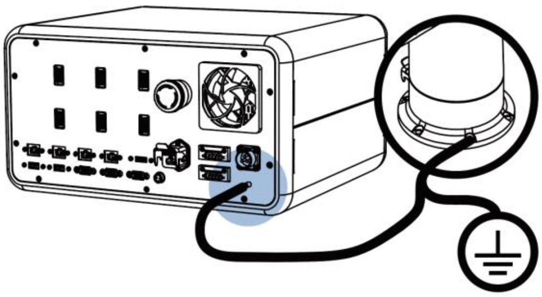
Caution

Caution

Different power cables are provided for each country. Be sure to use the appropriate power cable for your country. Also, make sure that the power supply ground, main fuse, earth leakage breaker, etc. are properly installed in the power supply. The manufacturer is not responsible for any accidents or failures caused by failure to keep these specifications.

Installing Ground Wire

Injection of over-current or over-voltage and occurrence of electrical noises can do harm to the facilities and/or people and electrical failures and cause robot to malfunction due to electrical shock. In order to prevent this happening a gound wire should be installed properly. Common grounding should be made by connecting the common ground and any **bolt fixing the robot base**, and the bolt to the **ground port** in the back panel of the control box using M6 8mm head cap screw. Note that the common ground means the ground shared by the constructed building and all electrical facilities in the building. You need to consult for electricity maintenance team.



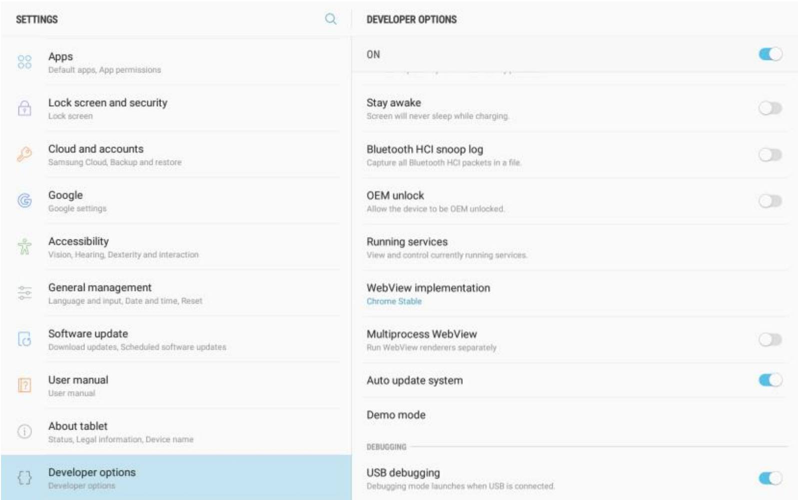
Installing Conty

Conty is an Android-based application that can be installed on any smart device with Android of ver. 5.0 or later installed. Since the screen configuration is optimized for display of size greater than 10 inches, we generally recommend using a tablet PC larger than 10 inches. At initial purchase it is a better idea to purchase the standard Conty tablet together with the robot from Neuromeka. Depending on the robot model you purchased, the suitable application is provided and the installation method is as follows.

① Install the Adobe AIR runtime application on Google® "Play Store".

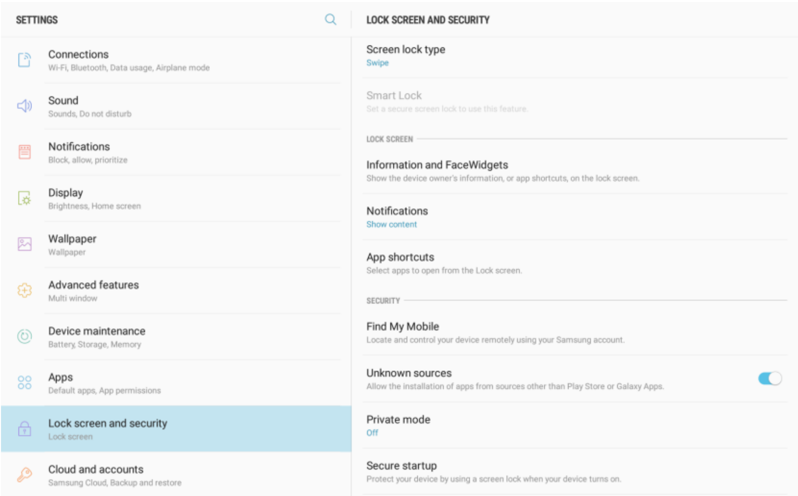
② Enable the USB debugging options:

- Select **Settings** in the Android device menu
- Activate **Developer options** by touching the build number of device information several times
- Enabling **USB debugging** in Developer Options

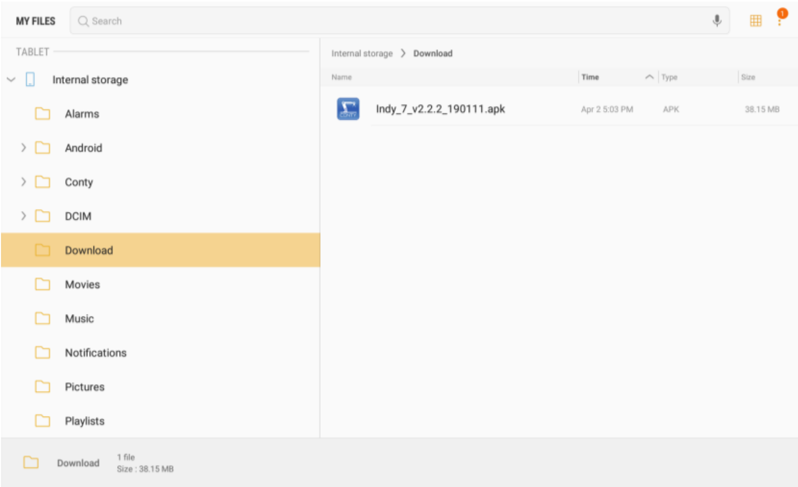


③ Enable unknown apps:

- Select **Lock screen and security** in Settings menu
- Activate **Unknown sources** from the Lock screen and security menu



④ Installing the Conty application stored in the tablet PC



Caution

Caution

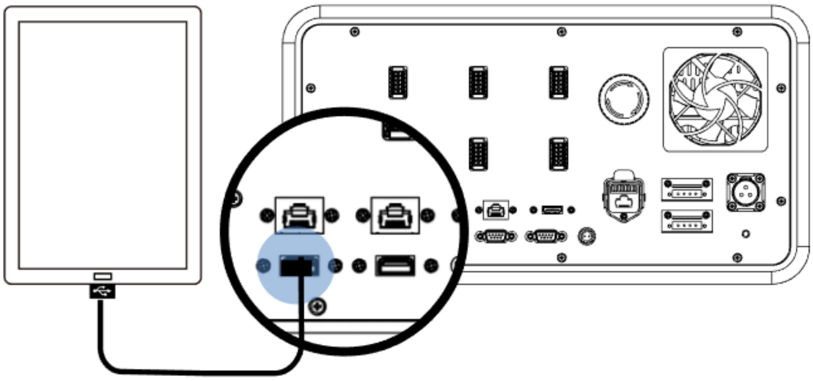
The Conty tablet with preconfigured Conty application by Neuromeka can be purchased separately as an additional component. In the case of user's tablet PCs purchased separately, Conty can be installed, but in this case Neuromeka is not responsible for performance and compatibility issues and any problems caused by it.

Connecting Conty tablet

To use Conty, you need to connect your Conty-installed tablet to the control box. Connection between the tablet and the control box can be made using a USB cable or Wi-Fi as follows.

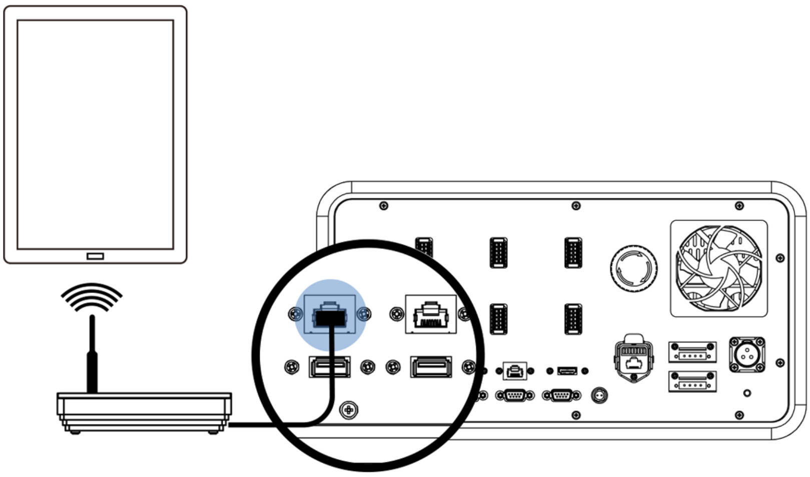
- **Using a USB cable**

  Connect the USB port on the back panel of the control box and the tablet with a USB cable.



- **Using Wi-Fi**

  Connect the LAN cable (from a wireless router) to the Ethernet port on the back panel of the control box.



Caution

Caution

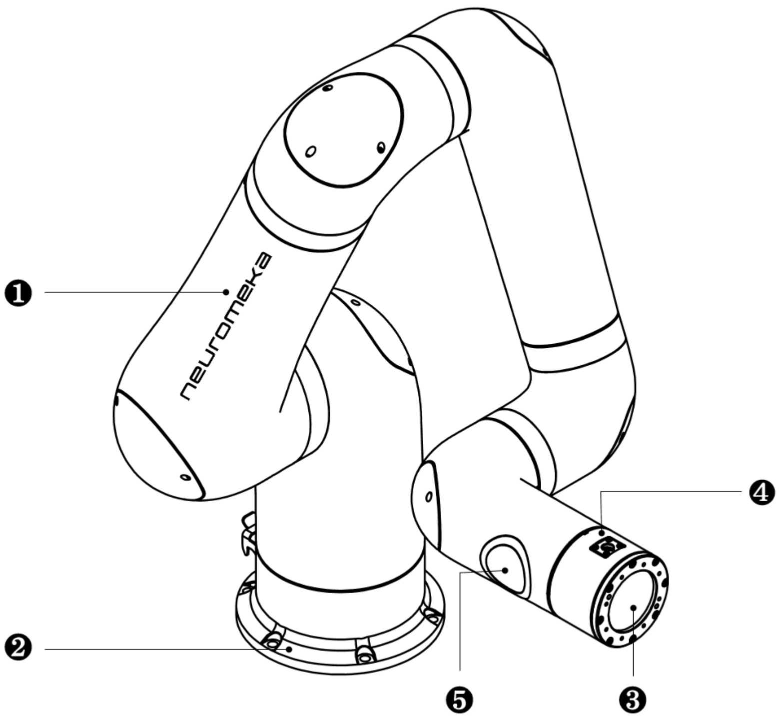
When using Wi-Fi, the tablet and the control box must use the same internal IP network. Contact your network specialist for technical details.

3 System Specifications and Interfaces

3.1 Robot Arm

The robot arm moves in space and is used to carry objects or assemble parts. To this end, various tools can be attached to the endtool of the robot, and these tools such as grippers can be controlled via electrical interface. In addition, the robot status is displayed at the endtool indicator of the robot.

The major functions of each part of the robot arm are as follows.



No.	Name	Description
❶	Robot arm	It uses a total of six rotating joints to move in space, where the work space is determined by the link length and the travel range of each joint. The weight of the tool that can be installed at the endtool of the robot is limited by the center-of-mass of the tool.
❷	Robot base	It is the area where the robot is fixed to the floor.
❸	Endtool flange	This is where the tool is mechanically fixed.
❹	Endtool port	It provides an electrical interface to operate the tool.
❺	Endtool indicator	It displays the status of the robot in terms of lighting color and option. • Green/Solid: Ready • Green/Blinknig: Moving • Blue/Solid: Collision • Blue/Blinking: Direct Teaching • Red/Solid: Error • Red/Blinking: Not ready

Joint Coordinates and Travel Range

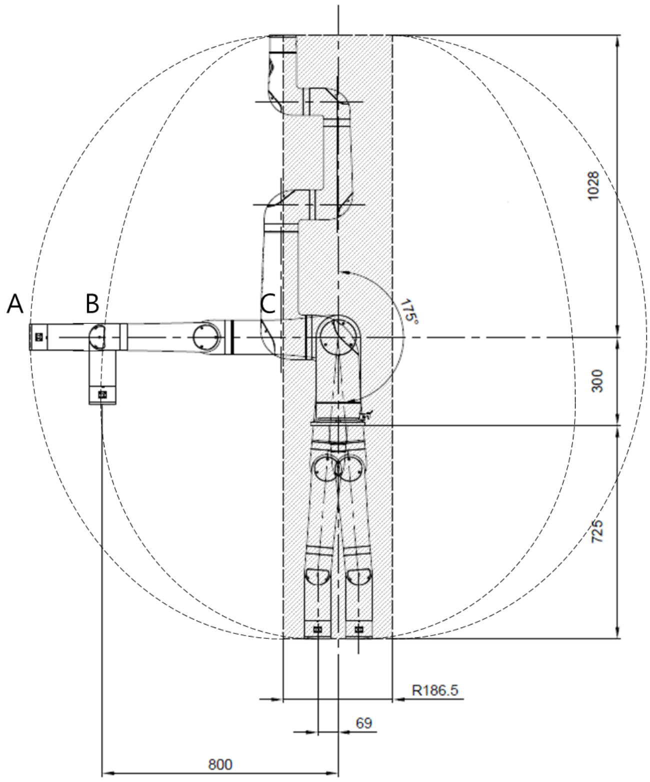
It consists of six revolute joints, each of which rotates around the joint axis. The following shows the robot position when every joint angle is 0 degree, which is called the zero position. Note that the direction indicated by the arrow is positive rotation, i.e. positive angle, and the opposite direction is negative rotation.

All joints have a limited travel range to prevent self-collision and internal cable disconnection. The travel range of each joint is as follows.

Joint number	Travel range
Joint 1	$-175° \leq \theta_1 \leq +175°$
Joint 2	$-175° \leq \theta_2 \leq +175°$
Joint 3	$-175° \leq \theta_3 \leq +175°$
Joint 4	$-175° \leq \theta_4 \leq +175°$
Joint 5	$-175° \leq \theta_5 \leq +175°$
Joint 6	$-215° \leq \theta_6 \leq +215°$

Workspace

The radius that can be reached with the fully extended arm is 1,028 mm, while the maximum radius with maximum allowable load is 800 mm. However, the radius of 186.5mm around the rotation axis of the robot base is the area where the end of the robot cannot reach due to the structure.



- A: The area where the end of the robot reaches when there is no payload
- B: The area where the robot end reaches with the maximum payload condition
- C: The area where the end of the robot cannot reach

Singularity and Singularity Region

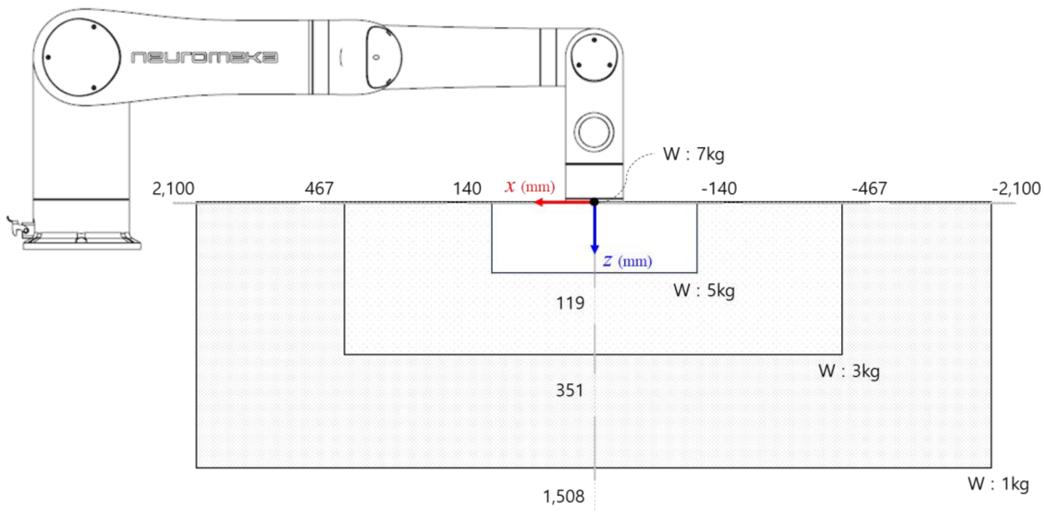
Unlike the joint motion of the robot that moves joints with respect to the joint space (e.g. in terms of the joint angle values), the robot's motion that moves the tool with respect to the three-dimensional Cartesian coordinate system has a position, where the robot cannot move in arbitrary direction, linearly or rotationally, within the workspace. This is a physical phenomenon where the robot can no longer be translated or rotated in a particular direction of the Cartesian coordinate system due to the restrictions on the kinematic or control algorithms of the robot arm. These positions are called singularities. Furthermore, the closer to the singular point, the greater the joint acceleration of some specific joints, which results in reaching the limit of the motor capacity. The singularity region is referred to as the neighborhood of a singularity which causes violation of motor capacities with abnormally fast motion.

Therefore, when the robot is operated with respect to the Cartesian coordinate system, which we call frame or task move hereinafter, the robot stops its motion with an alarm upon approaching a singularity region in order to prevent safety accidents from sudden rotation of some joints in the singularity region.

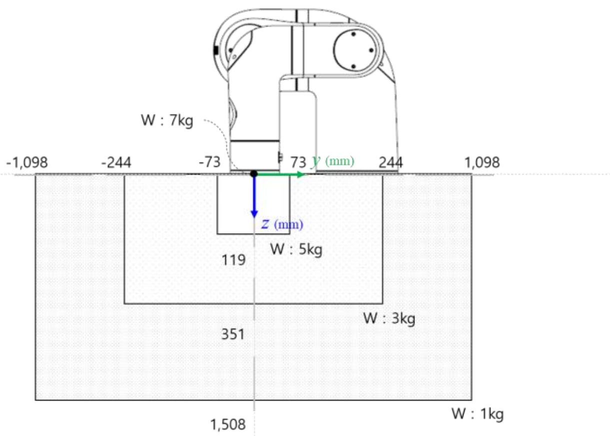
Maximum Allowable Payload

The allowable payload of the robot arm is determined according to the distance from the center point of the endtool flange to the tool's center-of-mass, with respect to the following robot posture.

The following graph displays the maximum payload in terms of the distance in the X-Z plane with respect to the tool coordinate frame, where the distance from Y axis is 0 mm.

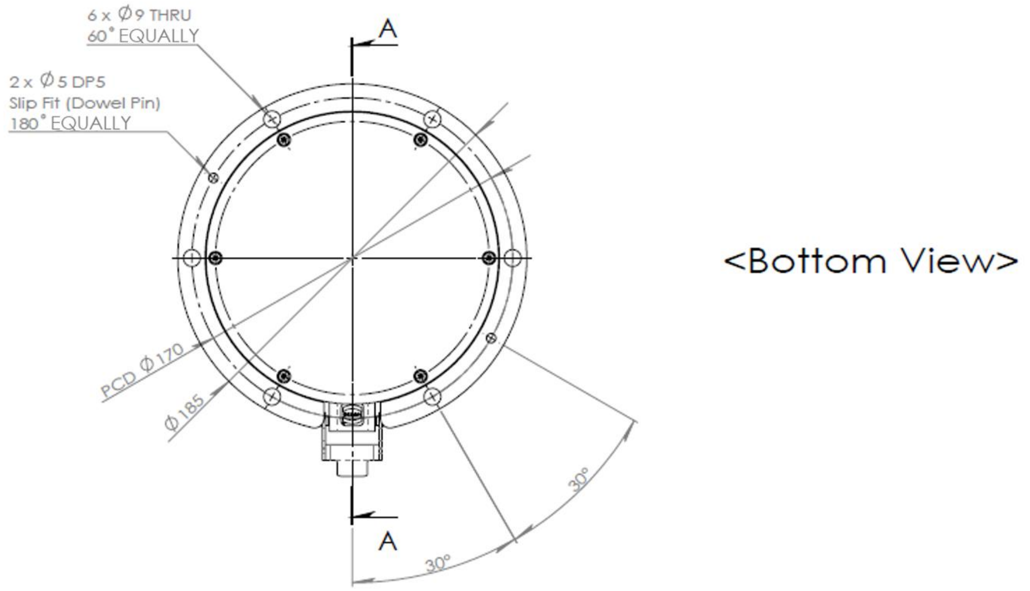


The maximum payload in terms of the distance in the Y-Z plane with respect to the same tool coordinate frame is displayed as follows. At this time, the distance from X axis is 0 mm.



Fixing Robot Base

Information on mounting the base for fixing the robot to the floor is as follows.

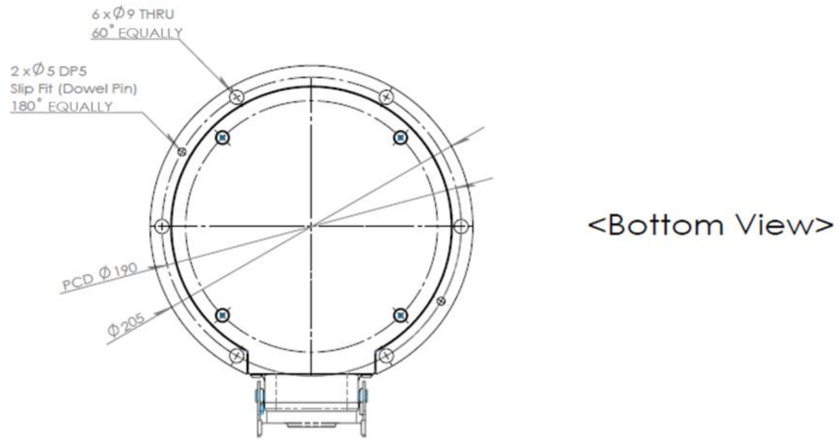


The default reference Cartesian coordinate system, simply called reference frame, of the robot is defined based on the robot base. The origin of the reference frame is the point at which the center axis of the base meets the floor, while the direction emanating from the origin facing away from the connector is the X axis, and the direction facing upwards (perpendicular to the floor) is the Z axis. The Y-axis is determined automatically by the right-hand rule. Refer to Section **4.2 Basic Operations** for details on the coordinate system and its position.

Note

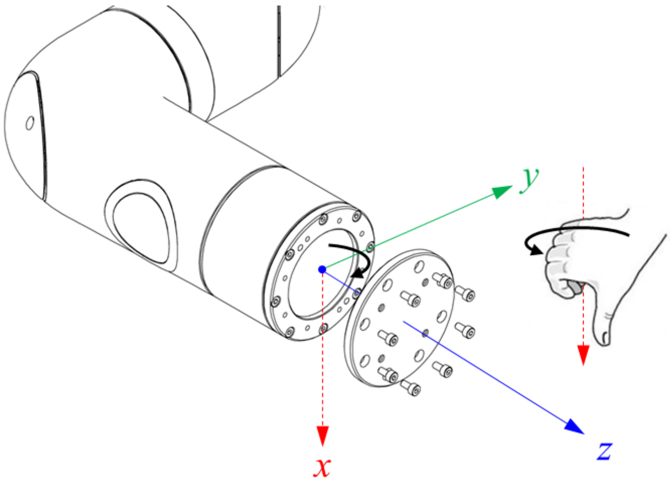
Note

For products released before Oct. 2018, the mounting information of the robot base is as follows. Note that all information in this manual is based on the time of creation, and all information provided in this manual is subject to change without notice. Always check the website https://www.neuromeka.com/ for the latest information.



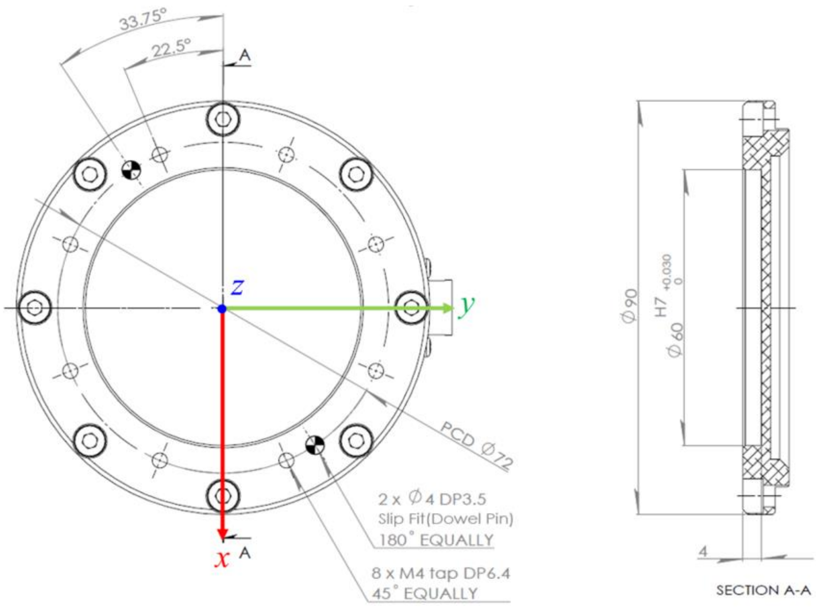
Mounting Tool

Use eight M4 bolts to secure the tools such as the standard grippers or any flanges to attach some tools to the endtool flange of the robot. It is recommended to tighten the bolts with a torque of 4.1 Nm.



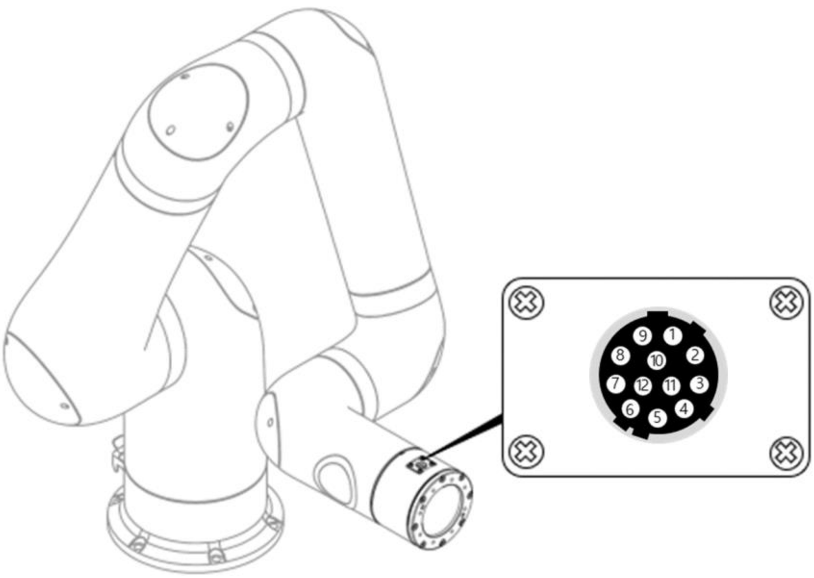
The position of the robot is defined by the distance and orientation of the tool coordinate frame, simply called tool frame, relative to the reference frame. The origin of the default tool frame is the point where the end of the endtool flange meets the sixth joint axis. The direction emanating from the origin to the endtool port defines the Y axis, and the Z axis is defined by the perpendicular direction to the endtool flange surface. The X axis is automatically determined by the right-hand rule. If you want to reflect the change of the attached tool to the change of the tool center point and the tool frame, you must reset the tool frame. Refer to **Section 6.1 Robot Settings** for setting tool center point.

Mounting information for attaching to the endtool flange is as follows.



Endtool Port

It is the auxiliary interface for signal input/output to operate tools. The end tool port is equipped with 24V DC and 5V DC power supply, and CAN communication, serial communication, EtherCAT communication interface are provided as well as NPN type digital output.



The signal lines according to each pin number are as follows.

Pin	Signal
①	Digital Output (NPN)
②	CAN High
③	CAN Low
④	RS485+
⑤	RS485-
⑥	EtherCAT Rx+
⑦	EtherCAT Rx-
⑧	EtherCAT Tx+
⑨	EtherCAT Tx-
⑩	+24V DC
⑪	+5V DC
⑫	GND

The cables necessary for connection to the endtool port are included if you purchase an additional component such as grippers or six-axis FT sensor. If you need an endtool port connection cable separately, please contact our sales representative.

Caution

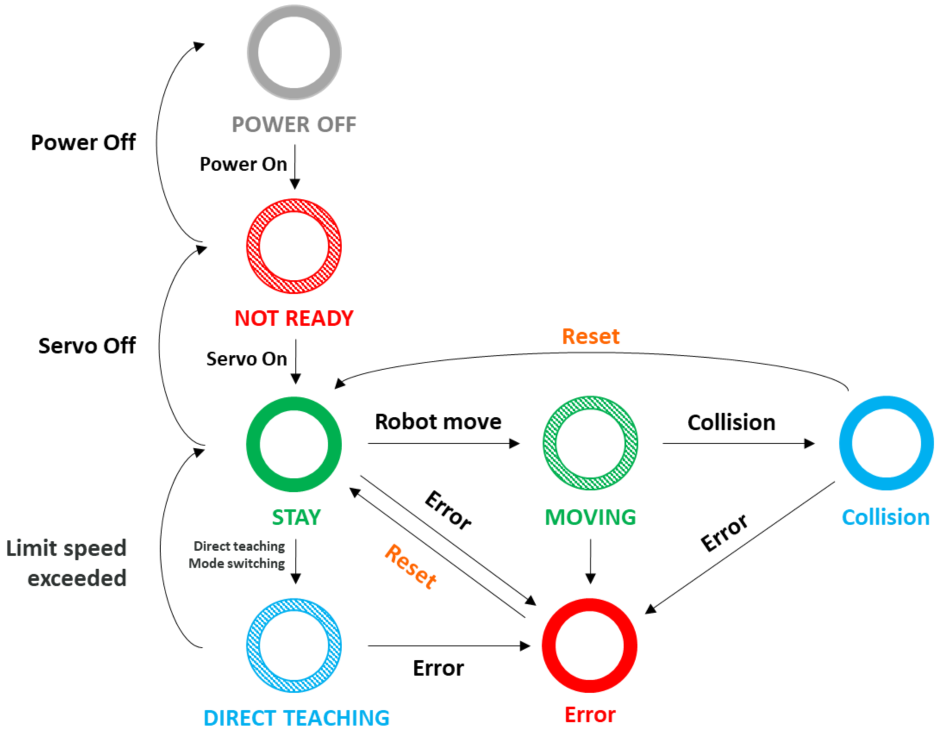
The manufacturer is not responsible for problems caused in the endtool port by using cables not supplied by Neuromeka. Be sure to use the standard products.

Endtool Indicator

The fifth link has the endtool indicator to inform the robot user of robot status or operation mode. The endtool indicator indicates each mode in terms of three colors and two actions, e.g. lighting-on and flashing, the meanings of which are as follows.

Color (Action)	Description
Green (Solid)	Ready
Green (Blinking)	Moving
Blue (Solid)	Collision
Blue (Blinking)	Direct teaching
Red (Solid)	Error
Red (Blinking)	Not ready (Booting or servo off)

Furthermore, the state transition in each mode is made according to the following rules.

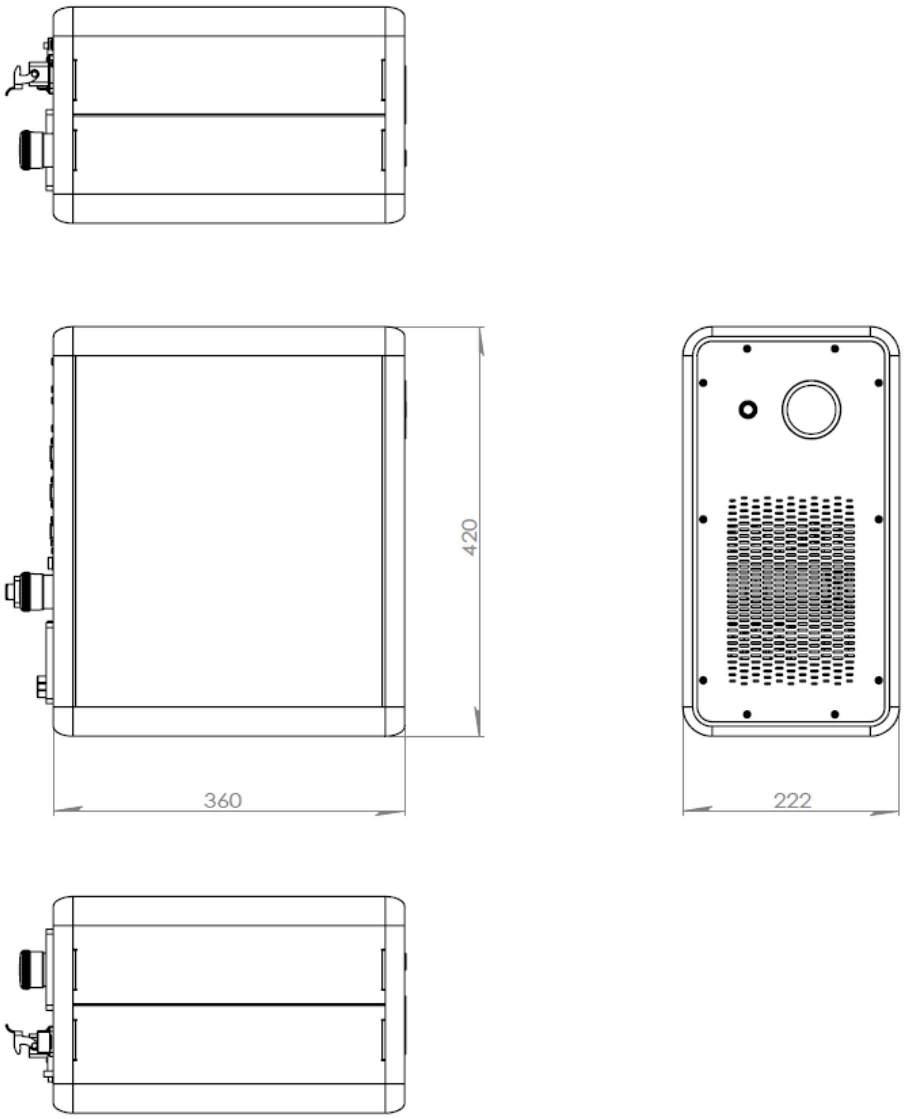


3.2 Control Box

The control box provides power to the robot, calculates all the control signals required for robot operation, and transfers them to the motor drivers, as well as processes all inputs and output signals through electrical connections to various peripherals. It can also turn off the power in case of emergency.

Mechanical Specifications

The mechanical specification of the control box is as follows.



Item	Specification
Size	Length 420 x Width 360 x Height 222 mm
Weight	15.5 kg
Color	White
Case material	Stainless Steel, Alloy and other

Electrical Specification

The electrical specification of the control box is as follows.

Categry	Item	Description
Power	Maximum Power	1,000 W
	Output	48VDC, 24VDC
Input	Input Range	100 - 240 VAC (Operating), 115/230 VAC (Nominal)
	Frequency	47 - 440 Hz, Nominal 50/60
	Input fusing	Internal 30 A fuses, both lines fused
	Input current	18A RMS max input current, at 100 Vac
Output	Output	48VDC / 30A, 24VDC / 1A
	Total regulation range	Main output ± 2%
	Power consumption	700 Wmax in Indy7
	Output noise (PARD)	1% max p-p, 50 mV max p-p
Environment	Operating temperature	-40 °C to +70 °C (Linear derating to 50% from 50 °C to 70 °C)
	Storage temperature	-40 °C to +85 °C
	Humidity	10 to 90% (Non-condensing, operating)

Cable Specification

There are three types of cables connected to the control box, and their specifications are as follows.

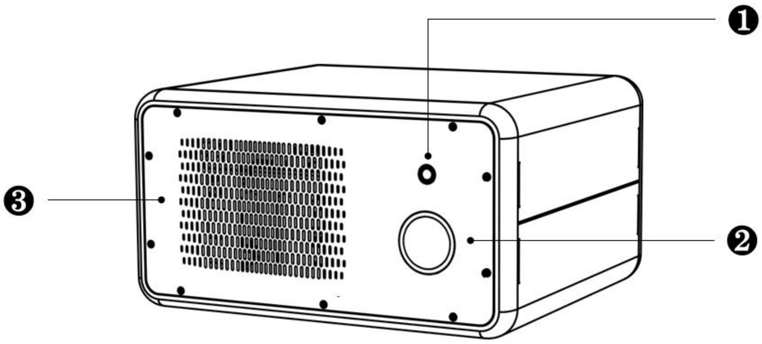
❶

❷

❸

No.	Name	Cable length	Specification
❶	Power cable	5M	AC 100~240 VAC, 50~60 Hz
❷	Robot communication cable	5M	DC power and Ethercat
❸	Emergency stop cable	5M	Double wiring method

Front Detail



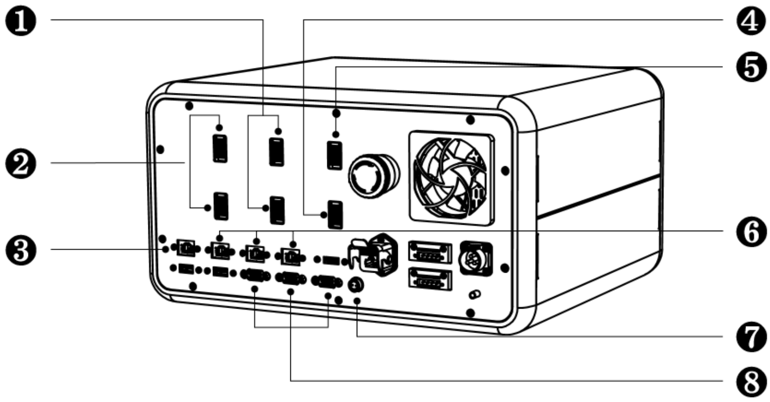
No.	Name	Description
❶	power switch	It turns all the power on and off. (The pressed state is the power-on state.)
❷	power indicator	It lights up blue when the power is on.
❸	air inlet hole	This is where the outside air is sucked in for cooling inside the control box. For smooth air circulation, be careful not to block the air inlet hole during installation.

Caution

Caution

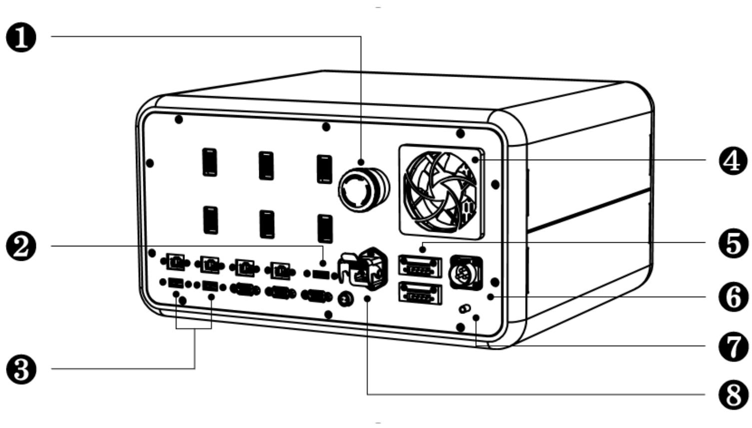
To ensure smooth air intake into the control box, periodical maintenance is required to prevent dust from getting into the air intake. Contact the manufacturer for cleaning and maintenance of the air inlet hole.

Rear Detail 1



No.	Name	Description
❶	24V digital outputs	It consists of two terminal blocks in total, providing ten ports for each block. The bottom left and right port of the upper terminal block are used for supplying external power to the internal 24V power supply and digital I/O board, and the bottom left and right ports of the lower terminal block are for the common power supply 24V and GND. The remaining 16 channels are all 24V digital outputs. Refer to Section **4.3 Connecting Tools and Peripherals** for detailed connection and use.
❷	24V digital inputs	It consists of two terminal blocks in total, providing ten ports for each block. The bottom left and right port of the upper terminal block are for GND for internal power supply and GND for external power supply to the digital I/O board, and the bottom left and right of the lower terminal block are for common power supply 24V and GND. The remaining 16 channels are all 24V digital inputs. Refer to Section **4.3 Connecting Tools and Peripherals** for detailed connection and use.
❸	EtherCAT port	This terminal is for EtherCAT communication. You can purchase the internal EtherCAT hub separately in order to activate this port. For information on purchasing an EtherCAT Hub, contact your local sales representative.
❹	Analog inputs and outputs	It is a terminal for analog input/output between 0 and 10V, and for RS485 communication.
❺	5V digital input/output	It provides digital input and digital output, each of four channels and of 5V range. The bottom left and right of the terminal block are 5V common power supply and GND. The 5V power supply uses internal power.
❻	Ethernet ports	It provides three ports for Ethernet communication.
❼	24V DC power	It supplies 24V DC power.
❽	Comm. terminal	It is a terminal for RS232, RS485, and CAN communication.

Rear Detail 2



No.	Name	Description
❶	Emergency stop button	It powers off the robot.
❷	HDMI port	This is for connecting a monitor to the control box. The monitor can be used for setting the static IP, monitoring of the status of the control box, and so on.
❸	USB ports	It is a terminal for connection with Conty tablet. It is also used to connect a mouse or an external storage device to the control box.
❹	Air outlet hole	Heated air inside of the control box is cooled by blowing out using a fan. For smooth air circulation, be careful not to block the air outlet hole when installing.
❺	Emergency stop cable terminal	It is the socket for connecting the emergency stop cable.
❻	AC power supply socket	It is the socket for connecting the AC power cable.
❼	PE terminal	It is a grounding terminal to protect the human operator from electric shock.
❽	Robot communication cable terminal	It is the socket for connecting the robot communication cable.

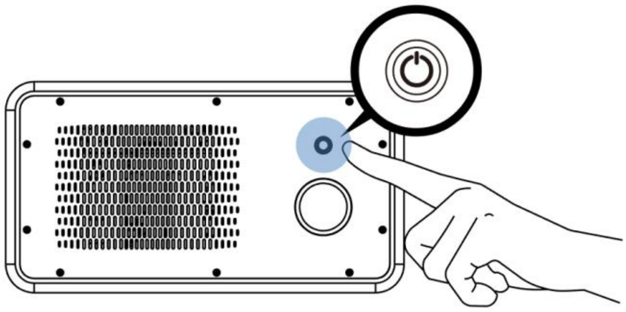
4 Getting Started and Connecting Peripherals

4.1 Getting Started

This section explains preparation procedures to the actual operation of the robot after installation.

Power On

Press the power switch located on the front panel of the control box.



When the power is turned on normally, the power indicator on the front panel of the control box lights up blue.

[Power Off]

[Power On]

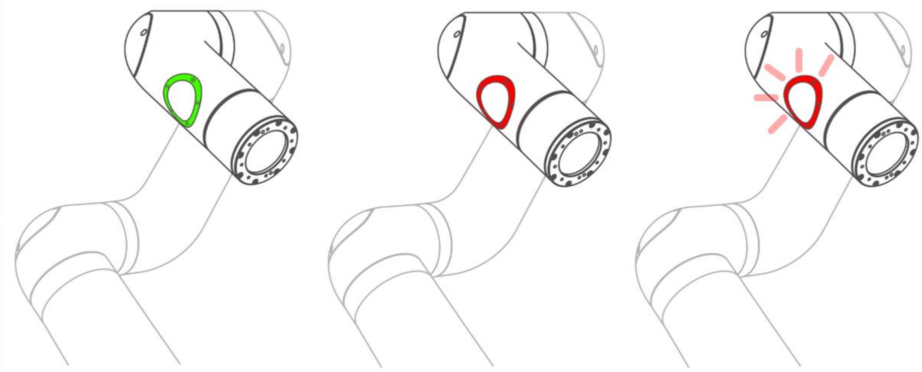
Warning

The power switch being pressed again when the power is on results in immediate turning off the control box and the robot. Do not turn off the power while the robot is in operation, except in an emergency cases, because unexpected power off may cause damage to the product.

Caution

If the power does not turn on even if you press the power switch, make sure that the power cable is properly connected to the power socket. If there is no abnormality, check the emergency stop button located in the back panel of the control box and the other emergency stop button connected to the emergency stop cable, because the emergency stop button may be pressed. If any of the emergency stop buttons is pressed, refer to Section **1.9 Emergency stop** for releasing them. If the power still does not turn on even after checking all the settings, contact the manufacturer.

When the control box is powered on, the system will start booting automatically. The boot process takes about two to three minutes. When all the boot process is completed normally, the endtool indicator lights up red or green according to the startup mode setting. Refer to **Section 6.1 Robot Settings** for a detailed description of the startup mode setting.



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Caution

If the endtool indicator does not turn on or if it continues to flash red, turn the control box off and then turn it on again. If the same problem persists after turning it on again, turn off the control box and contact the manufacturer.

Start Screen

Upon running the Conty application installed on your Conty tablet, the following start screen appears.

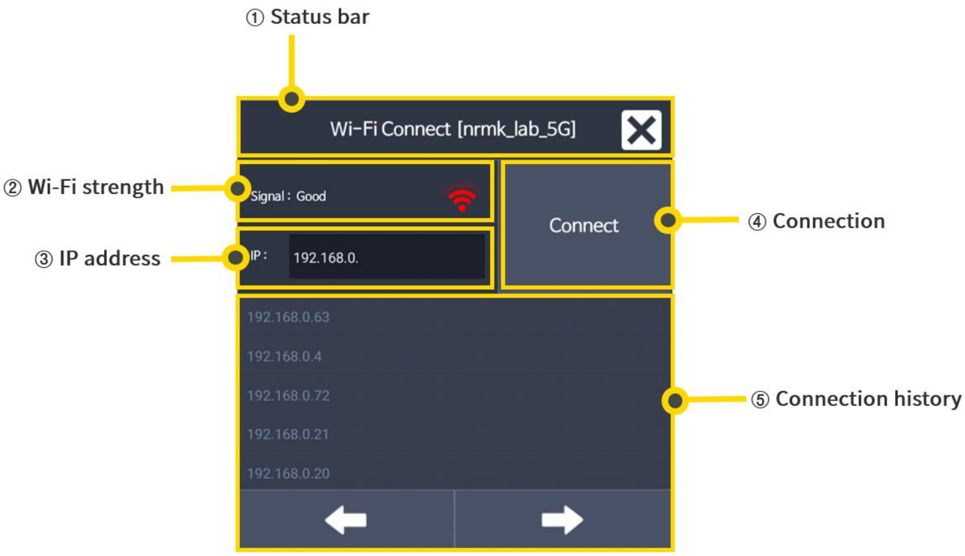
The start screen provides three modes for using Conty depending on the connection environment between the control box and the tablet.

- **Local Connect**

  Conty is used alone without connection with the robot. Conty has a built-in simulator that allows you to simulate a simple teaching with a virtual robot. However, only some functions are available as the robot is not real.

- **Wi-Fi Connect**

  Conty is used in an environment with wireless network. When you touch Wi-Fi connect on the start screen, the following pop-up window will be displayed. After entering the IP address of the control box and touching connection, you will be connected to the robot.



The pop-up window provides the following functions.

① **Status bar**
It displays the information on the network currently connected.

② **Wi-Fi strength**
The signal strength of the network currently connected is displayed in five levels. The stronger the Wi-Fi intensity, the more antennas it shows.

③ **IP address**
You can enter the IP address of the control box you want to connect.

④ **Connection**
It tries to establish communication to the control box with the IP address you entered. Upon successful connection the home screen is displayed.

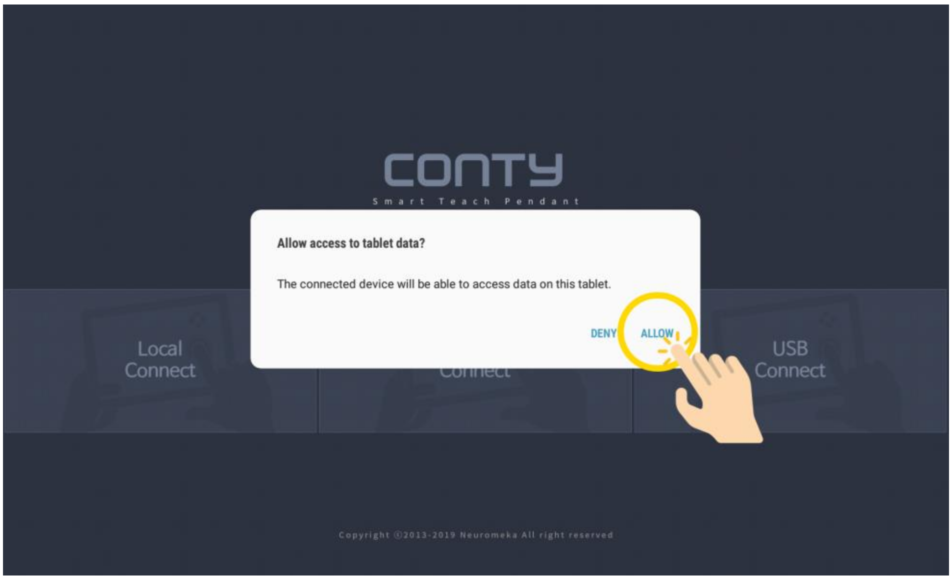
⑤ **Connection history**
A history of the past IP addresses is shown. When you select an IP address from the list, it is automatically entered into the IP address.

Caution

The worse the Wi-Fi connection is, the worse the robot operation on the Conty is because the operation is not smooth or the connection with the robot can be disconnected automatically. Thus, it is strongly recommended to use this mode in an environment where the wireless network signal is stable.

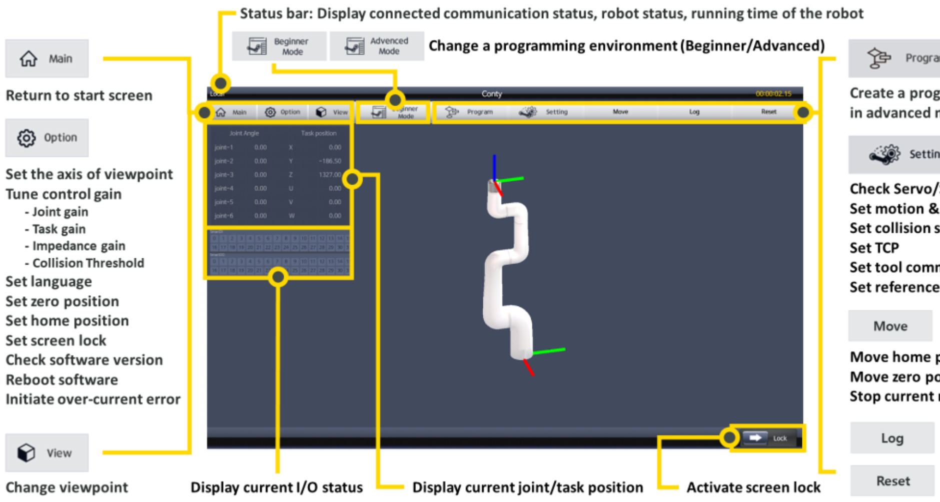
- **USB Connect**

  In environments where wireless networking is not stable nor available, use a USB cable to connect the Conty tablet to the control box of the robot. Upon connecting the USB cable between the tablet and the control box while Conty is running, the following message is displayed. Touch **Allow** and touch USB mode on the start screen to connect with robot.



Home Screen

When the connection to the robot is completed normally either by running Local mode, Wi-Fi mode or USB mode on the start screen, the home screen will appear as shown below. The home screen displays various status information on the robot in many windows and provides menus necessary for setting and operation of the robot in the top menu bar.



- **Status bar**

  It displays various statuses of the robot. The status bar at the top of the screen shows the status of the currently connected communication and the robot, as well as the running time of the robot, all in real time. On the left side of the home screen are the current joint angles of the robot and the position and the orientation of the tool frame displayed, while just below these the digital I/O status of the control box is displayed in real time. In the center of the screen the current position of the robot is rendered as a three-dimensional model.

- **Menu**

  A total of nine menus are available via the menu bar at the top.

  ① **Main**

  It returns to the start screen.

  ② **Option**

  Conty-related settings and those for the manufacturer's service engineers are accessed in this menu. Refer to **Section 6.2 Options** for more information.

  ③ **View**

  The viewpoint of the 3D viewer in Conty rendering can be changed.

④ **Beginner / Advanced mode**

You can choose a programming environment depending on your proficiency.

⑤ **Program**

You can create a program in Expert mode. See **Chapter 5 Programming** for details.

⑥ **Setting**

It provides settings related to robot operation and signal input/output before operating the robot. Refer to **Section 6.1 Robot Settings** for details.

⑦ **Move**

It moves the robot to pre-defined positions. They include the home position and the zero position. Refer to **Section 6.2 Options** for more information on the home position setting.

⑧ **Log**

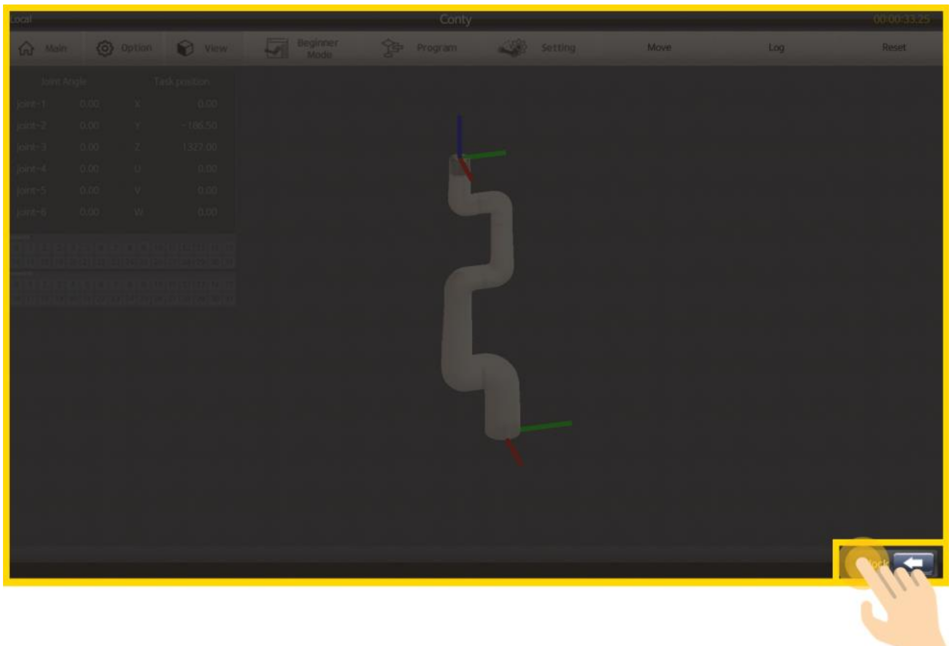
It provides a history of all event messages that occurred during use. For details on how to check the log, refer to **Section 7.3 Recovery**.

⑨ **Reset**

This is a procedural function to return the abnormal state of the robot to the normal state when the robot is stopped due to some safety function. It operates only in abnormal state. For details on the reset function, refer to **Section 7.3 Recover**.

- **Screen Lock**

  It is a function to prevent the robot from malfunctioning due to unintended user input. If you touch the arrow and slide it to the right, the screen locks and Conty does not respond to any touches. To unlock the screen, move the arrow in the opposite direction.

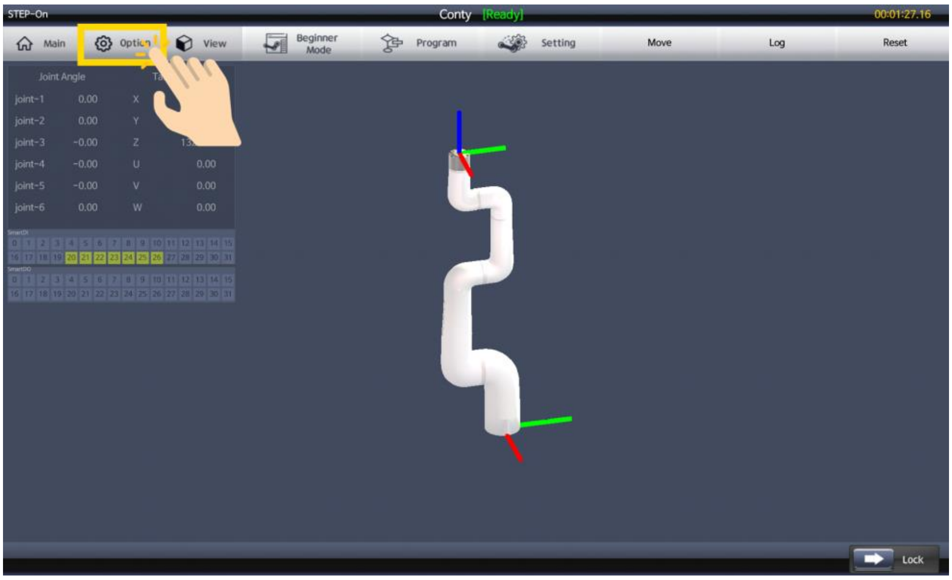


Language Setting

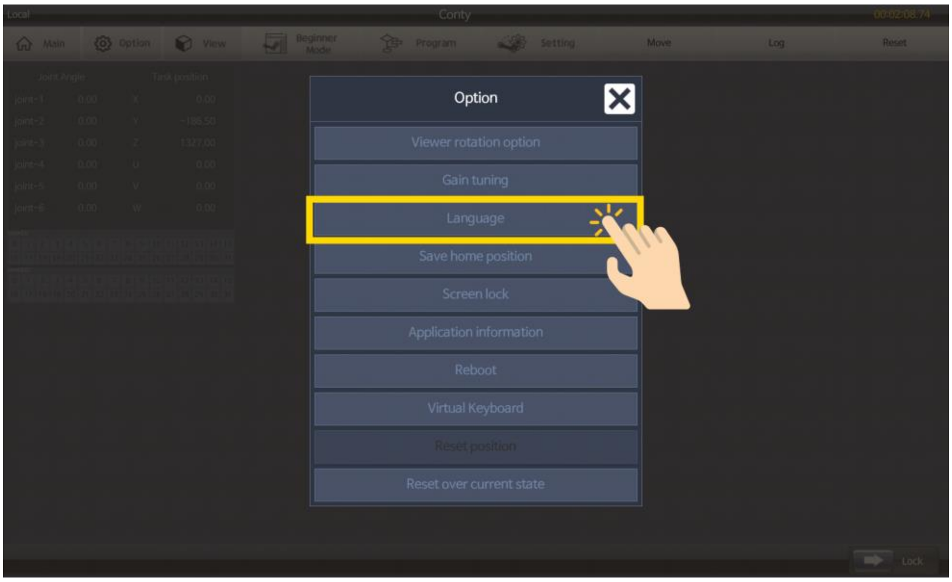
The first time you run Conty, the default language is English. The language can be altered to the language appropriate for your country for proper use of the product. We currently support three languages: Korean, English and Chinese.

Here we change the language setting from English to Korean for example.

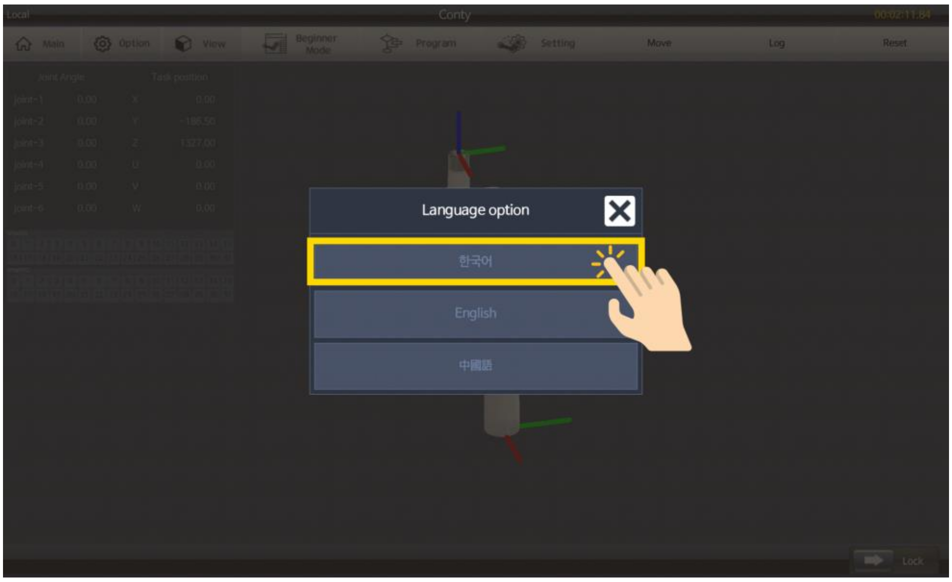
① Touch **Option** in the menu bar at the top of home screen.



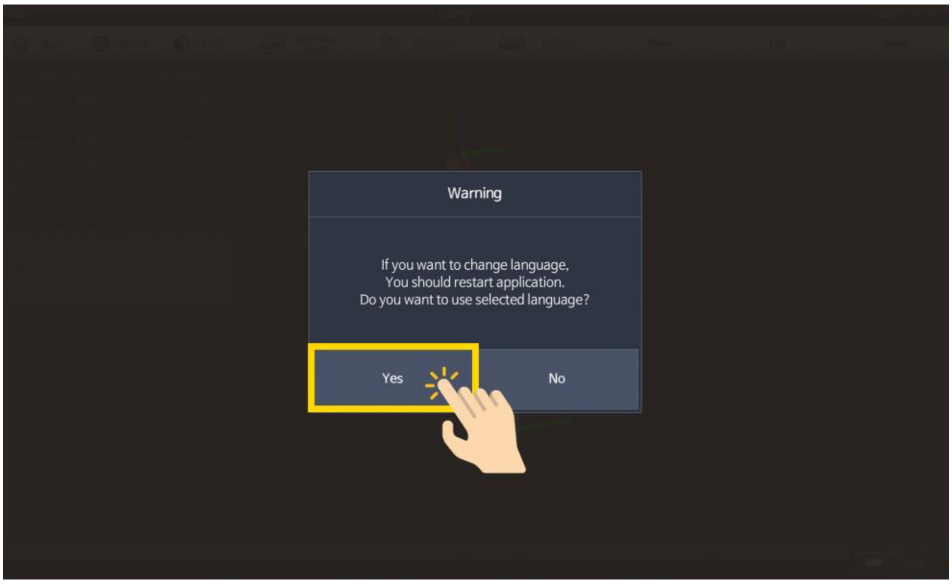
② Touch **Language** in the list of options.



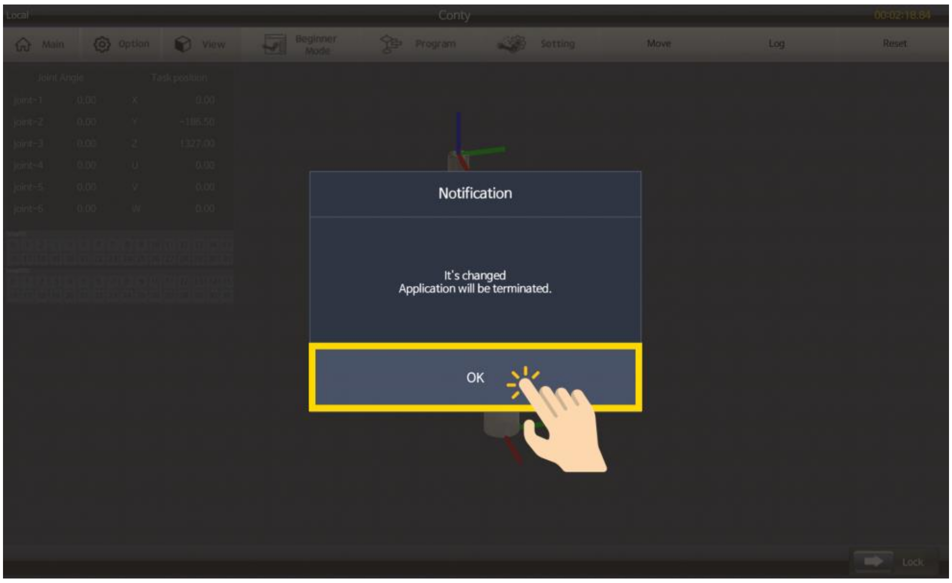
③ Touch one of the following languages of your preference.



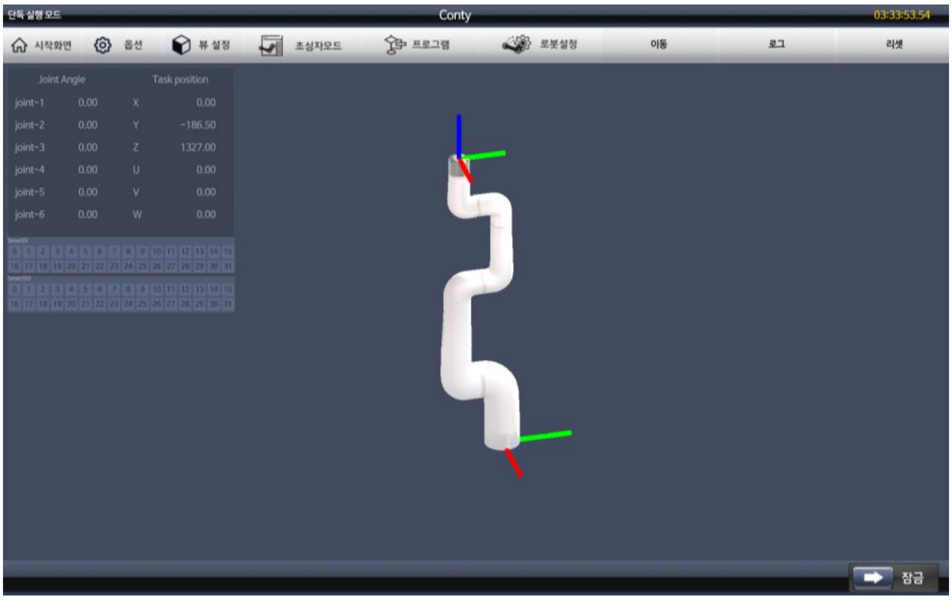
④ You must restart the application to use the selected language. When the warning message "**Do you want to use selected language?**" is displayed, touch **Yes**.



⑤ On the message "**It's changed. Application will be terminated.**", touch **OK** to finish Conty. Restart it.



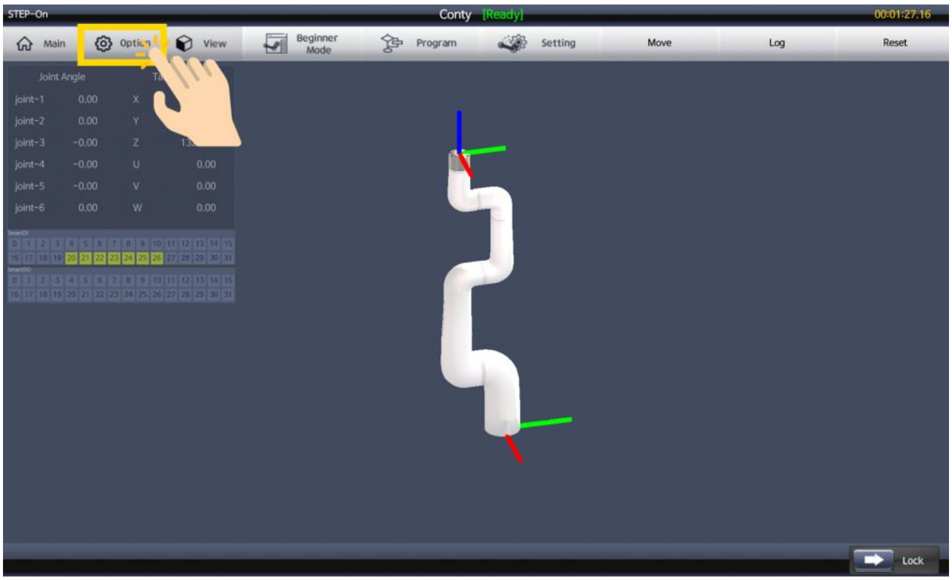
⑥ If you run Conty again, the language will change as shown below:



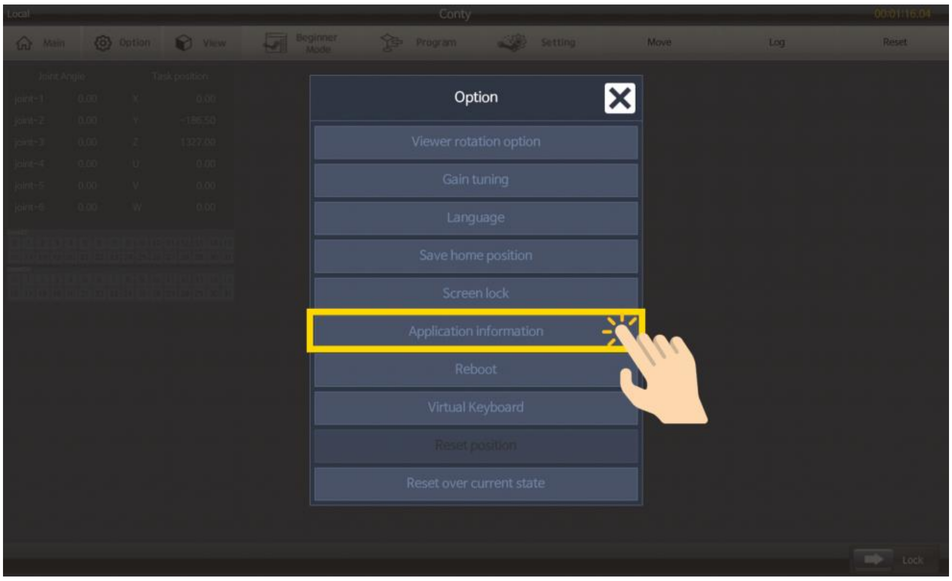
Check Software Information

You must use the latest software to use the Neuromeka product with the latest features and the best performance. Users should check the software information after receiving the product.

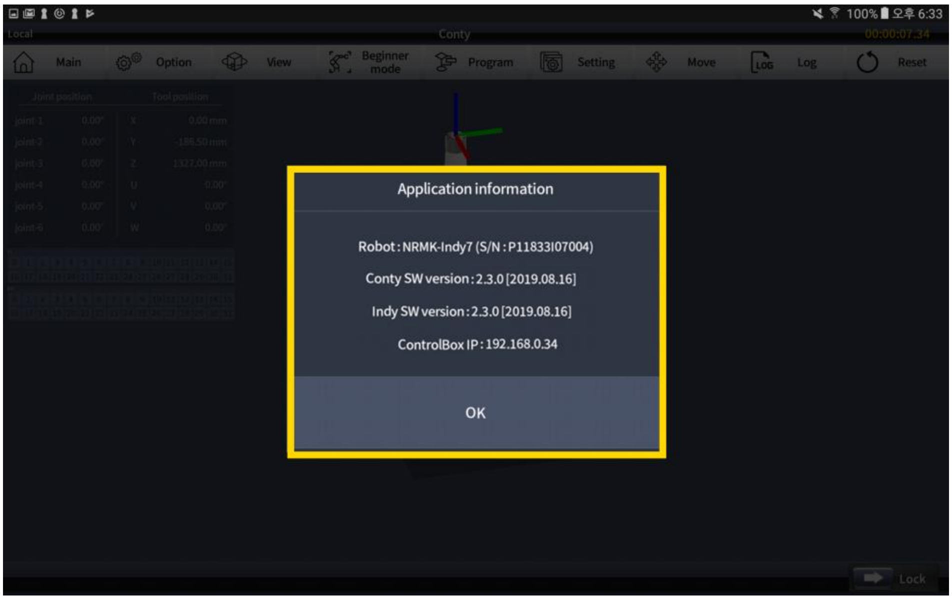
① Touch **Option** in the menu bar at the top of the home screen.



② Touch **Application Information** in the list of options.



③ The software information is displayed along with the model name of the product you are using, as follows:



Caution

Caution

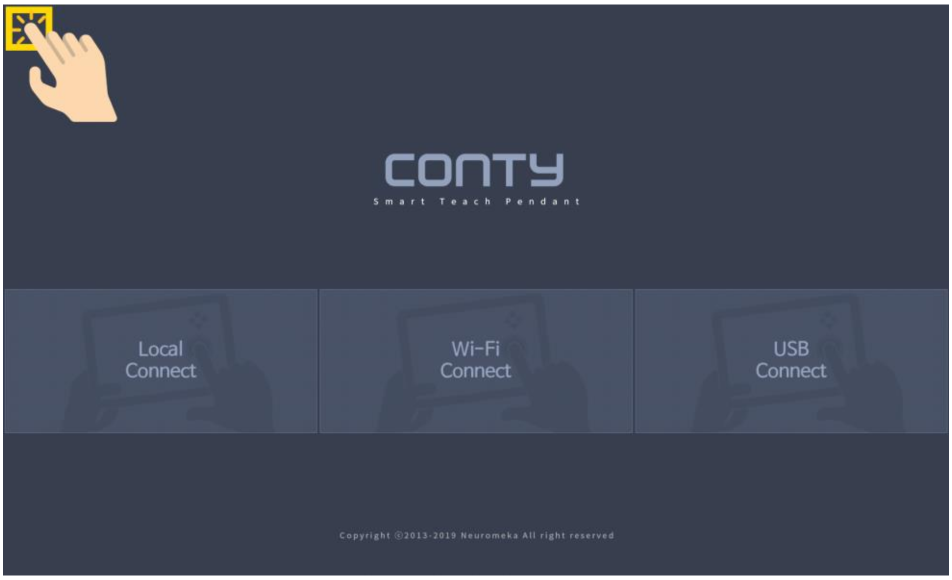
In order for the robot to run normally, the Conty application and the control box software version must match. If the version is different, there is a possibility of malfunction. Please update the software as follows.

Software Update

The information on the latest software can be found on the Neuromeka website (https://www.neuromeka.com/). If the version of the installed software is older than the latest version, please update using Conty. First of all, be sure to install the latest version of Conty before updating to the latest software. Contact the manufacturer for the latest version of Conty. The following steps describe the procedure to update to the latest software using Conty, assuming that Conty is already latest version.

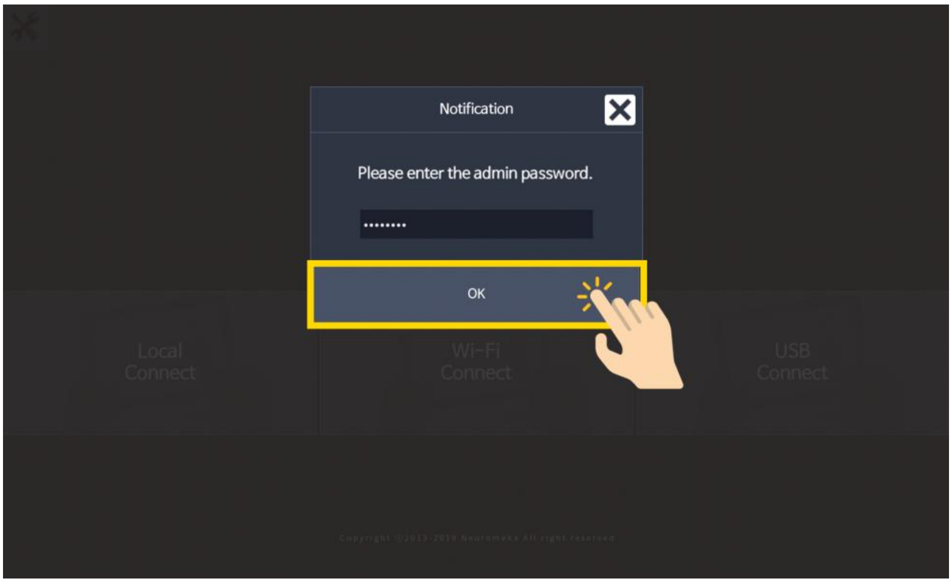
① Stops all work in progress.

② Touch the left corner five times in the start screen as follows.

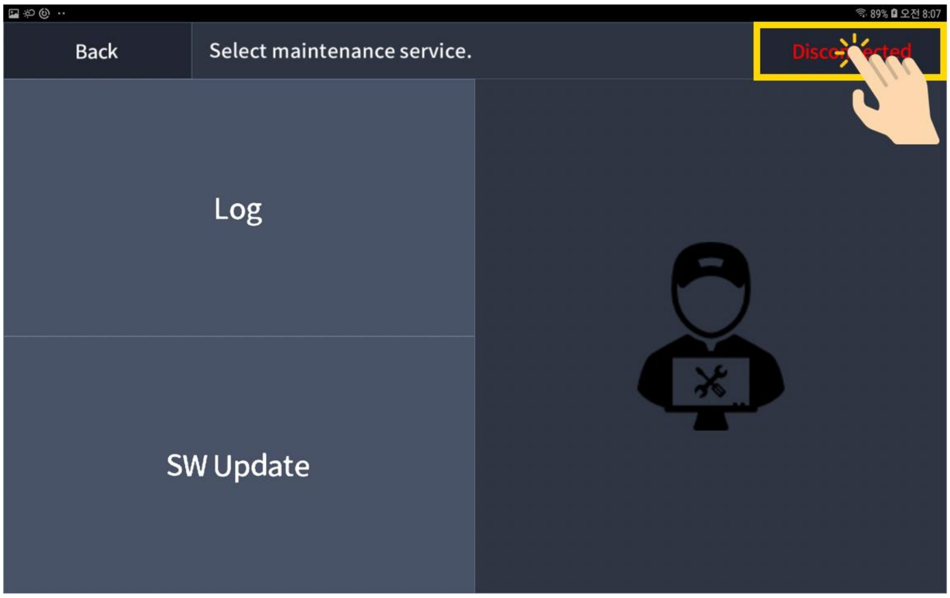


③ The instant message "**Maintenance mode is enabled.**" will display together with the administrator mode button activated at the corner you touched.

④ If you touch the administrator mode button, you will see a notification saying "**Please enter the admin password.**". The password is the one given when the robot is purchased. Enter the password and touch **OK**.



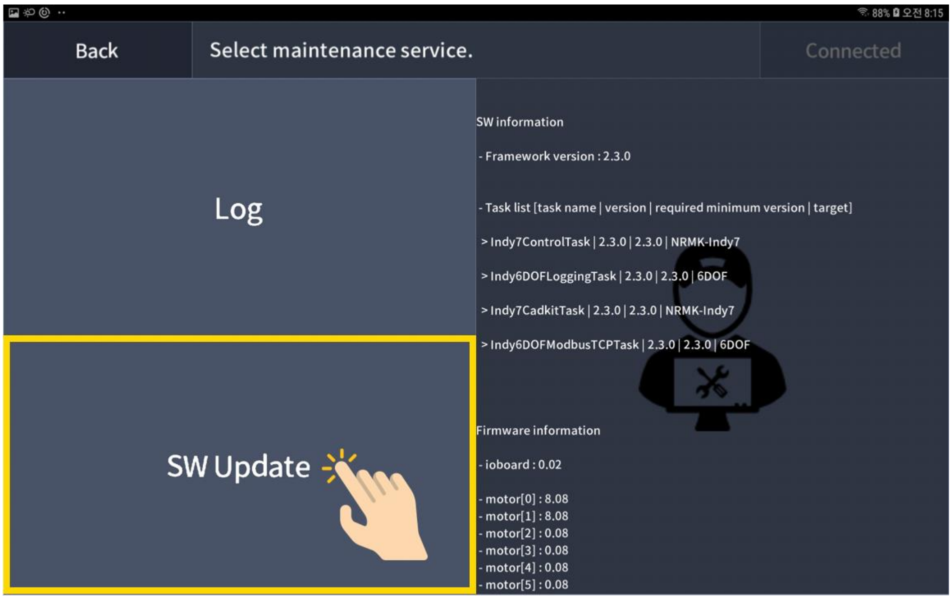
⑤ When the administrator authority is confirmed, the following maintenance screen appears. In order to execute software update, the tablet and the control box should be connected by a USB cable. After connecting the USB cable between the tablet and control box, touch on the button **Disconnected**. For how to connect a USB cable refer to **Sec. 2.4 Installation**.



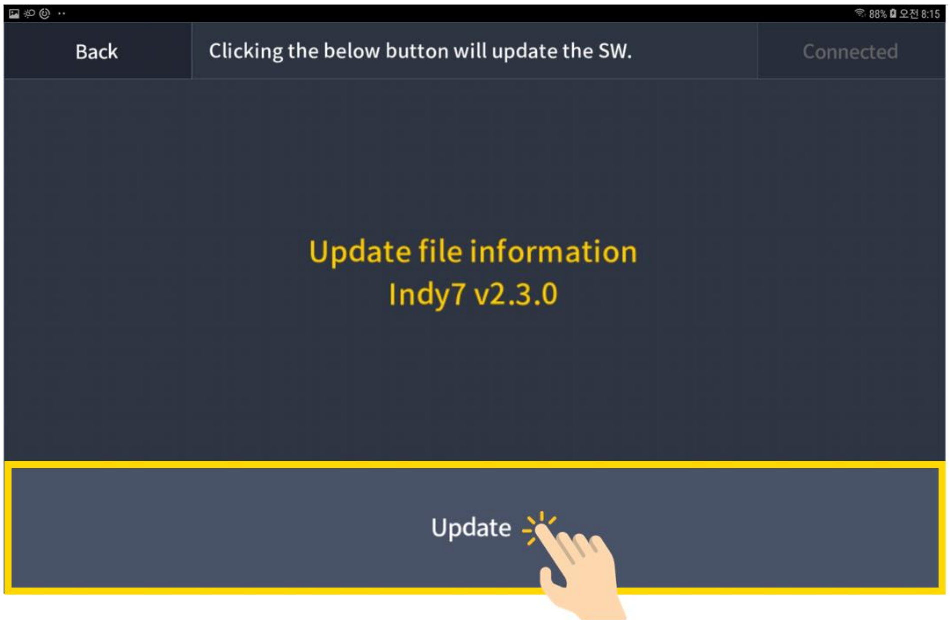
Caution

The settings in Administrator mode has profound effect on the sequel functions and the performance of the product. Therefore, the administrator password should not be shared. If you forget the administrator password, please contact the manufacturer.

⑥ After successful connection of Conty to the robot in USB mode the button in the top right corner changed to **Connected** and the information on versions of the installed software and the firmware in the right window. Touch **Software Update**.



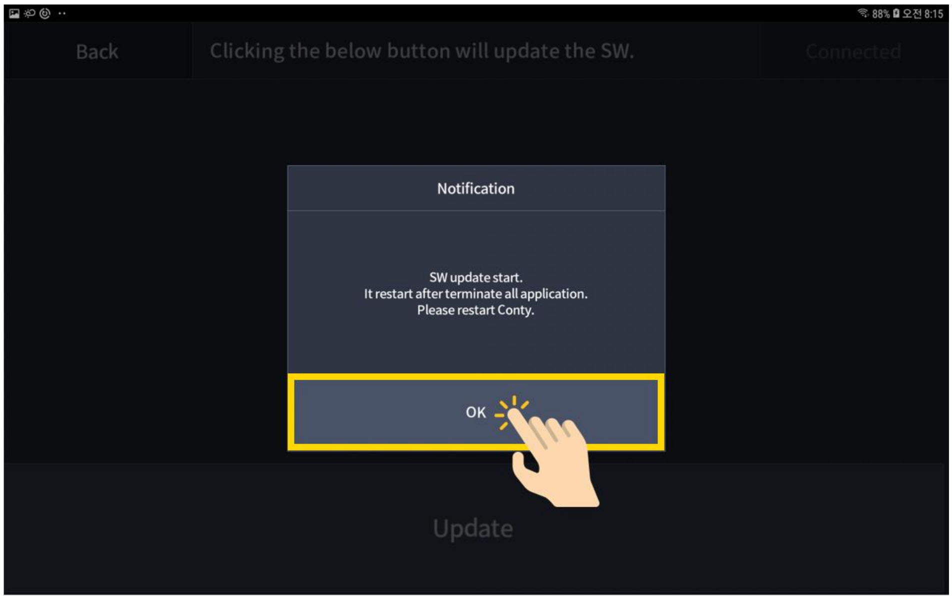
⑦ After confirming the information on the new version touch **Update**.



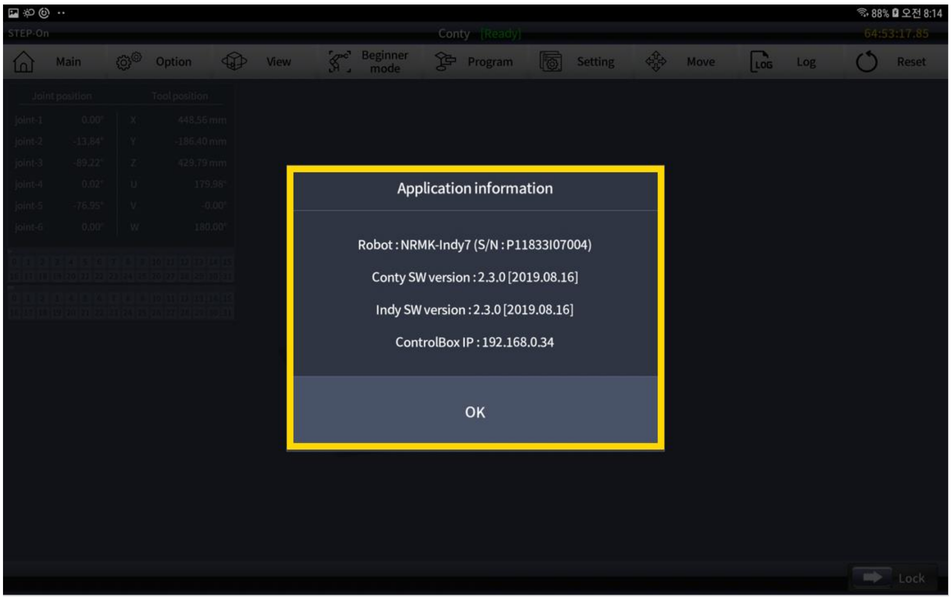
Warning

Never turn off the power during software update. If the power is turned off in the middle of update, the operation of the robot becomes impossible. If the power is turned off during the update and it is no longer possible to operate, contact the manufacturer.

⑧ The alarm message is displayed as follws. Upon touching **OK** all running applications are terminated, the power is off, and software update begins. It will take four to five minutes in average. Upon successful completion of software update the system will reboot automatically and the endtool indicator turns to red or green according to the startup mode. For startup mode see **Sec. 6.1 Robot Setting.**



⑨ To confirm that software has been updated properly check the software information. For detailed information on how to check software information see **Sec. 4.1 Getting Started**.



4.2 Basic Operations

This section describes how to operate the robot manually. When all preparation procedures have been completed, perform a simple check of robot operation using manual operation.

Operation Mode

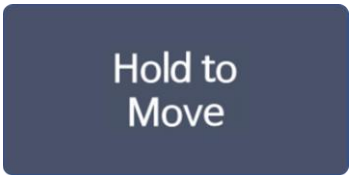
There are two operation modes: the first is the automatic mode in which the robot executes the specified operation automatically when the user command is transmitted, and the other is the manual mode in which the robot operates only while the button provided in Conty is continuously pressed.

- **Automatic mode**

  When the program created by Conty is executed or the command is executed by an external equipment such as PLC or PC, the robot performs the specified action. If the stop command is not taken explicitly, the robot will continue to operate until the specified action is completed.

- **Manual mode**

  Except for the automatic mode, all motion performs in the manual mode. In the manual mode, the robot operates only when the user keeps pushing the button of each function of Conty or when the user keeps applying the force to the robot in direct teaching. If the button is released or the user force applied to the robot disappears during operation, the robot will stop operation immediately. The buttons in the manual mode are marked as **Hold to Move** or **Direct teaching**.

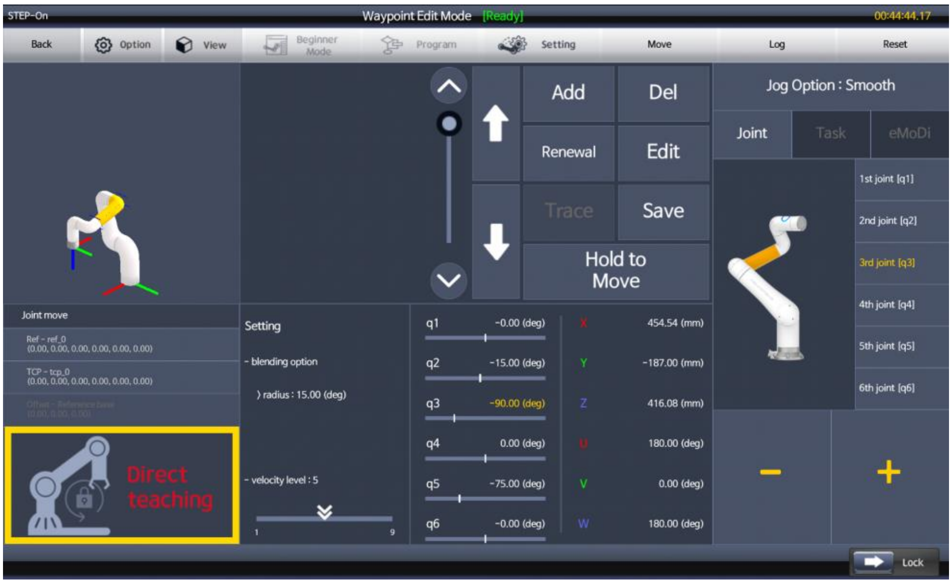


Danger

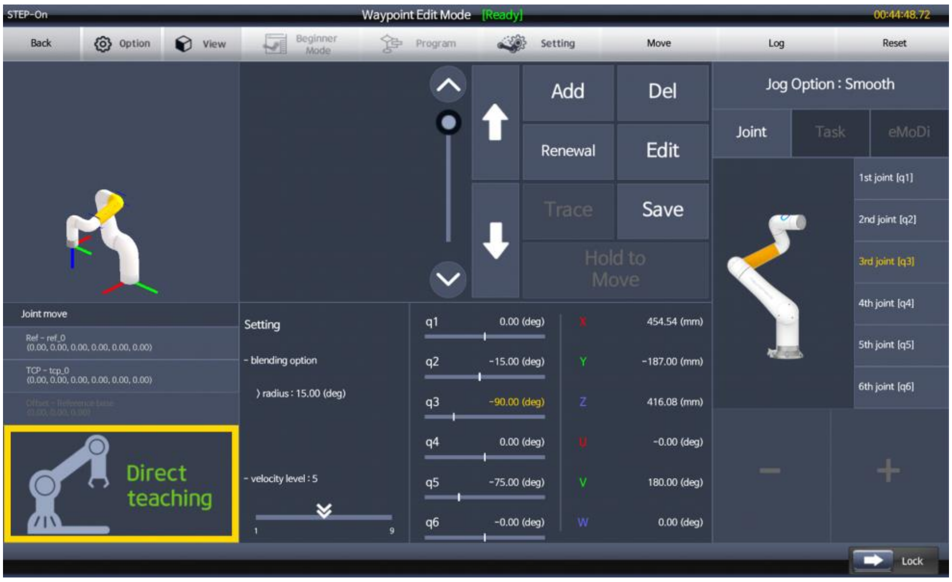
Do not turn off the collision detection function when you operate the robot in the automatic mode in a workspace shared with a person. Even if collision detection is activated, people should not approach the robot within the working radius if a sharp or dangerous tool is mounted on the robot. Even in other cases, the robot's operation should be assumed always dangerous. Be sure to perform a proper risk assessment before use by referring to the relevant regulations of international standards and national laws. For a detailed description of the risk assessment, see **Section 1.7 Risk Assessment**.

Direct Teaching

Direct teaching is a manual operation function in which the user applies force directly to each joint of the robot and moves the robot to the desired position. It is provided on all Conty screens that require robot motion.



If direct teaching button is indicated in red, direct teaching mode is deactivated. In this state, if you touch the direct teaching button, the mode changes to green and the direct teaching mode is activated. Touch again to turn it off.



With the direct teaching mode turned on, you can move the robot in the direction of the applied force by applying force to each joint of the robot. Try moving to the desired position.

Note

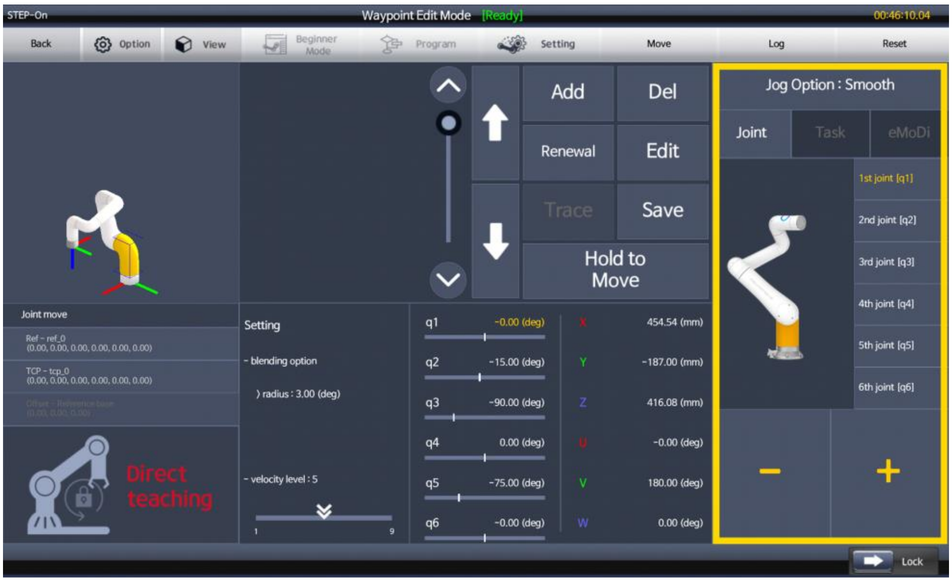
Note

When the direct teaching mode is on, all motion commands except direct teaching are ignored. When you finish using the direct teaching, turn off the direct teaching mode.

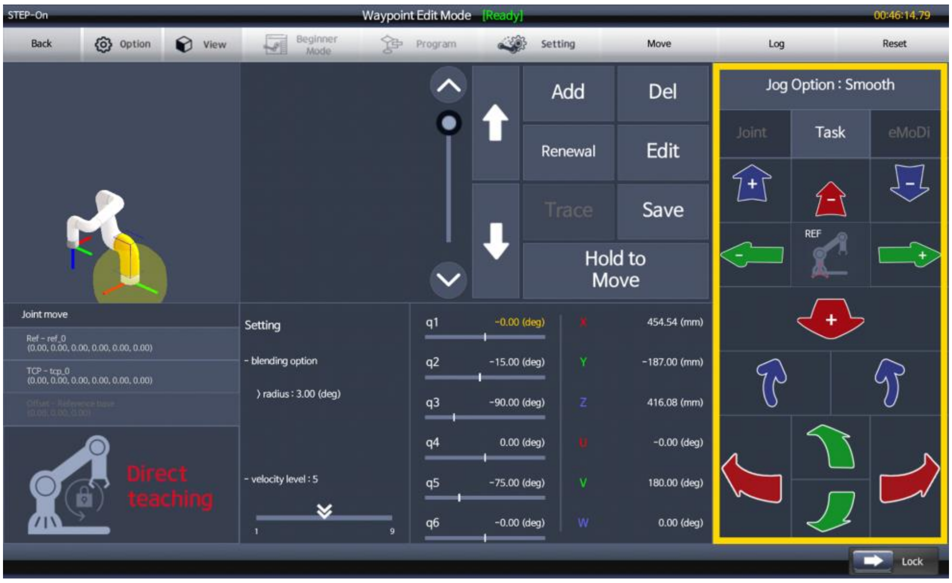
Jog

Jog is a manual operation function that moves the robot's joint or the tool frame at a constant speed or at regular intervals based on the user-defined coordinate system. It is provided on all Conty screens that require robot motion, and provides two methods according to how you want the robot to move.

Jog method based on joints.



Jog method based on the tool frame.



- **Joint space and task space**

  There are two spaces in describing the robot movements, that is the joint space and the task space. The joint space is a set of joint positions defined by the angles of joint rotation, whereas the task space is a set of position and orientation of the tool coordinate system defined with respect to the reference coordinate system in three-dimensional space. Therefore, the position required for the movement of the robot is expressed differently depending on the defined space.

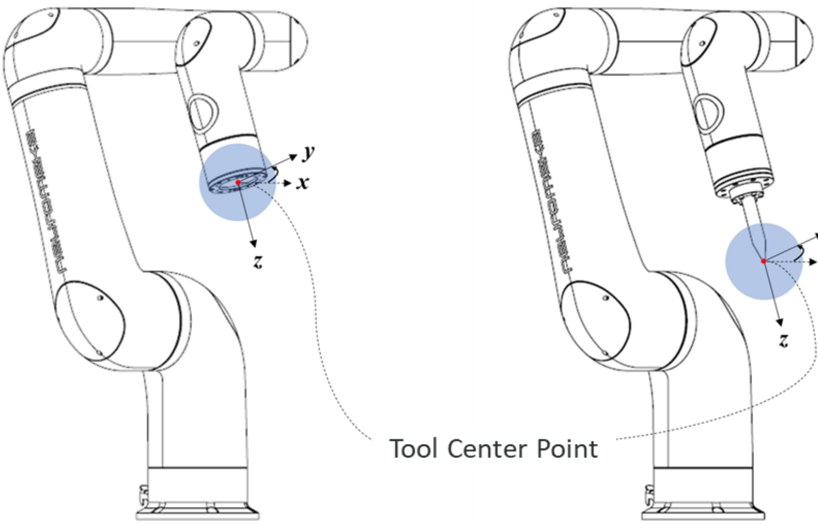
Caution

Caution

Every movement specified in the joint space is feasible in the whole workspace. On the other hand, some movement in the workspace is not possible in some portion of the task space due to singularities. Neuromeka robot stops its operation by the safety function when approaching a singularity or a singularity region in the task space. Refer to **Section 3.1 Robot Arm** for a description of the singularity and singularity regions.

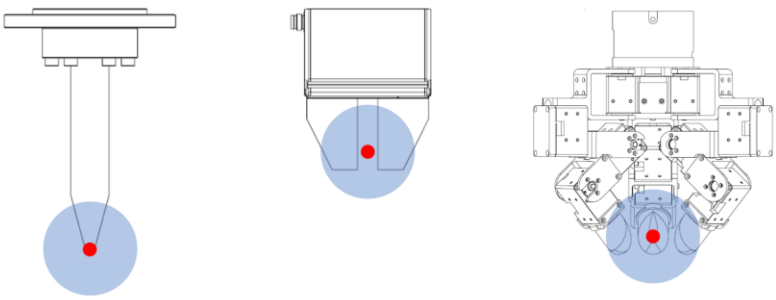
- **Tool Center Point (TCP)**

  The tool center point is an important entity that defines the position of the robot in the task space and it is the point of interaction between the tool attached to the endtool flange of the robot and the workpiece as follows.



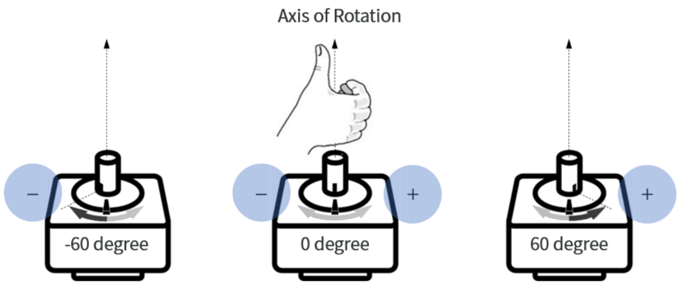
The default tool center point is located at the center point of the endtool flange surface. As a matter of fact, this tool center point is the origin of the default tool coordinate system. The default tool coordinate system has the Z axis perpendicular to the flange surface and the Y axis as the direction to the endtool connector. This coordinate system is also simply called the tool frame. A custom tool frame can be defined by the distance of the origin and the rotation of each axis with respect to the default tool frame. Note that a new tool coordinate system is necessary with a new tool.

The following are the tool center points for various tools. Refer to **Section 4.3 Connecting Tools and Peripheral Devices** for details on setting tool center points.

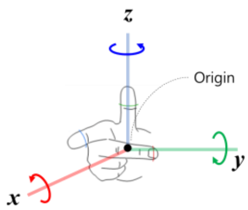


- **Coordinate system and position**

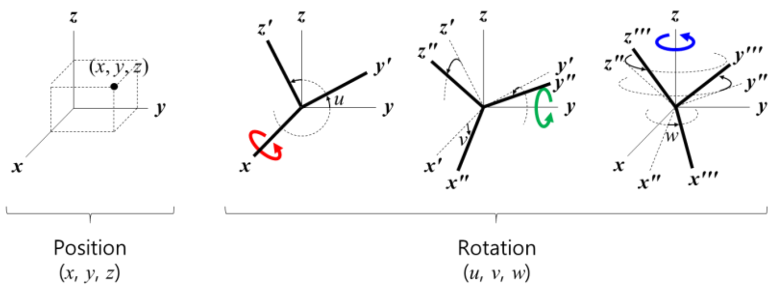
The coordinate in the joint space consists of all joint angles, which are defined by rotation angles about each joint axis with respect to the zero angle of each joint as follows. Therefore, the position of the robot in the joint space, denoted simply by the joint position, is expressed by the vector of the rotation angles of all joints based on this coordinate system. In this case, the direction of rotation is determined by the right-hand rule, and the counterclockwise rotation from the zero angle has positive value and the clockwise one is negative.



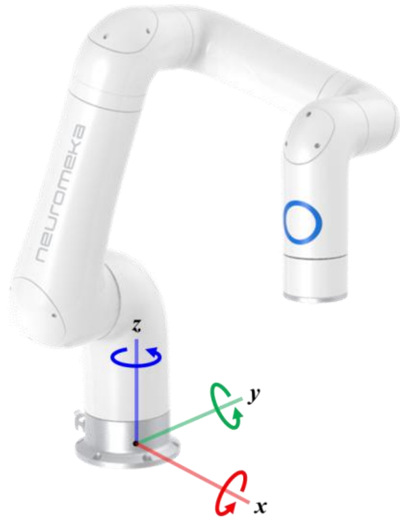
In general, the coordinate system in the task space is defined by three axes, called the X-, the Y-, and the Z-axis, respectively, that are mutually orthogonal to each other emanating from a point, called the origin, in three-dimensional space, Note that, the direction of each axis is determined by Euler's right-hand rule. Such a coordinate system is referred to as the Cartesian coordinate system.



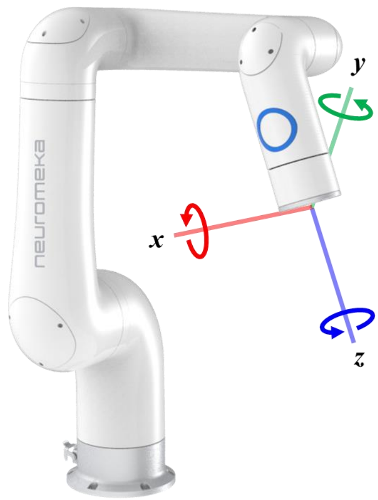
Therefore, the position of the robot in the task space is specified by the distance to the origin of the tool frame, or the tool center point, of the robot tool together with the rotation angle around each axis, with respect to the current reference Cartesian coordinate system in space. It is simply called the task position or tool position. At this time, the rotation angles are determined by three consecutive rotations necessary to align the reference frame to the tool frame, and it results in different numbers according to the order of rotation. Neuromeka robots follow the fixed XYZ convention, which is defined by the rotation order of the X, Y and Z axes fixed in the reference coordinate system.



Also, the movement of the robot in the task space is denoted differently according to the coordinate system selected by the user. That is, the user can define the movement of the robot by selecting the reference frame or the tool frame. In the former case, the current reference frame is used as a reference to represent the target tool position and this leads to a sort of absolute movement, as the reference frame is fixed in the task space regardless of robot motion and operations. The default reference frame is defined as follows: The center point of the robot base coincides with the origin, while the perpendicular direction to the robot mounting surface is defined as the Z axis and the direction opposite to the robot communication cable connector is defined as the X axis. Then, the Y-axis is automatically determined by Euler's right-hand rule.

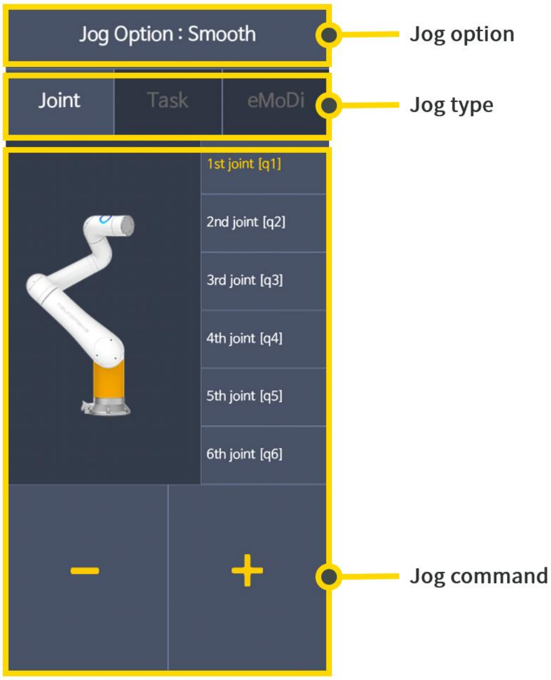


On the other hand, the current tool frame can be used as a reference to represent the task (or tool) movement of the robot. It can be said that this is describing task motion in a sort of relative manner, as the coordinate system is located at the tool center point moving with the robot. The tool frame can be newly set for each new tool. The default tool frame is the frame defined at the surface of the endtool flange as shown below. For details on how to set the new reference frame and the new tool frame, see **Section 6.2 Robot Options**.



- **Jog menu**

  Jog menu consists of jog option, jog type and jog command.



① **Jog option**

It is used to set various attributes for jog motion.

② **Jog type**

It chooses whether to move the robot in terms of the joint space position or the task space position. One can choose either the joint jog or the task jog.

③ **Jog command**

Depending on the selected jog type, different units are provided for jog movement. When the joint space is selected, the jog commands are displayed in joint coordinate units. When the task space is selected, they are displayed in cartesian coordinate units.

- **Jog option**

  There are two jog modes, i.e. smooth and interval. In the case of task jog type, one can select which frame is used as a reference to represent the task jog movement.

① **Smooth mode**

The robot moves at a constant speed only while touching the jog command. Therefore, in Smooth mode, the moving speed is set for each jog type, and the speed is applied in jogging.

② **Interval mode**

Each time you touch a jog command, the robot moves at regular intervals. Therefore, in the Interval mode, the movement interval is set for each jog type.

- **Joint jog**

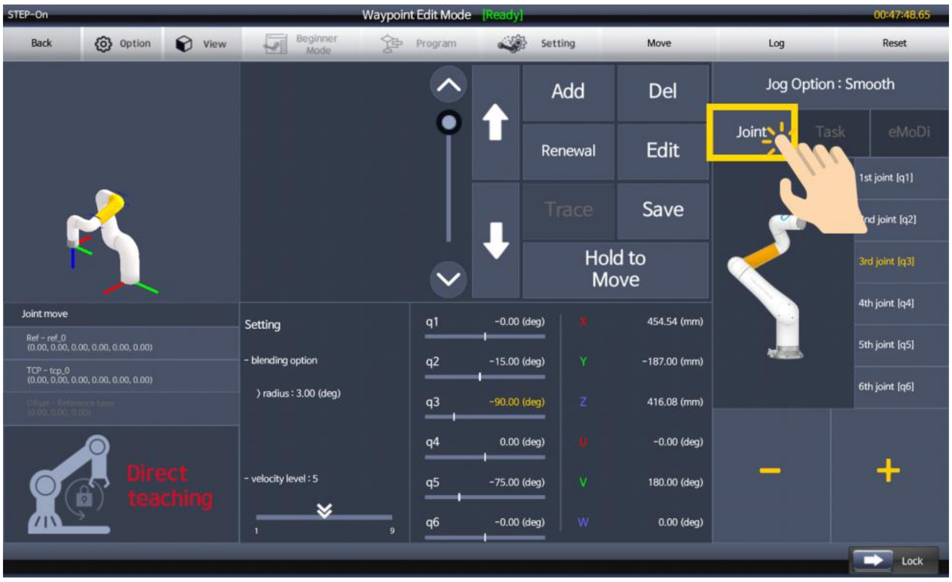
  It moves each joint of the robot.

Depending on the jog mode selected in the jog option, it moves joints either at the preset constant speed while touching, or by the preset interval at each touch. Joint jog moves the robot in the joint space so it can move in every workspace point.

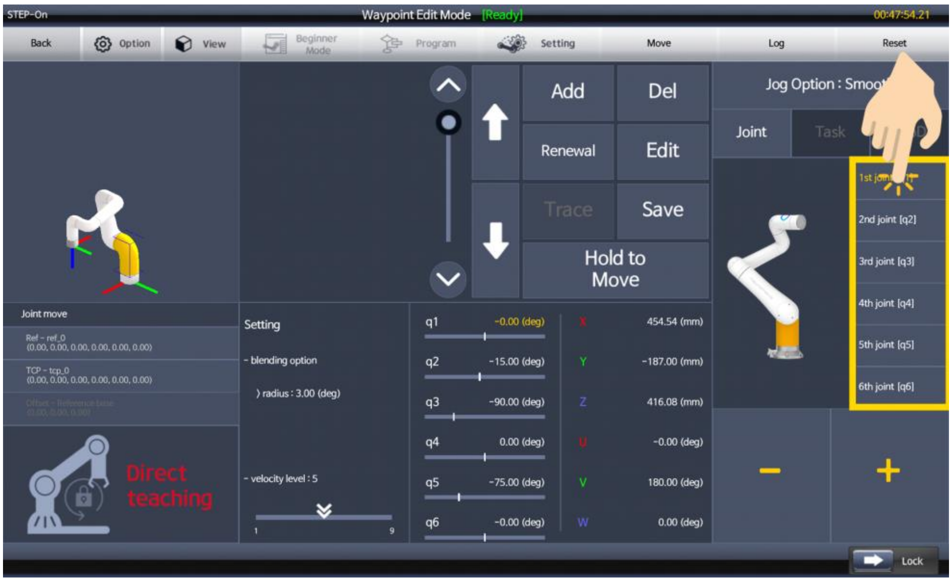
The following describes how to use joint jog:

① Set the jog mode and the related jog parameters in the jog options.

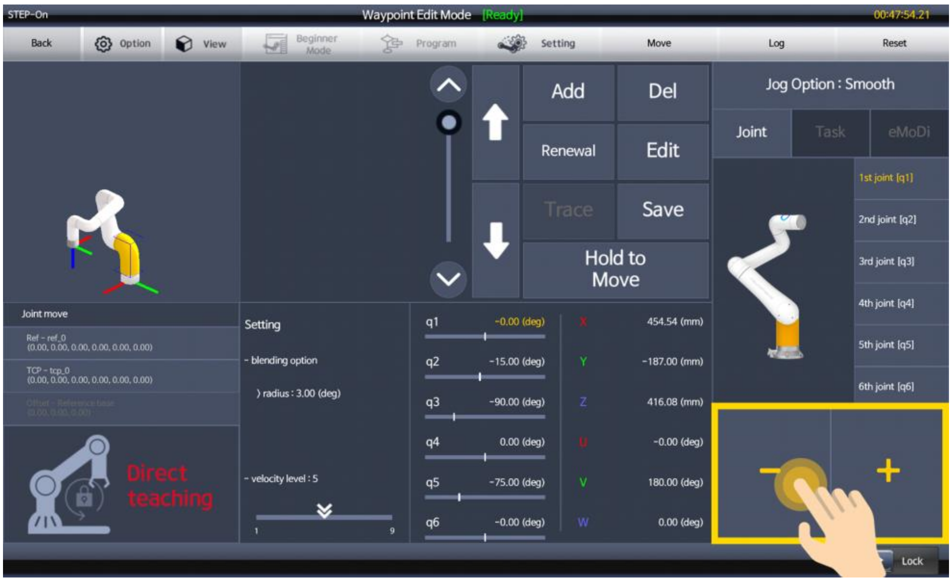
② In Jog Type, select **Joint**.



③ In Jog command, select the **joint** you want to move. Then, the selected joint is displayed in yellow on the robot model.

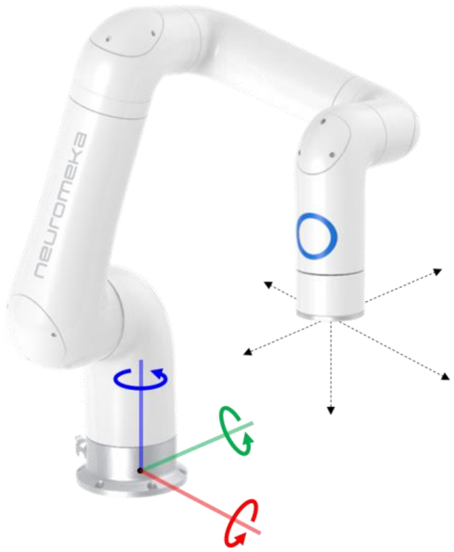


④ Touch **(+)** or **(–)** to rotate the selected joint.

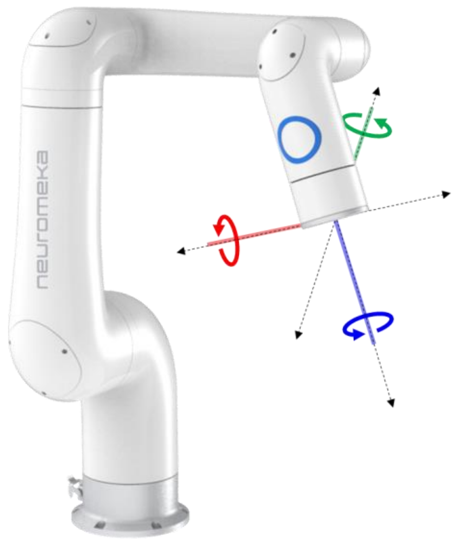


- **Task jog**

  It moves the tool center point and/or rotate the tool frame relative to the preset reference coordinate system.



[Task jog based on the reference frame]



[Task jog based on the tool frame]

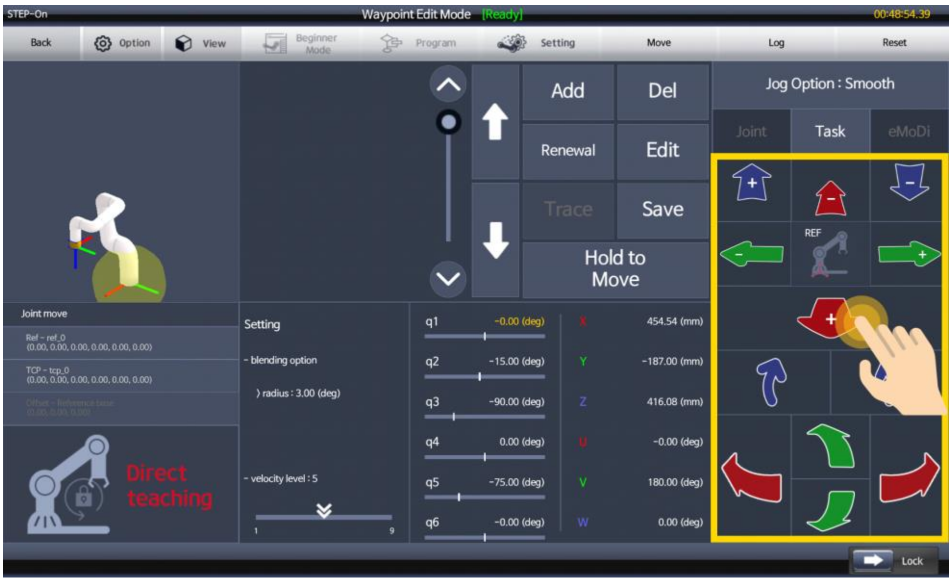
Depending on the jog mode selected in the jog option, it moves the tool frame either at the preset constant speed while touching or by the preset interval at one touch. The robot moves with respect to the reference frame or the tool frame according to the jog coordinate system selected in the jog option. Task jogs move the robot in the task space, so some workspace regions are limited due to singularities. Therefore, if the tool center point approaches a singularity region during jog operation, the robot stops the jog function immediately by the safety function while displaying the alarm message.

The following describes how to use Task Jog:

① Set the jog mode and the related jog parameters in the jog options.

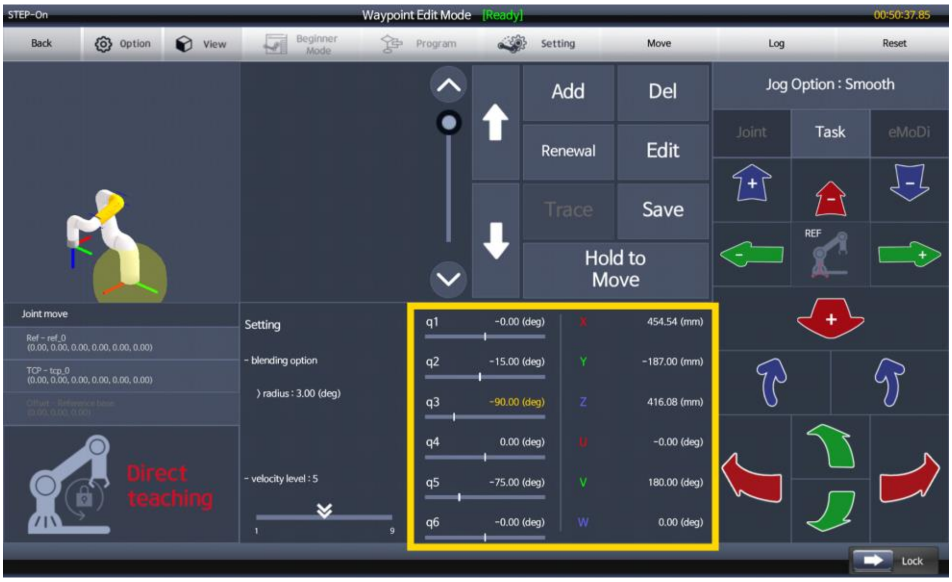
② Under Jog Type, select **Task**.

③ When you touch the **arrow** indicating the direction that you want to move in the jog command, the robot moves. The color of the arrow is the same as the coordinate axis color shown in the robot model. Red indicates the X axis, green indicates the Y axis, and blue indicates the Z axis. Also, the straight arrows in the upper stand for position movements, whereas the curved arrows in the lower represent rotation movements. When the jog coordinate system is selected as reference in the jog option, the robot moves with respect to the current reference frame. When the tool is selected, the robot moves with respect to the current tool frame.



Desired Position Movement

It is a manual operation function that moves the robot's joint or the tool frame to a position value specified directly. It is provided on all Conty screens that require robot motion.

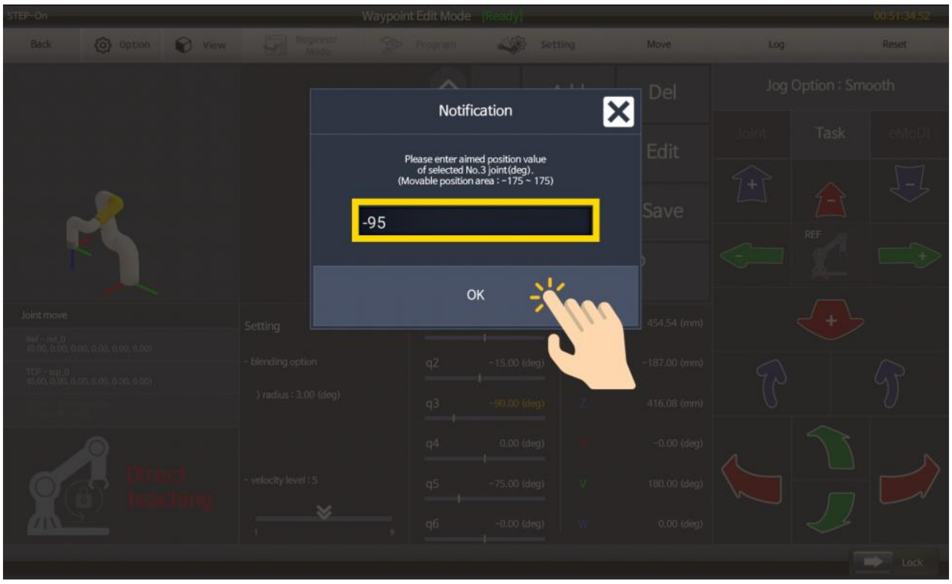


- **Joint position movement**

  Here's how to move the joint to the desired position:

  ① Touch the **joint value slider** for the joint you want to move.

② The current joint value is displayed in the notification message. Enter the desired joint value in place of the current value, then touch **OK**.



Caution

Note

Joints have different travel ranges. In the notification message, check the movable range of the joint.

③ Select the **speed level**. The speed level is selectable from level 1 to level 9. The higher the number, the higher the speed.

④ Touch **hold to move**. While touching, the robot moves to the entered joint values. When the touch stops, the robot stops moving immediately. Keep touching while you are reaching your goal position.

⑤ Once you've successfully reached your goal position, the pop-up disappears and you'll see an instant message like "**It reached target position.**"

- **Task position movement**

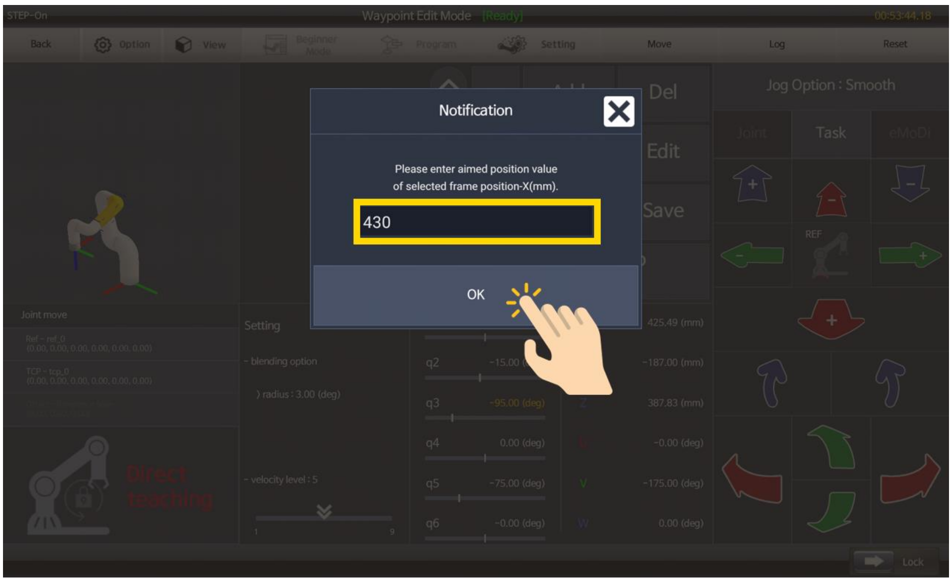
  The following describes how to move the tool frame to the desired position and orientation. It should be noted that the coordinate values of x, y, z, u, v, and w are displayed based on which frame is the reference for task movement.

Caution

Movement of the robot in the task space is stopped immediately by the safety function when approaching singularity regions. In such cases, move in joint space.

① Touch the **coordinate value** that corresponds to the coordinate axis you want to move.

② The current value of the selected coordinate is displayed in the notification message. Enter the desired value instead of the current one and touch **OK**.



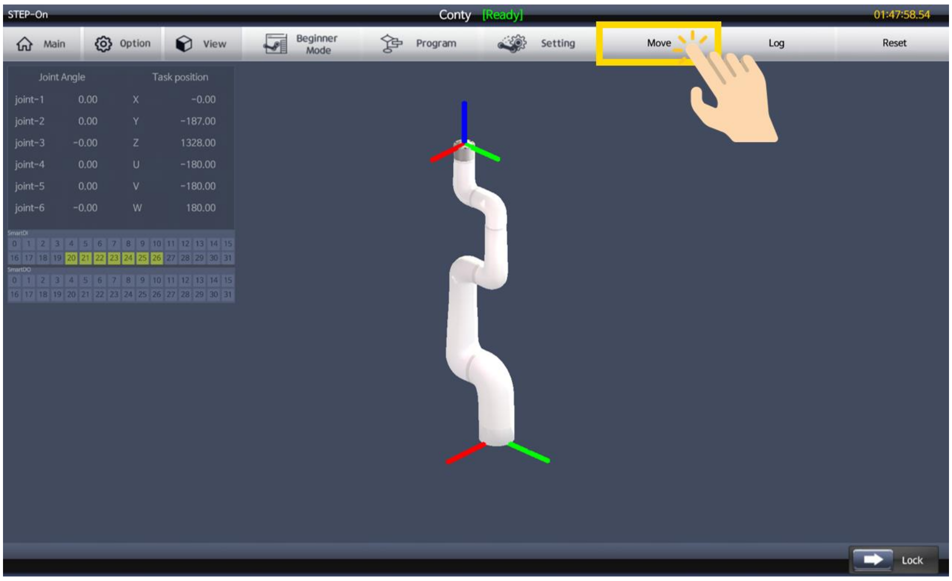
③ Choose the desired **speed level** from 1 to 9. The higher the level is, the faster the movement will be.

④ Touch **Hold to Move**. While touching, the robot moves to the preset target position and releasing touch stops the robot immediately. Continue to touch so that the target position is reached.

⑤ Upon arrival at the target position normally, the pop-up window disappears with the instant message displaying "**It reached target position.**" as follows:

Preset Movement

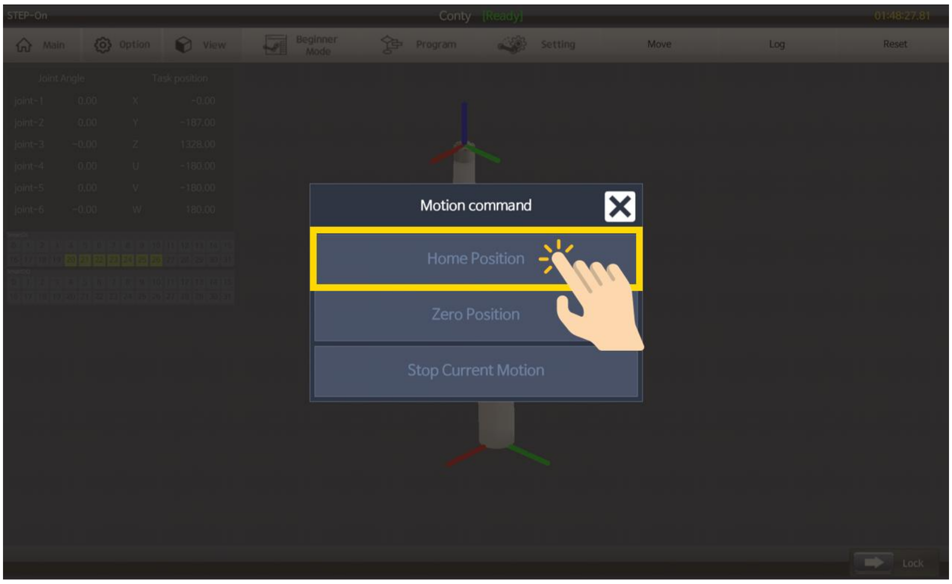
Preset movement is a manual operation that moves the joint of the robot to preset positions. Currently there are two preset positions available, such as the zero position and the home position. The zero position is a special position that defines the origin of each joint and cannot be changed by the user. On the other hand, the home position is used as the position initiating and terminating general motions or as the docking position to which the robot returns in case of an error. Users can define a new home position based on their intended use. See **Section 6.2 Options** for a detailed description of setting the home position. Preset movement is accessed in the top menu bar of the Home window. Touch **Move** from the top menu bar.



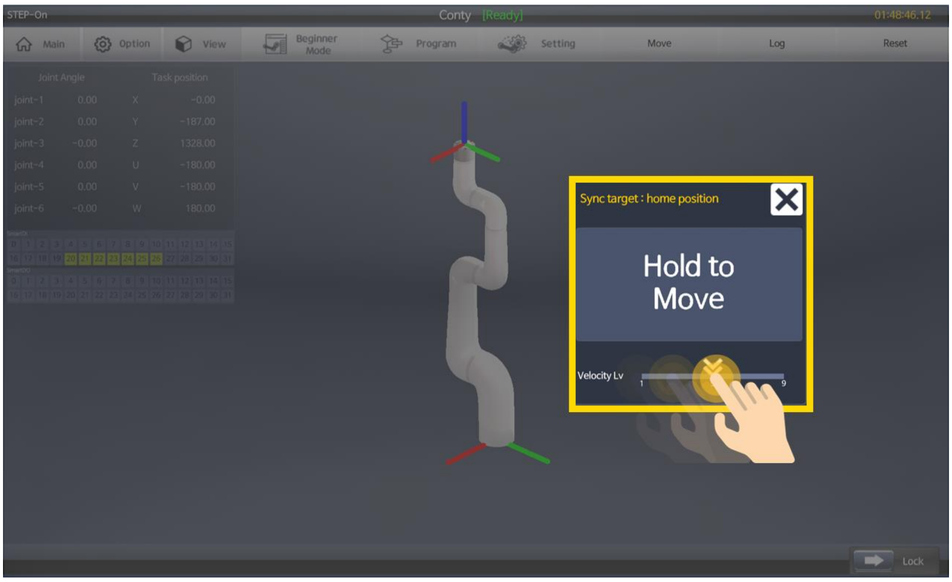
- **Movement to home position**

  Movement to the home position is performed as follows:

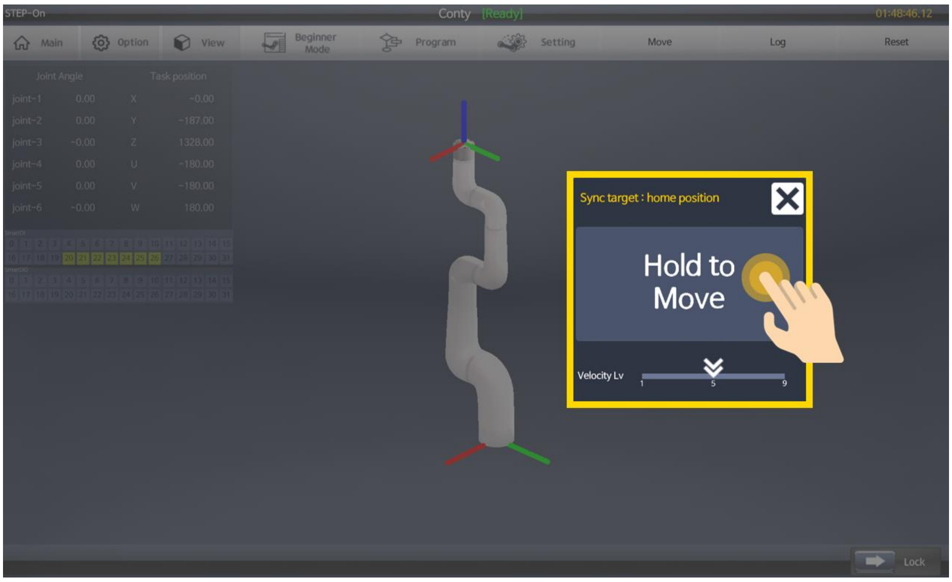
  ① Touch the **Home Position**.



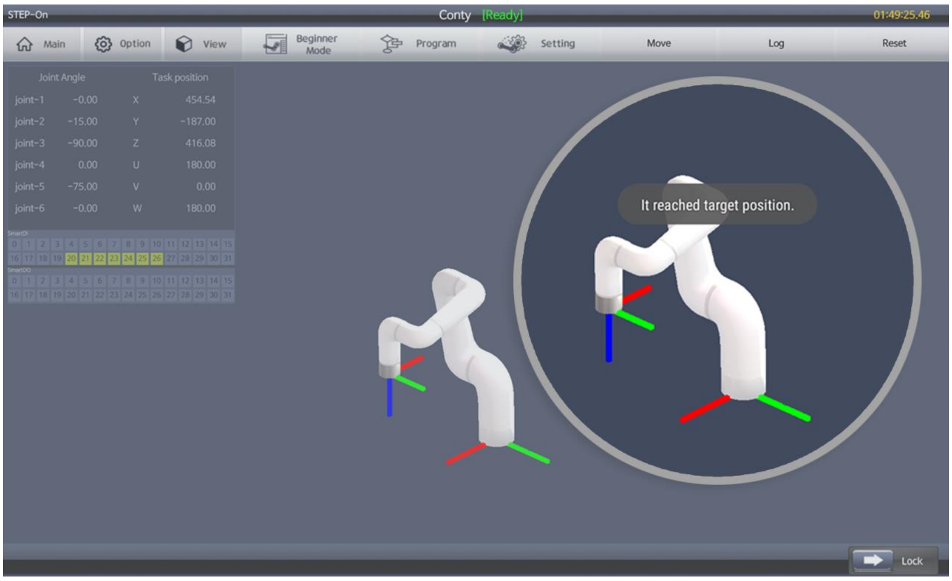
② Choose the desired **speed level** from 1 to 9. The higher the level is, the faster the movement will be.



③ Touch **Hold to Move**. While touching, the robot moves to the preset home position and releasing touch stops the robot immediately. Continue to touch so that the home position is reached.



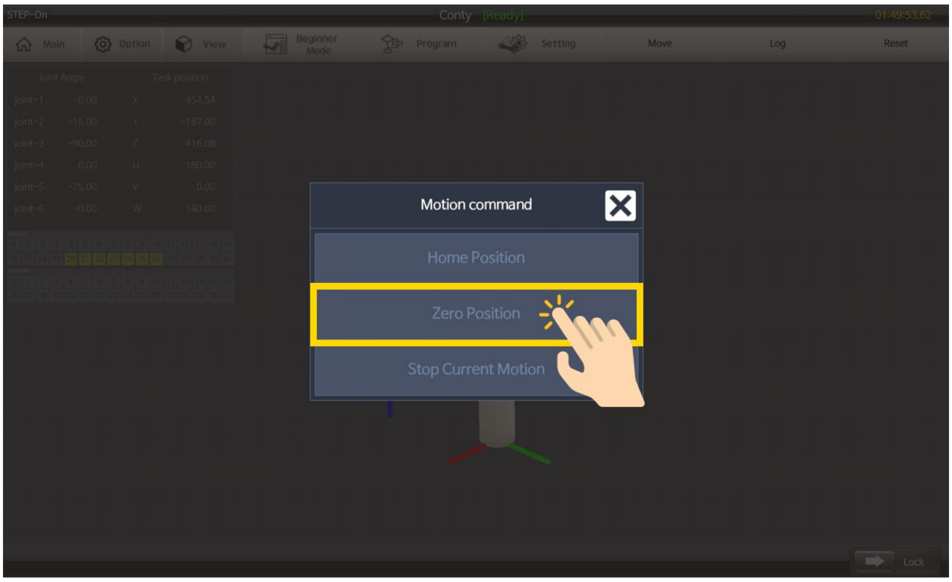
④ Upon arrival at the home position normally, the pop-up window disappears with an instant message displaying "**It reached target position.**"



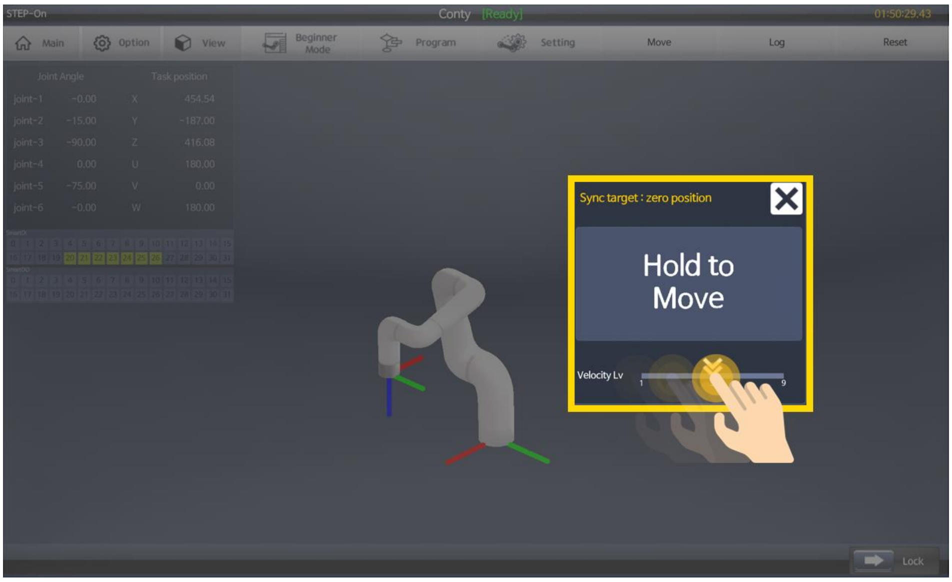
- **Movement to zero position**

  Movement to the zero position is similarly performed as follows:

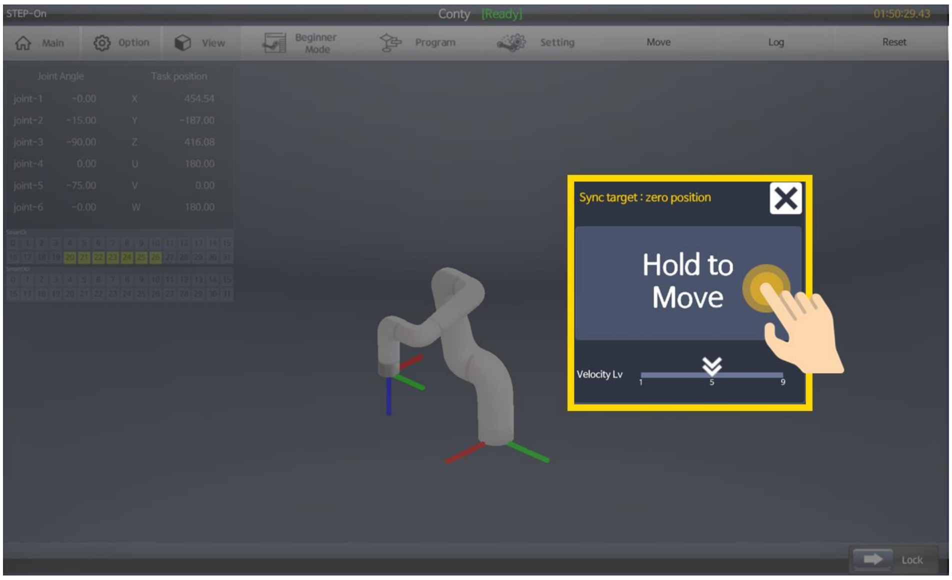
① Touch the **Zero Position**.



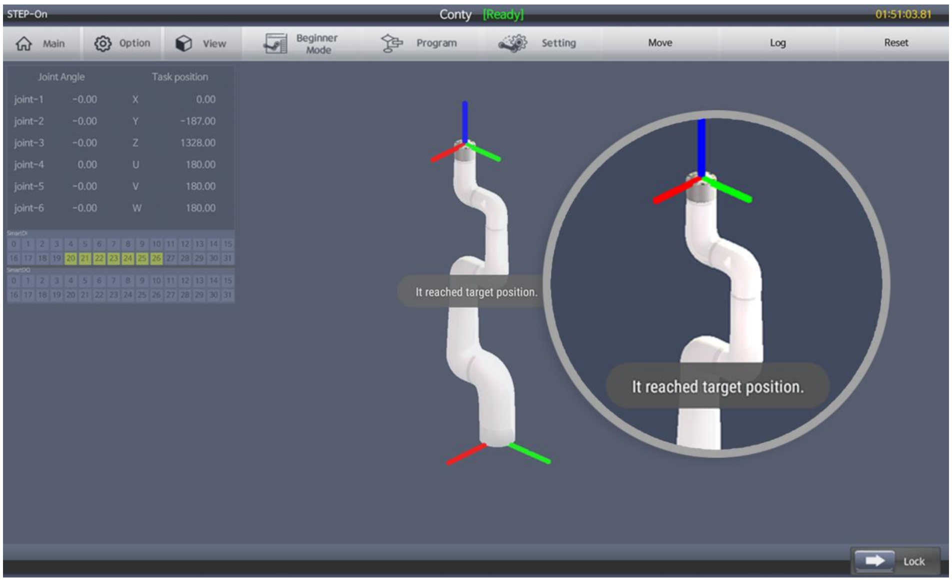
② Choose the desired **speed level** from 1 to 9. The higher the level is, the faster the movement will be.



③ Touch **Hold to Move**. While touching, the robot moves to the preset zero position and releasing touch stops the robot immediately. Continue to touch so that the zero position is reached.



④ Upon arrival at the zero position normally, the pop-up window disappears with an instant message displaying "**It reached target position.**"



4.3 Interface with Tools and Peripheral Devices

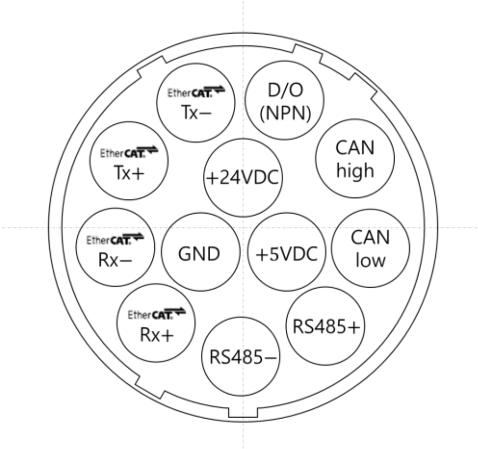
To use tools or other external devices together with the robot the robot should be electrically connected with each of these devices. These external devices include relays, PLCs, computers and various sensors as well as tools such as grippers, gluing guns, and bolt runners. These devices can be connected to the robot through the input/output interface of the endtool port or the control box.

Interface

The input/output interface for tools and devices is located on the robot arm's endtool and the rear of the control box. The layout of each electrical interface is as follows:

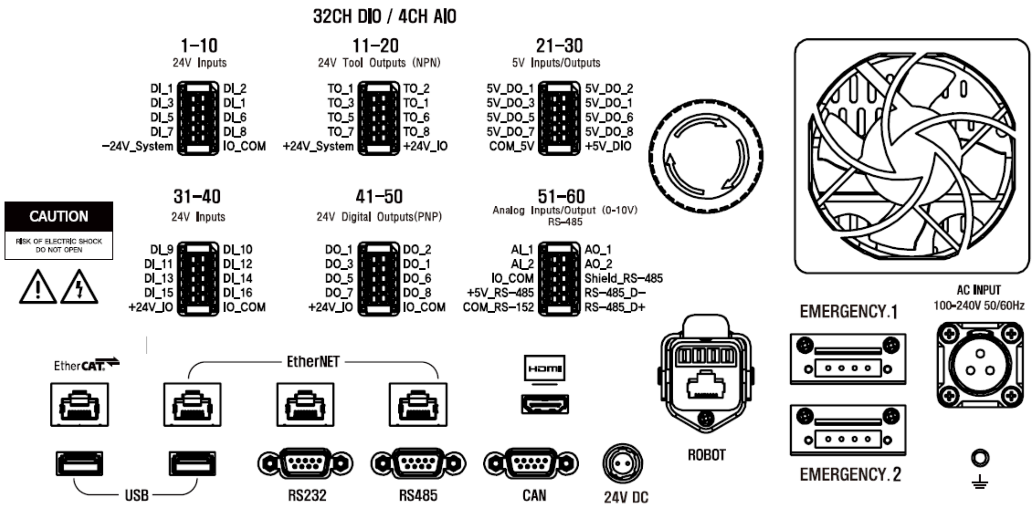
- **Endtool port**

  A total of twelve female pins are provided on the endtool port. The connector for the endtool port is compatible with SN-10-12(P) push-pull type male and should be properly wired for use. In need of custom connectors contact the manufacturer if necessary.



- **Control box**

  The control box comes with a variety of input and output interfaces, in addition to digital input and output. Details are found in each of the following functional descriptions.



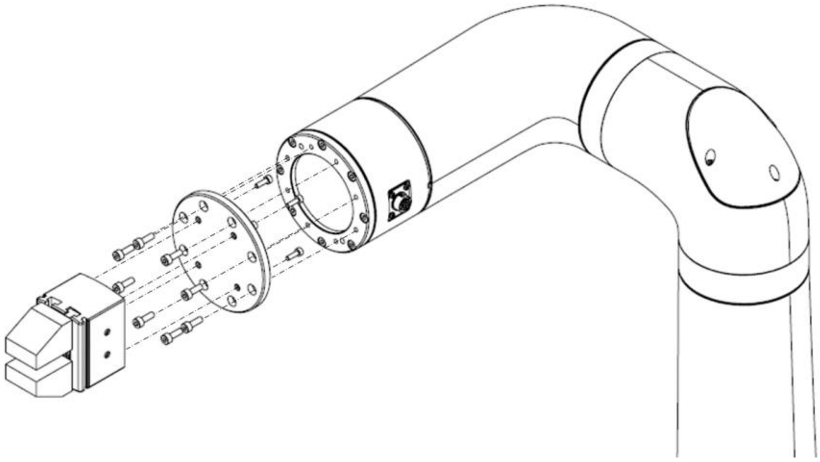
Connecting Tools

In order for the robot to perform a variety of tasks, the appropriate tools must be fitted to the robot. Robotic tools include devices for holding or placing objects, such as electric grippers, pneumatic grippers, and vacuum grippers, as well as devices for specific purposes, such as welding devices, gluing devices, and bolting devices. Connection of these tools requires mechanical and electrical connections as well:

- **Mechanical connection**

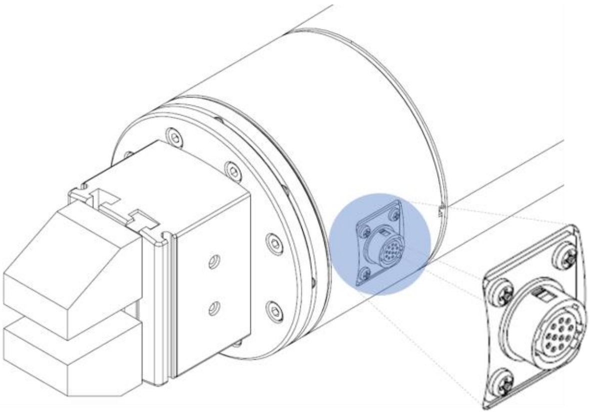
  To install a tool on the endtool flange, it may be necessary to make a separate adaptor that connects the tool to the flange. Refer to **Section 3.1 Robot Arm** for the information on dimension for fabrication. Here we're going to install the gripper on the endtool flange.

  Secure the gripper to the endtool flange using an intermediate adaptor. Tighten the eight M4 bolts securely to prevent them from falling apart off the endtool. Check with your gripper dealer for the information you need for mechanical connection.



- **Electrical connection**

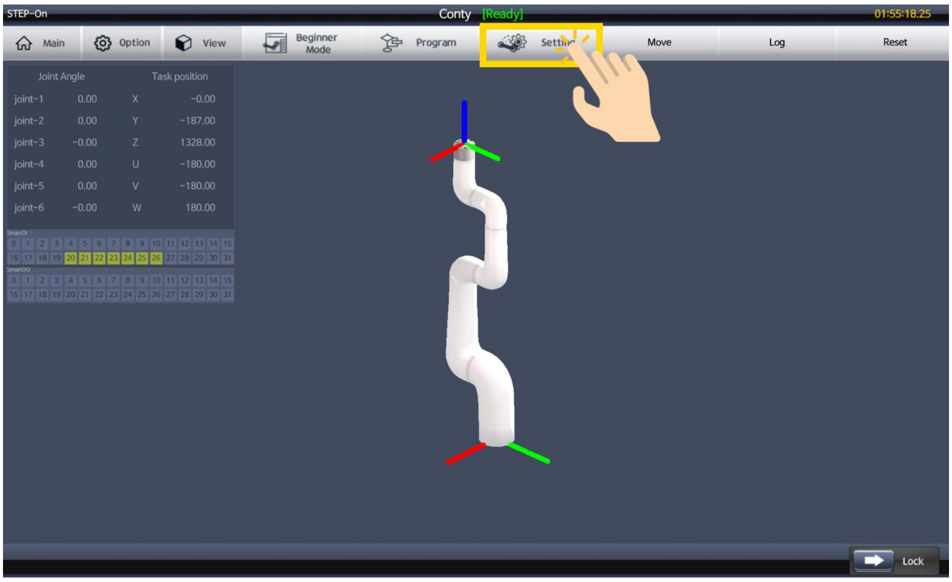
  A total of twelve female pins are provided on the end-tool port. The connector for endtool port is compatible with SN-10-12(P) push-pull type male and should be properly wired for use. In need of custom connectors contact the manufacturer if necessary. Here is an example of connecting an additional component of the gripper.



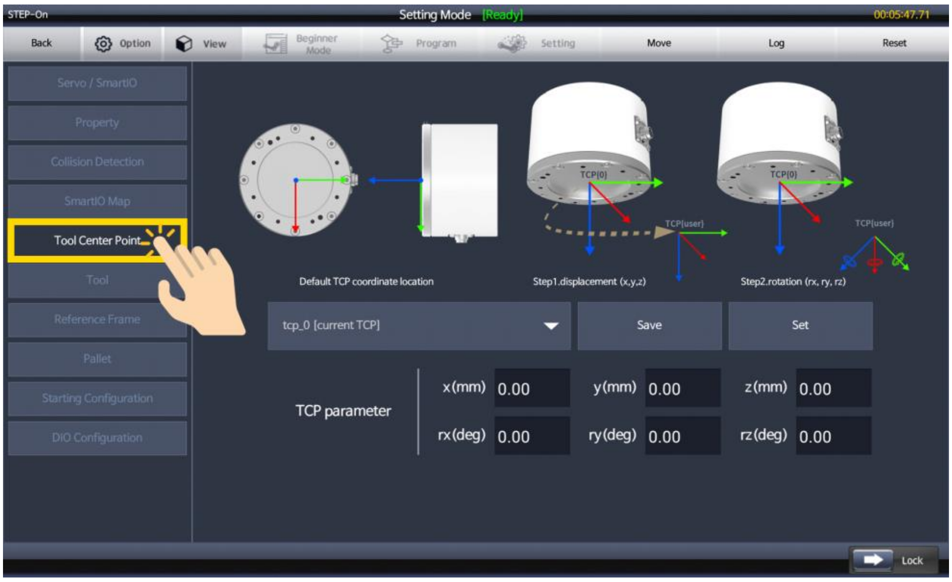
- **Tool properties**

  In order to work properly with the robot after installing the tool, it is necessary to reflect the physical properties of the tool and conduct the test. First, you use Conty to set the tool center point with the weight and the center-of-mass of the tool to use the existing functions of the robot normally.

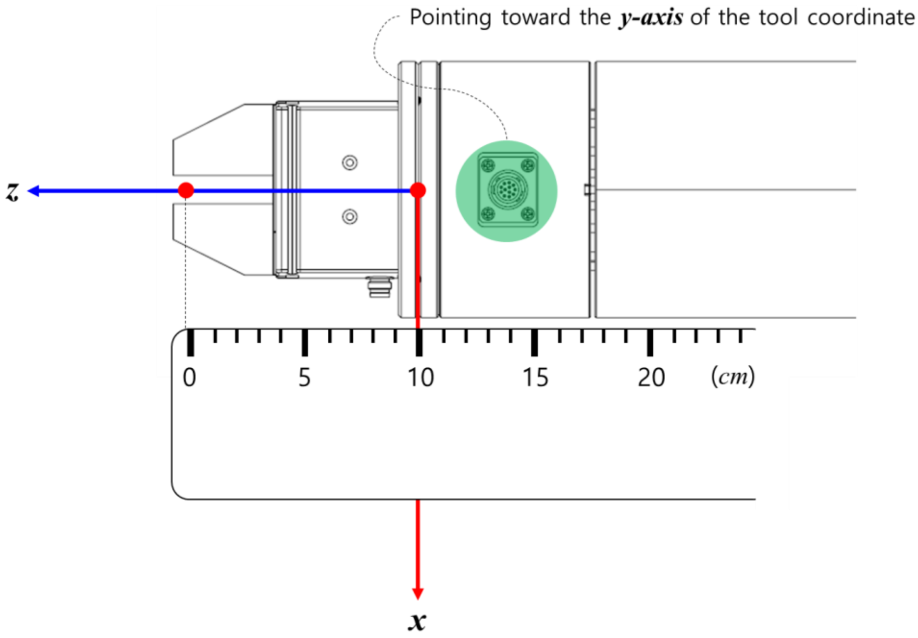
  ① Touch **Setting** from the top menu bar.



  ② Touch **Tool Center Point** in robot setting menu in the left.

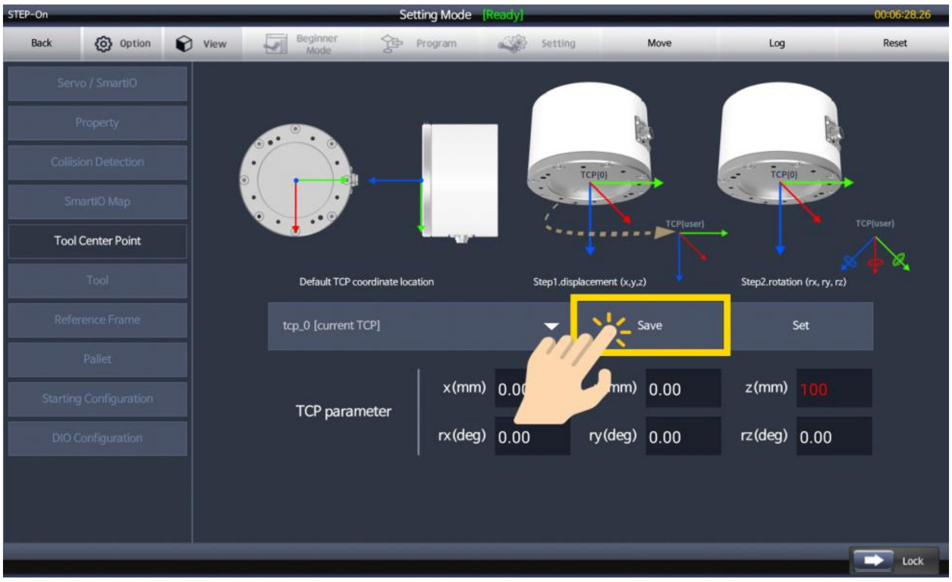


③ Measure the displacement and the rotation of the tool coordinate system with its origin at the new tool center point with respect to the default tool frame origined at the endtool flange. In case you have dimensional information in your design drawing, record it.

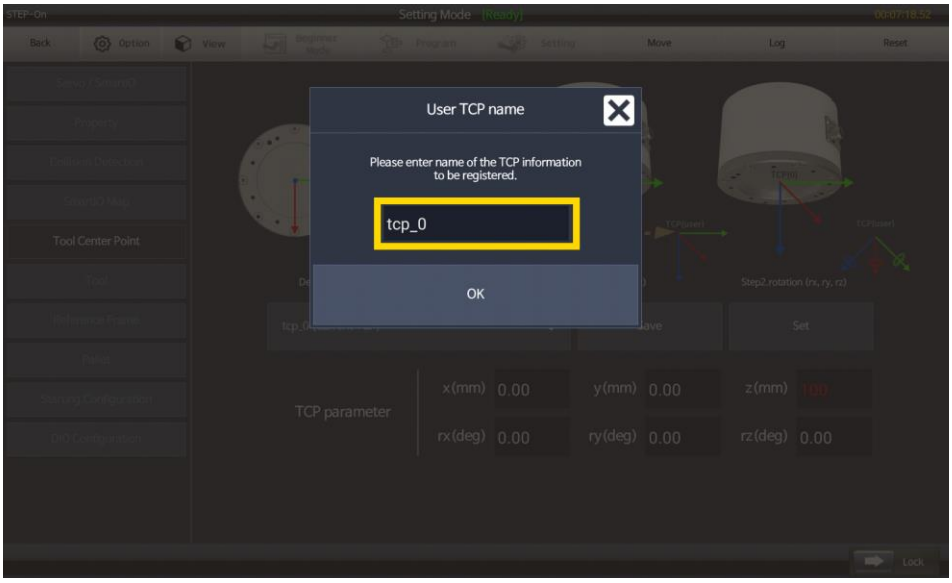


④ Enter the tool center point parameters measured or recorded in ③ into the TCP Parameter. The x, y, and z values are the distances and the rx, ry, and rz values are the rotation angles of the new tool frame origined at the new tool center point with respect to the default tool frame. If the input values have not been saved, it will be displayed in red as follows:

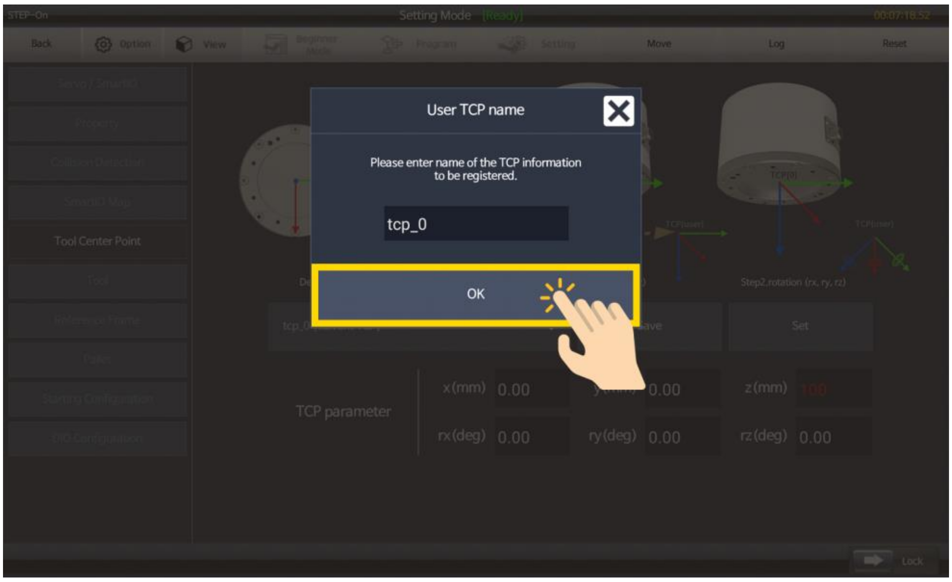
⑤ Touch **Save** to store the newly set tool center point.



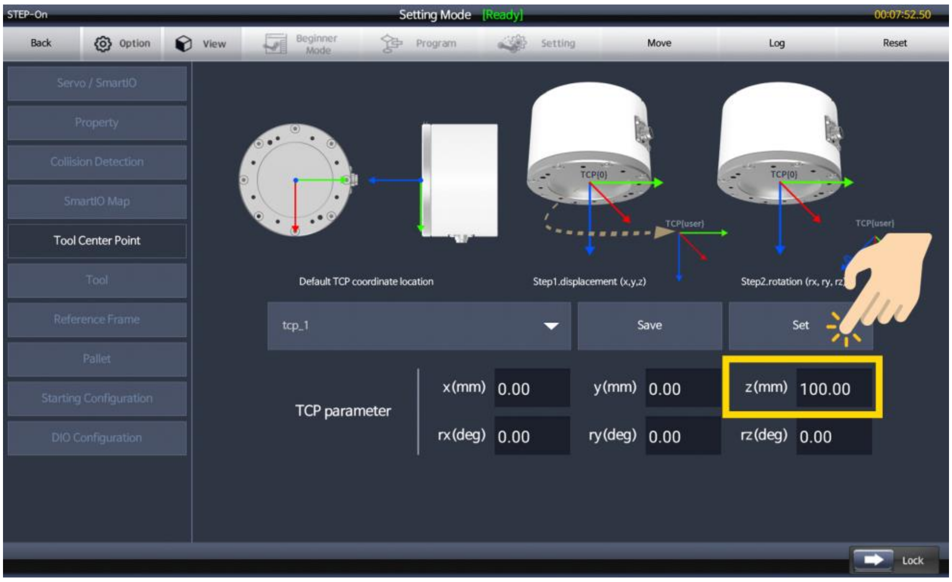
⑥ Multiple tools can be registered. However, you cannot modify the currently available information already registered. Touch Save to display the name of the current tool center point.



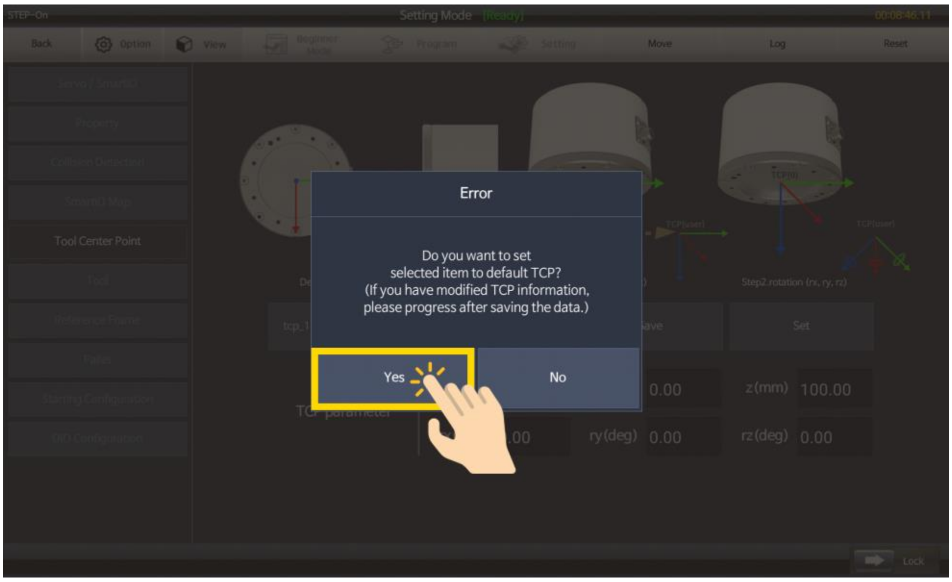
⑦ Enter a new name for the new tool center point and touch **OK**. Here we will enter the new tool center point name as tcp_1.



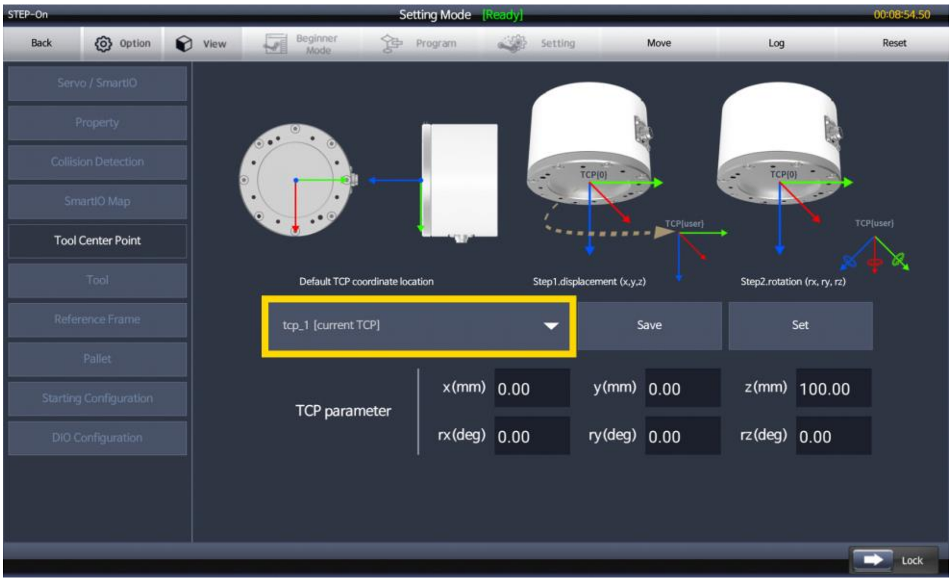
⑧ Once the settings entered with the new tool center point name are saved normally, the red text will be displayed in white. However, this does not mean that it now becomes the currently activated tool frame. Touch **Set** to set the new tool frame shown in the combo box to the current tool frame of the robot.



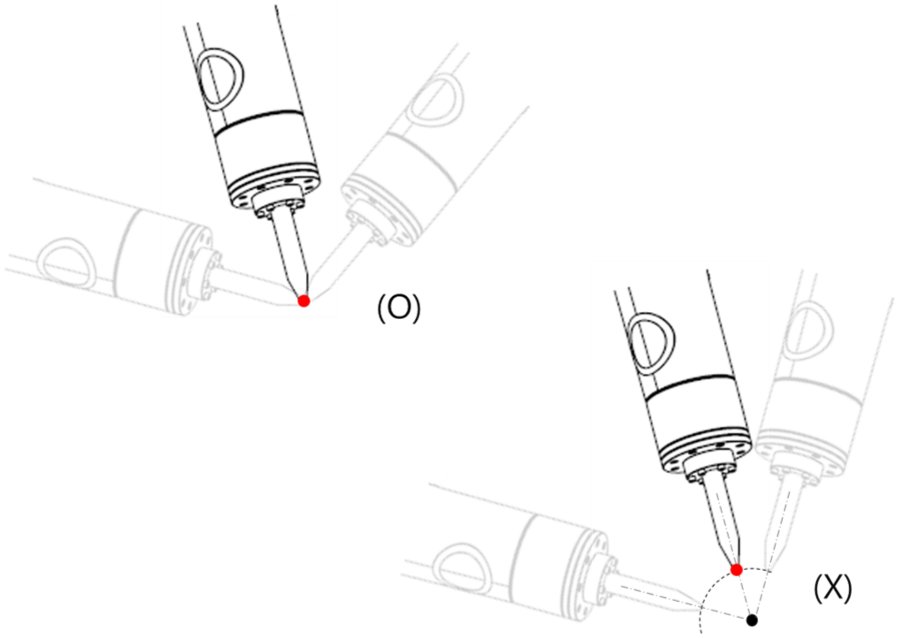
⑨ Touch **Yes** when you see the following message.



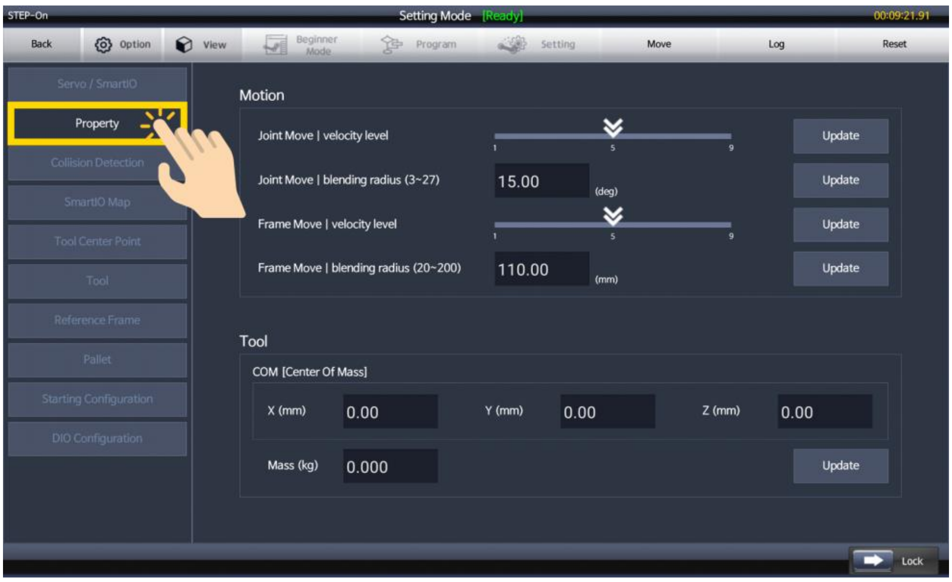
⑩ If the tool center point name has the tag [current TCP] displayed on its right side, the tool frame is normally reflected as the current value. For a detailed description of the tool frame settings, see **Section 6.1 Robot Settings**.



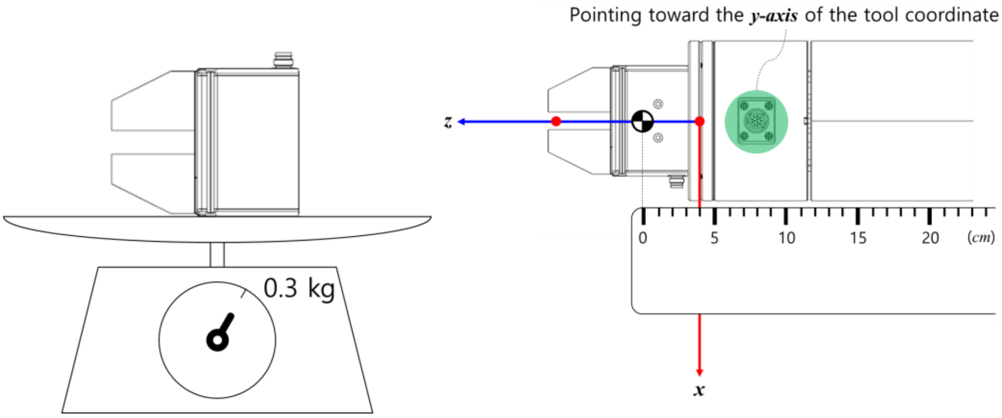
⑪ Use the task jog to test whether the robot rotates about the X, Y, and Z axes with the tool center points fixed. If the robot's tool center point deviates significantly from the center of rotation during rotation, the tool center point setting is incorrect. Re-enter the tool center point value until the robot can rotate around the tool center point.



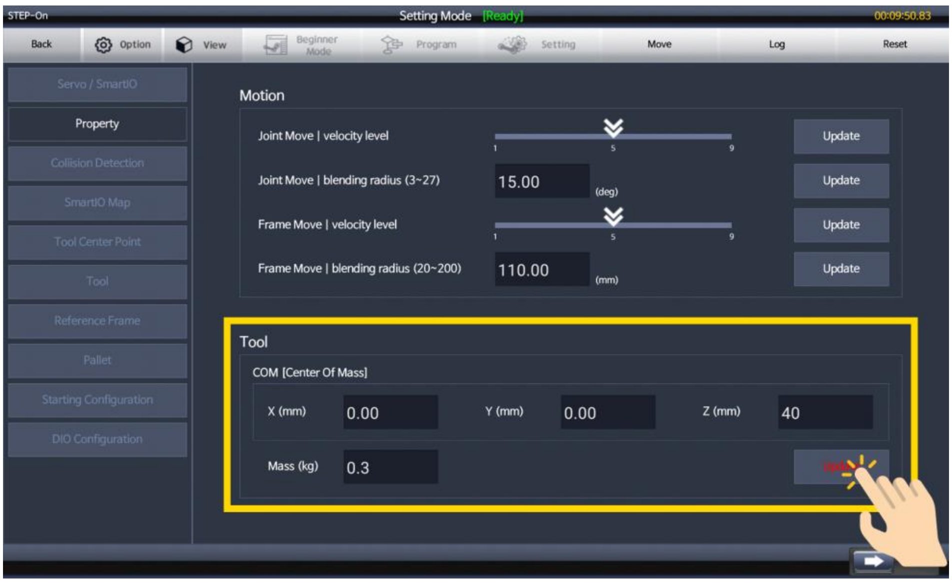
⑫ After the tool center point is properly set, then the tool's mass with the center-of-mass must be entered. Touch **Property** in the robot setup menu in the left.



⑬ Record the mass and the center-of-mass of the tool by the help of CAD software if it is designed directly or by reference to the specification if it is a commercial product. If it is difficult to retrieve the relevant information, measure the weight directly using a scale. Locate the center-of-mass and measure it from the default tool frame located at the endtool flange.



⑭ Enter the center-of-mass and the mass of the tool measured or recorded in ⑬ and touch **Update**.



⑮ Test whether the robot is maintaining its current position in direct teaching mode. If the robot moves by itself in a certain direction without applying external force, then the mass and the center-of-mass of the tool are set incorrectly. Re-enter its mass and the center-of-mass so that the robot keeps the current position in direct teaching mode.

Warning

Warning

Failure to correctly enter the mass and the center-of-mass of the tool may result in malfunction of collision detection during operation. Also, in the direct teaching mode, the robot can move in a direction even if no external force is applied. Therefore, immediately after reflecting the mass and the center-of-mass of the tool, make sure that the direct teaching mode operates properly, and then operate the robot.

Caution

Caution

If you do not enter the exact distance and rotation information of the mounted tool's center point, the robot may suffer from significant deviation from a specified path during rotation.

Interface to Peripheral Devices

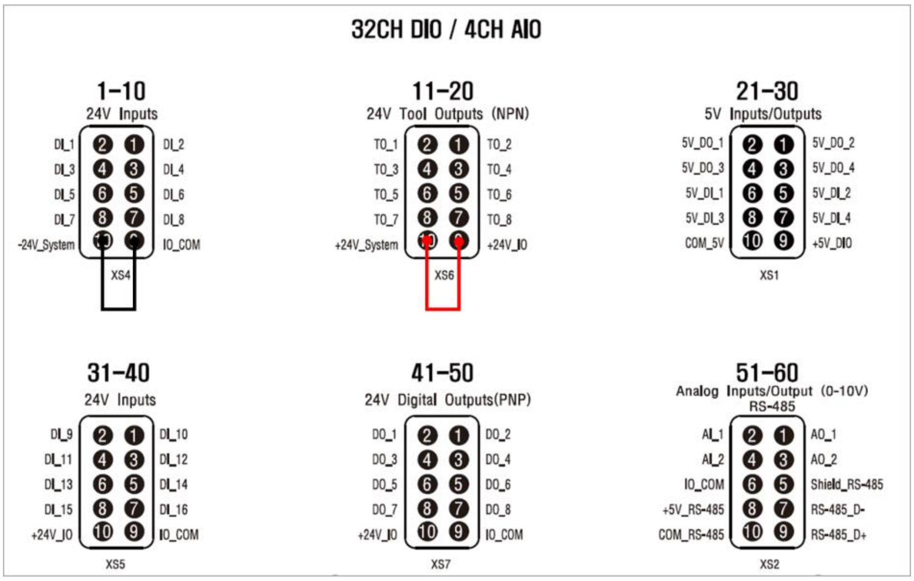
In addition to use of tools, robots need to be electrically connected to various peripheral devices to interact with each other by receiving or transmitting various signals in order to perform more various tasks. Interactions with peripherals are made by electrical signals, such as digital or analog I/O, and communication methods such as EtherCAT, Ethernet or RS232 and RS485.

Warning

Be sure to turn off the robot and disconnect the power plug from the power socket before proceeding with any electrical work. Wiring while powered on can cause I/O board fuses to break or damage the product itself. Failure due to incorrect connection and misuse is not the manufacturer's responsibility.

- **Power supply to I/O board**

  To use the 24V input/output signal on the control box's I/O board, you must first supply 24V power supply to the I/O board. The I/O board power supply can be provided by connecting the internal 24V power source or an external 24V power supply. No separate supply is required for the 5V input/output signal. The default way of power supply is to connect and use the internal 24V, which is wired as follows:

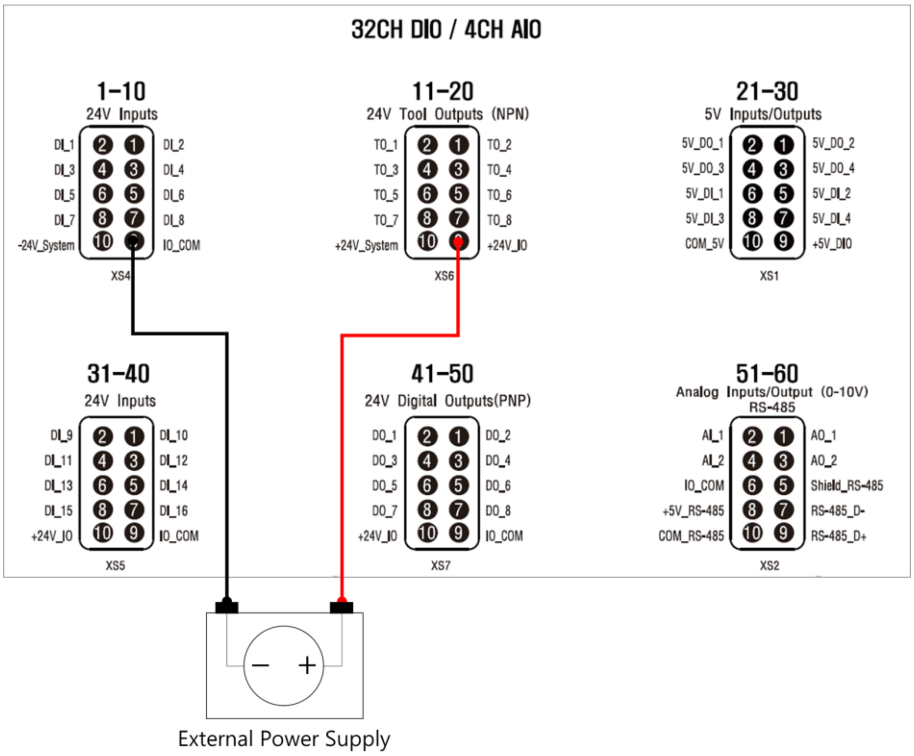


  Connect the GND of the internal power supply and the common GND of the I/O board by connecting two pins of number 10 and 9 of the DIO 1-10 terminal block located on the back panel of the control box. If you connect two pins of number 10 and 9 of the DIO 11-20 terminal block, the +24V of the internal power is supplied to the I/O board.

pin location	name	description
Terminal 11-20 (pin 10)	+24V_System	internal 24V power (+24V)
Terminal 1-10 (pin 10)	−24V_System	internal 24V power (GND)
Terminal 11-20 (pin 9)	+24V_IO	power to the I/O board (I/O board common +24V)
Terminal 1-10 (pin 9)	IO_COM	power to the I/O board (I/O board common GND)

If the power required for operation of the I/O board is insufficient by only the power supplied from the control box, connect the external power supply instead of the internal power supply. At this time, the external power supply must satisfy the supply voltage of 24V.

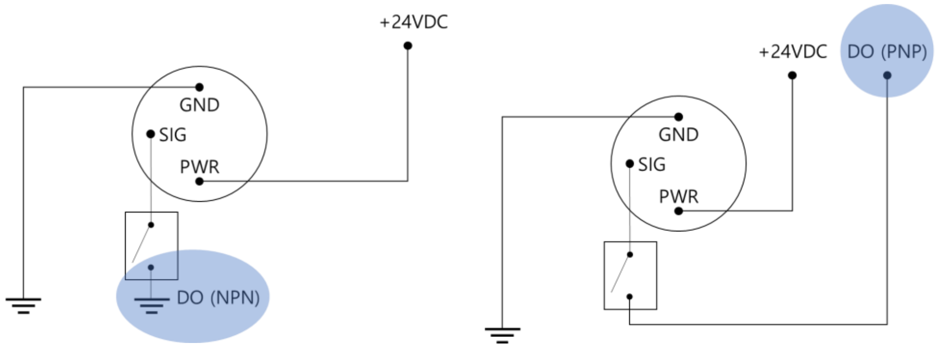
Connect the external power supply as follows.



Connect pin 9 of DIO 1-10 terminal block located on the back panel of the control box to GND of the external power supply and connect pin 9 of DIO 11-20 terminal block to + 24V of the external power supply to supply power to the I/O board.

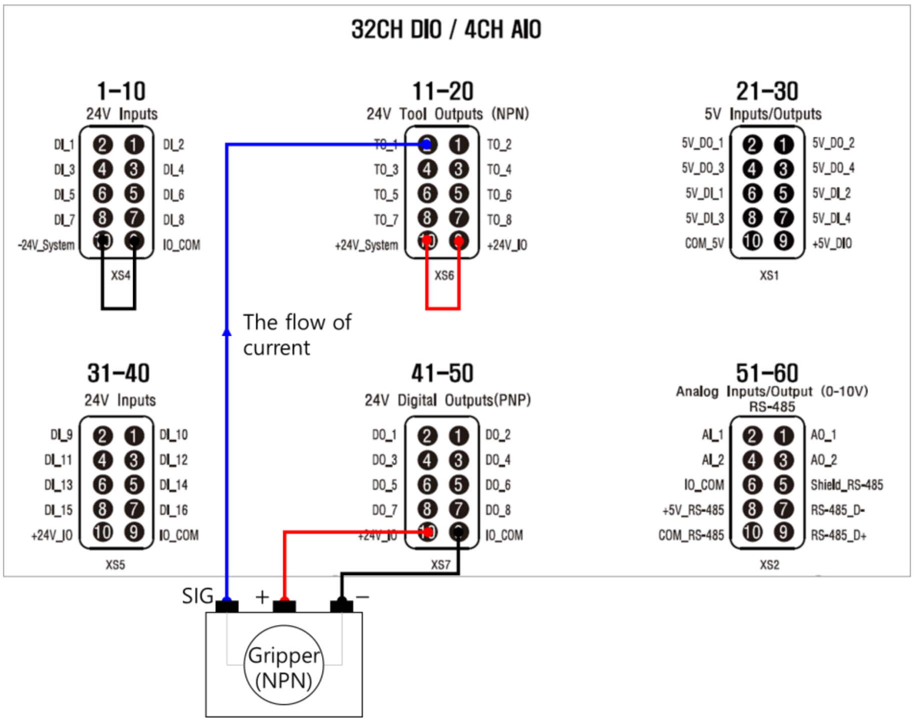
- **Digital signal output**

  The digital signal output is used to send signal to other equipments or to control the electrical load. There are the NPN open collector type and the PNP open collector type according to the type of transistor (a kind of switch) that outputs the digital signal.

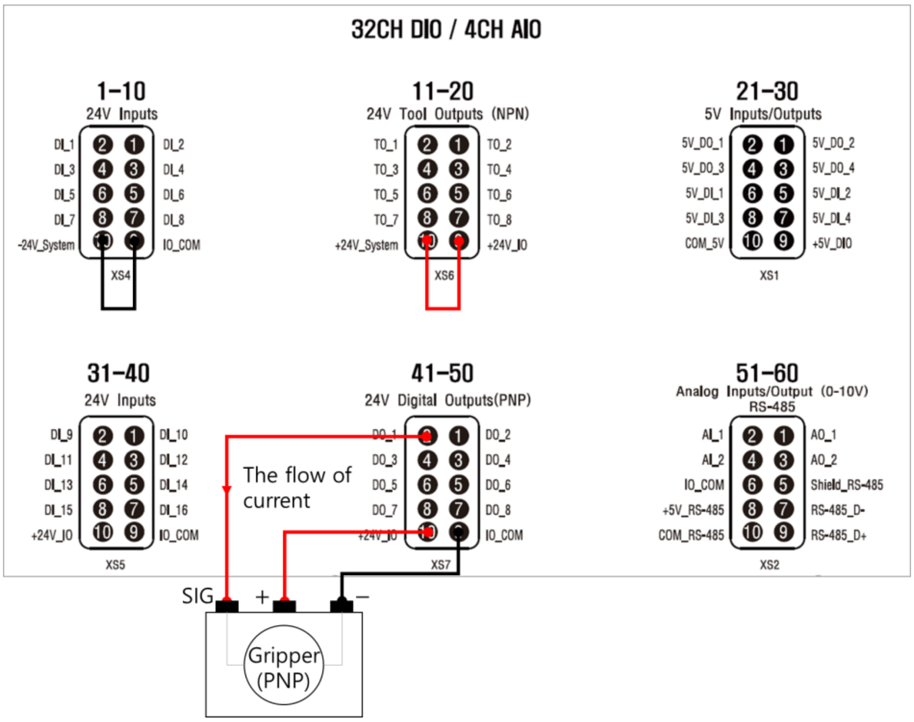


Roughly speaking, the NPN open collector draws current when the transistor is operating, but the PNP open collector sends the current.

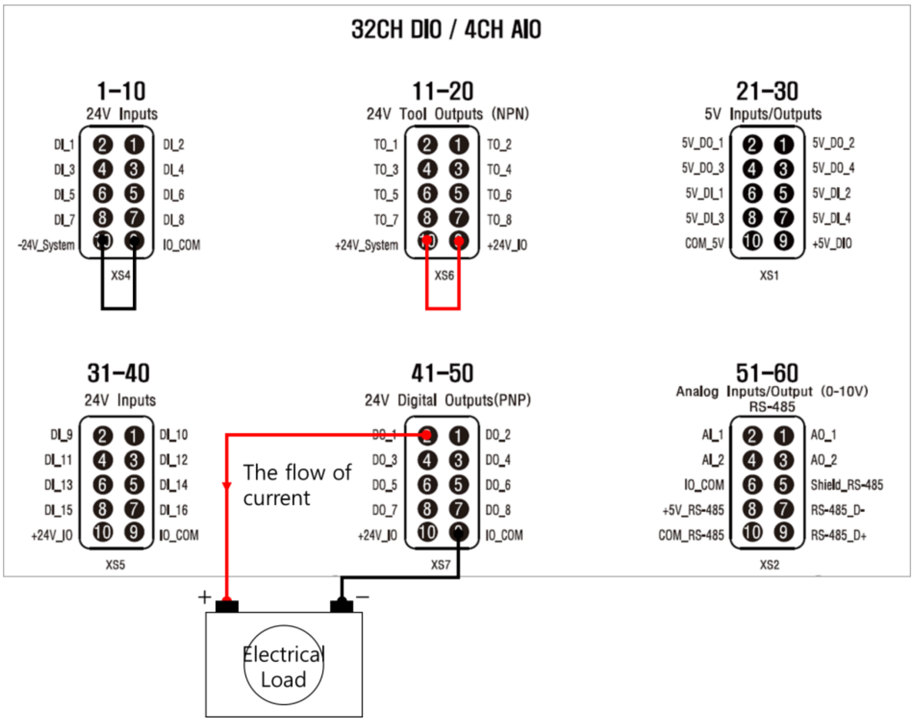
The following is an example of connecting a 24V electric load of the NPN open collector type to the control box. Note that NPN type devices had better be connected to Terminal block 11-20 as it is of NPN type. Here, we will supply power to the I/O board using the internal power.



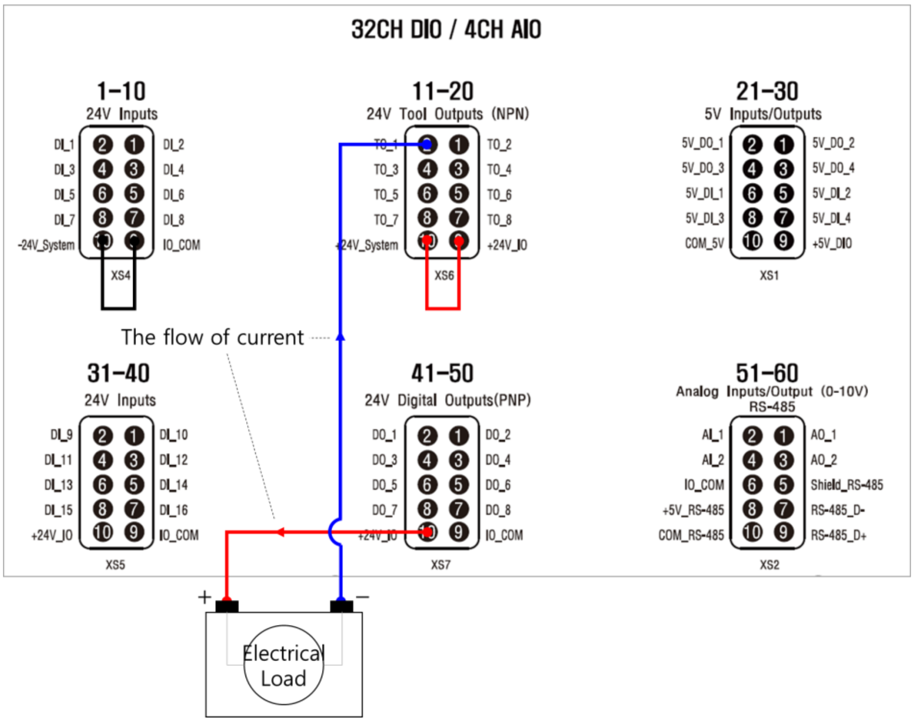
Connection to a 24V electrical load of PNP open collector type is as follows. Note that PNP type devices should be connected to Terminal block 41-50 as it is of PNP type.



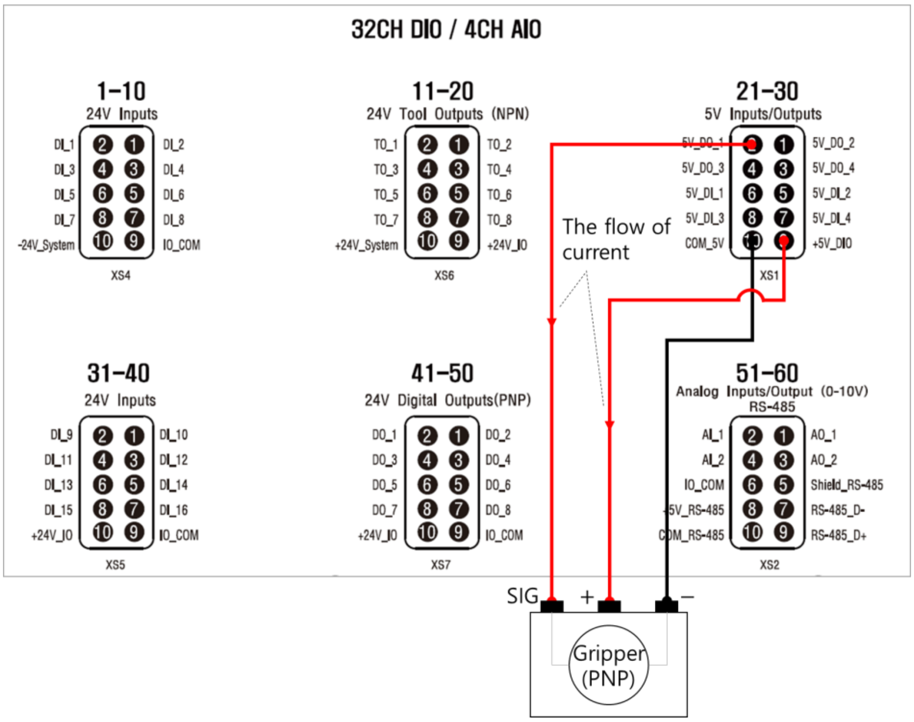
The following is an example of connection that controls the 24V electrical load simply through digital signal output.



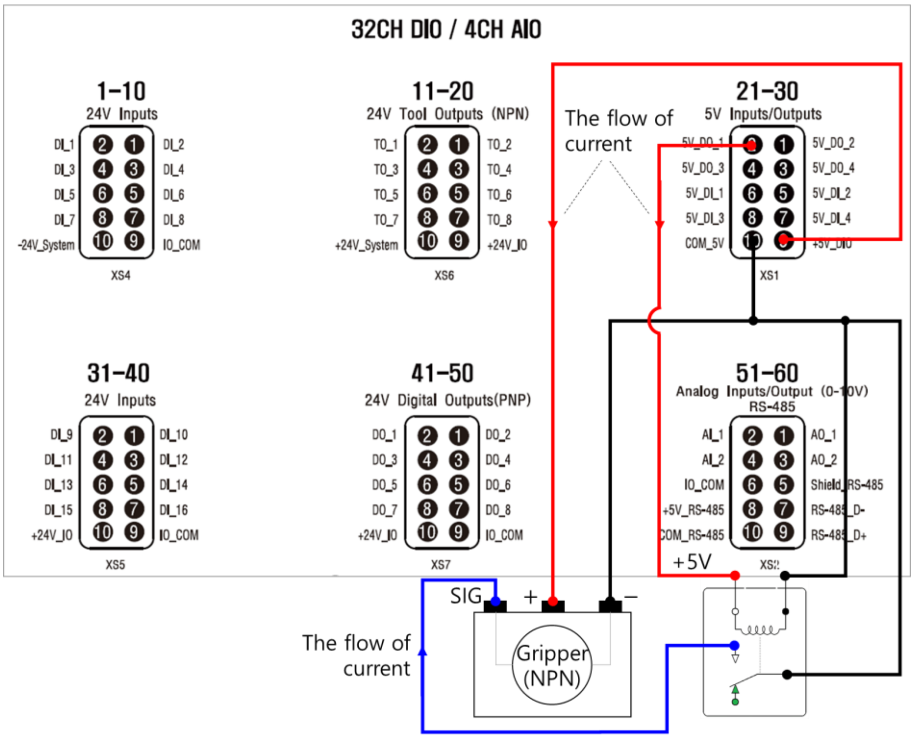
Or, the connection can be made as follows. Both works properly except whether either NPN or PNP port is used.



The 5V signal output connection method is similar to the 24V output connection method, except that the power is already supplied internally and the pins to be connected are different. However, only the PNP open collector type can be directly wired, while the NPN type requires separate relay connection. The following shows the connection to the 5V electric load of the PNP open collector type.



The NPN open collector type is connected using relays as follows.

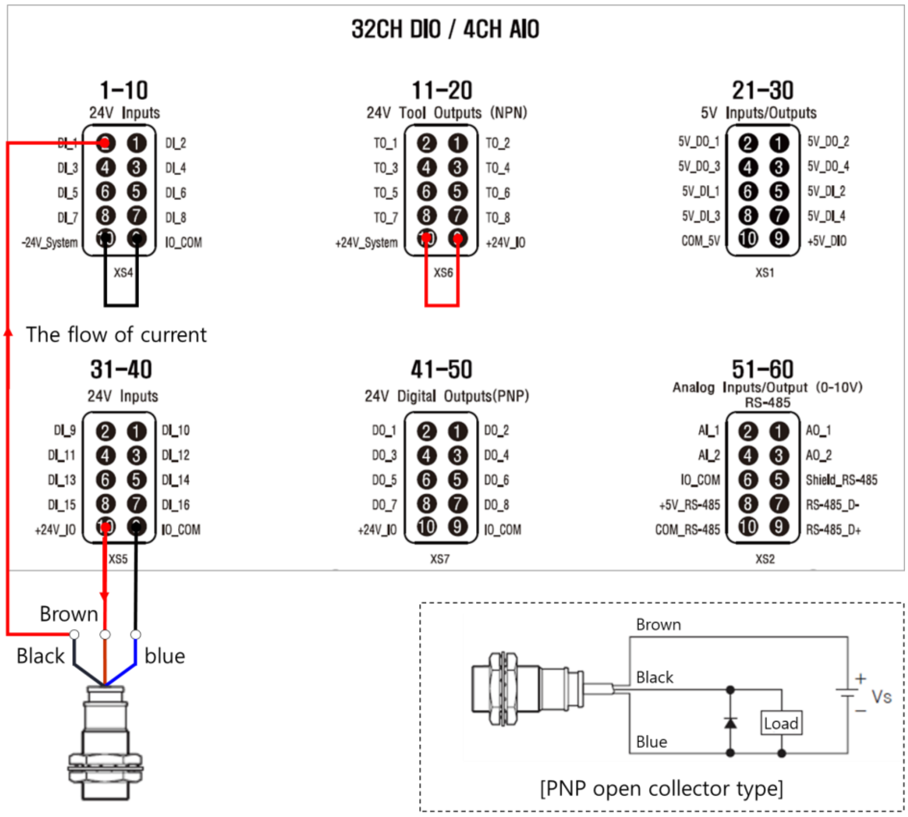


- **Digital signal input**

  Digital signal input is used to detect when an external device generates a signal. These external devices include sensors, e.g. to detect the presence of objects, or I/O buttons, e.g. to generate a signal when it is pressed.

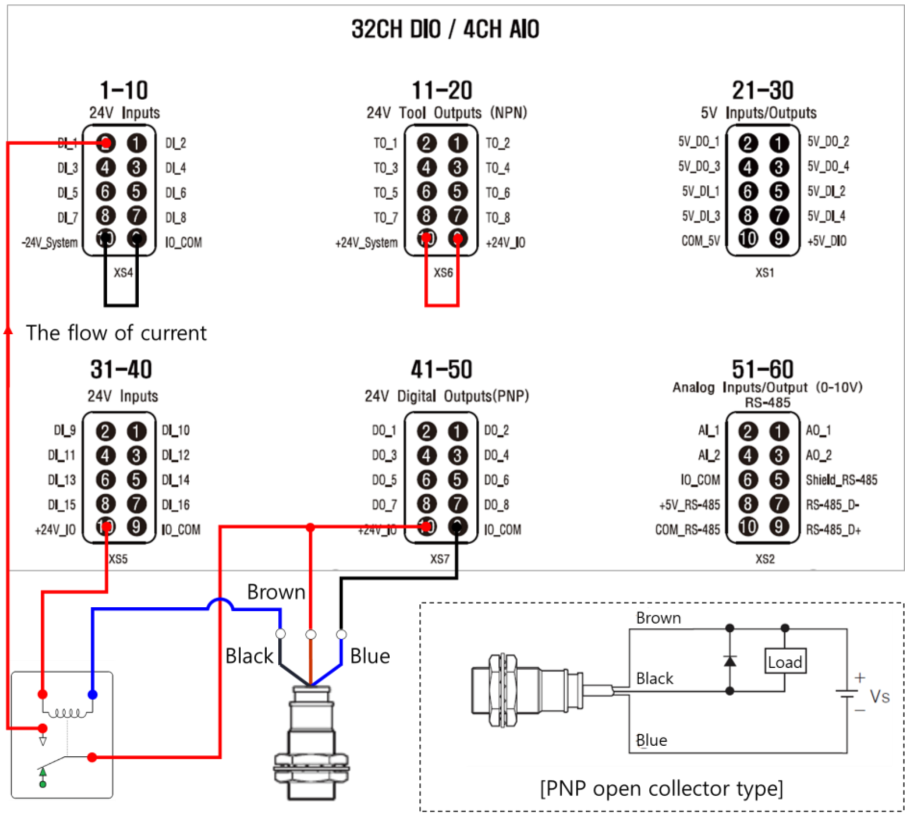
  Among those sensors connected to the control box, there are PNP open collector type and NPN open collector type depending on the output type. If the sensor output is of PNP open collector type and common GND is used, it can be connected directly to the control box. On the other hand, when using sensors of NPN open collector type, it is necessary to use the relay in the middle to configure so that current flows into the digital signal input port of the control box.

  The following is an example of connecting 24V DC three-wire proximity sensor of PNP open collector type to digital signal input of the control box. Here, the internal power is supplied to the I/O board.

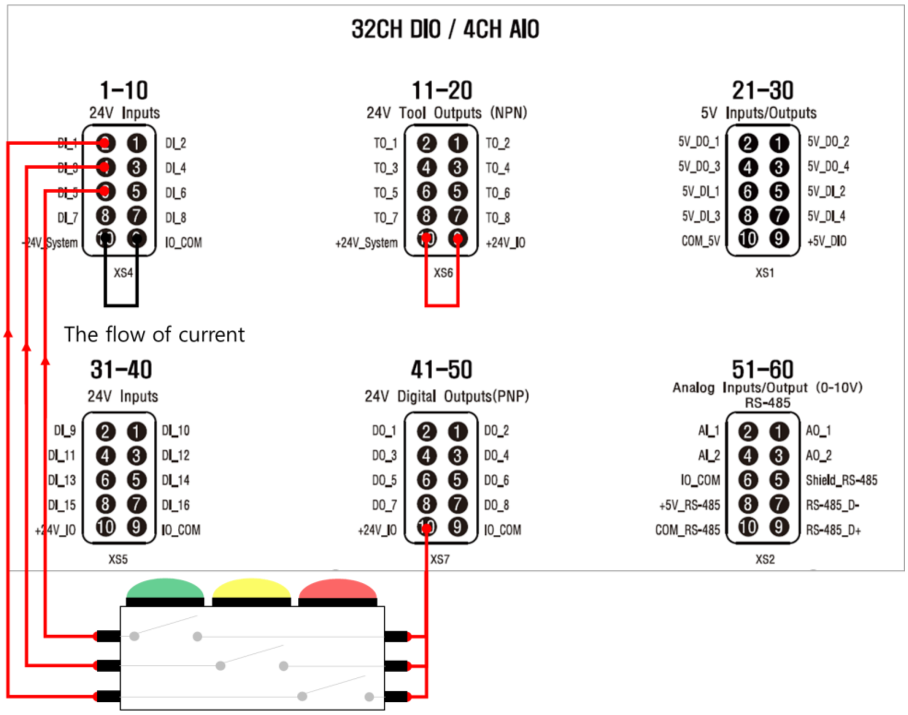


  It provides 24V digital signal inputs at the DIO 1-10, 31-40 terminal blocks located on the back panel of the control box. First connect the common +24V_IO and IO_COM to the (+) and (–) port of a sensor, respectively, to supply power to the sensor. Next, connect the output signal of the sensor to one port of terminal block 1-10 or 31-40 to complete the wiring. Conty's home screen or Servo/SmartIO in the upper menu bar of Setting can be used to check if sensor signal is coming in normally. Refer to **Section 6.1 Robot Settings** for a detailed explanation of sensor signal check.

The following is an example of connecting type 24V DC three-wire proximity sensor of NPN open collector type to digital signal input of the control box using relay.



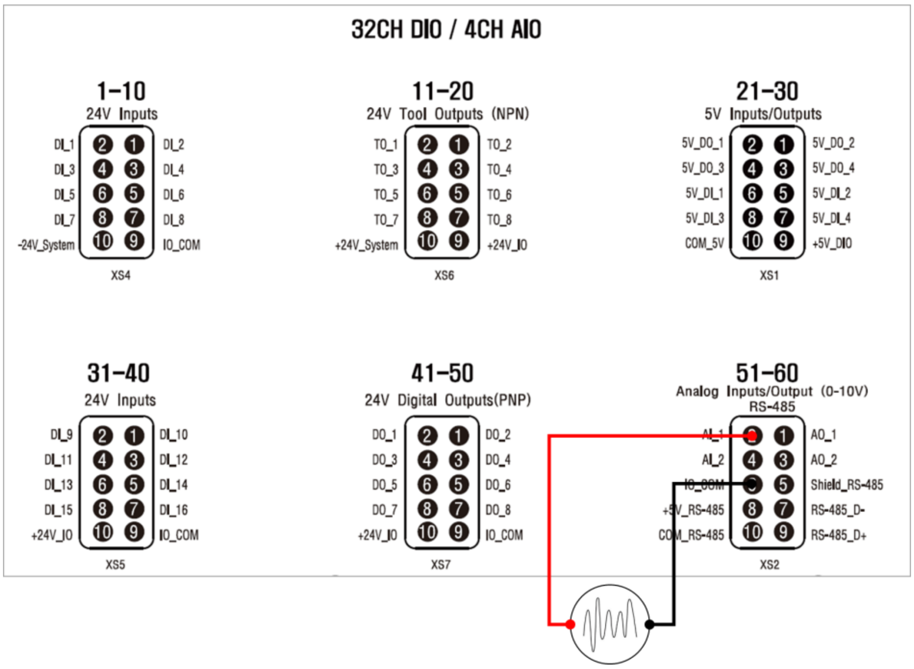
The following is an example of connecting a digital signal input from a button.



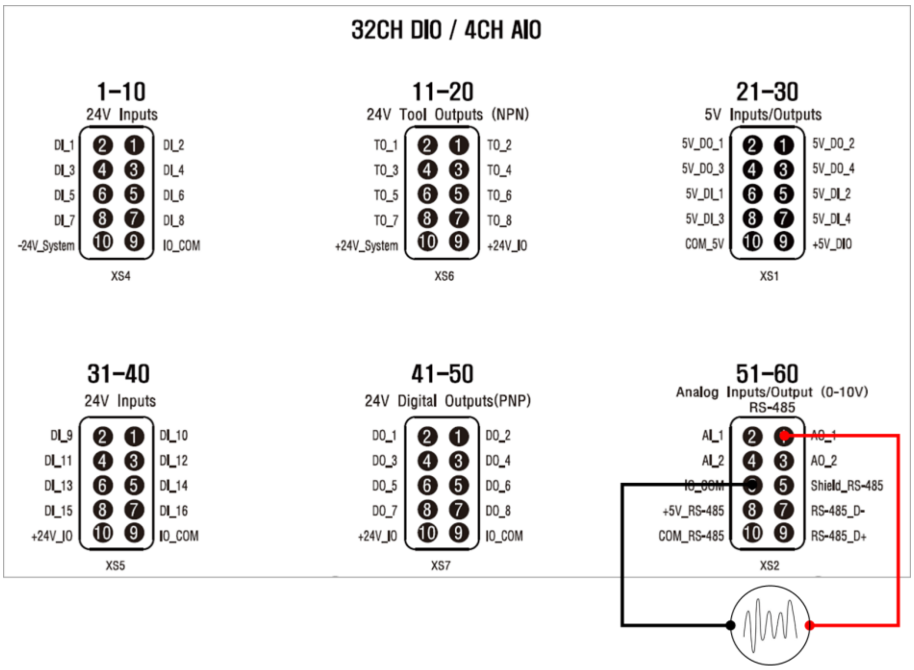
The 5V signal input connection method is the same as the 24V input connection method, only except that the power is already supplied internally like 5V signal output and the pins to be connected are different.

- **Analog signal Input and output**

The analog input and output modules convert the analog signal input to the control box into a digital value, and the digital value that is sent as a command value from the control box to an analog signal output. The following is an example of connection to an analog signal input.



Connection to the analog signal output is as follows.



The Terminal block 51-60 provides analog inputs and outputs, each of two channels, and can be used in the range of 0 to 10V.

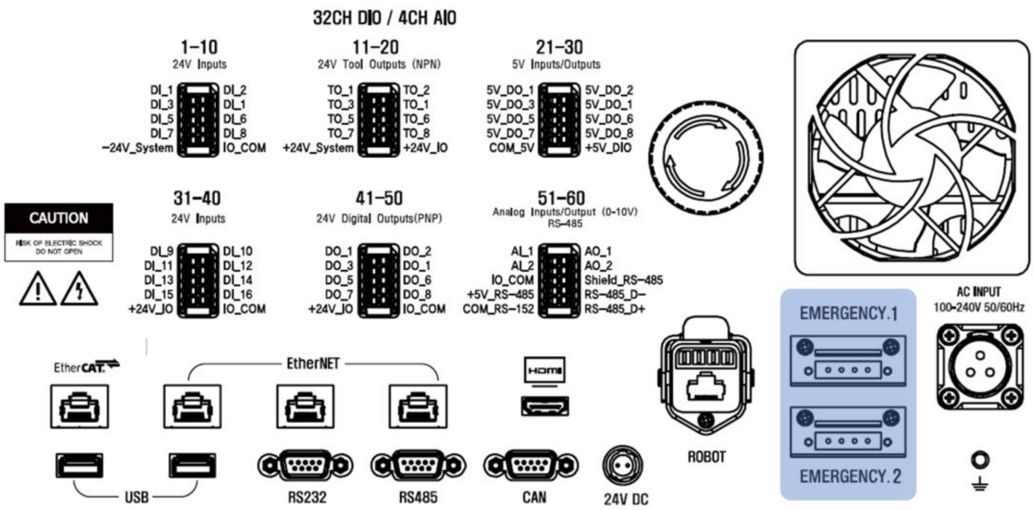
- **External control devices**

  Robot operation can be controlled by external control devices besides Conty. These external control units include PC or PLC, for example. The operation of the robot by the PC is possible by using TCP/IP socket communication connected to Ethernet ports of the control box. For PLC, Modbus TCP or digital signal-based method can be applied. In the case of using Modbus TCP, it is used in connection to the Ethernet port of the control box. In the case of using digital signal, it is used by connecting to digital I/O terminals. Refer to **Section 6.1 Robot Settings** for how to operate the robot using digital signals. For a detailed description of TCP/IP and Modbus TCP of the control box, see **Indy Communication User Guide** available separately.

Connecting Emergency Stop Buttons

Emergency stop is a safety feature that immediately stops all robot operations in case of an emergency. Therefore, this function should be available in spite of any fault in the signal connections, so the emergency stop is connected by the double wiring method. The double wiring means that a signal line that carries the same signal must be connected in plural to normally transmit the signal. It is a kind of safety mechanism to prevent the signal from being transmitted to the remaining normal signal line if any one of them cannot transfer a signal due to any problem such as disconnection. Therefore, if a problem occurs in one or more of the signal lines connected to the emergency stop, the power supplied to the robot is immediately shut off automatically.

Two emergency stop terminals are provided on the rear panel of the control box as shown below.



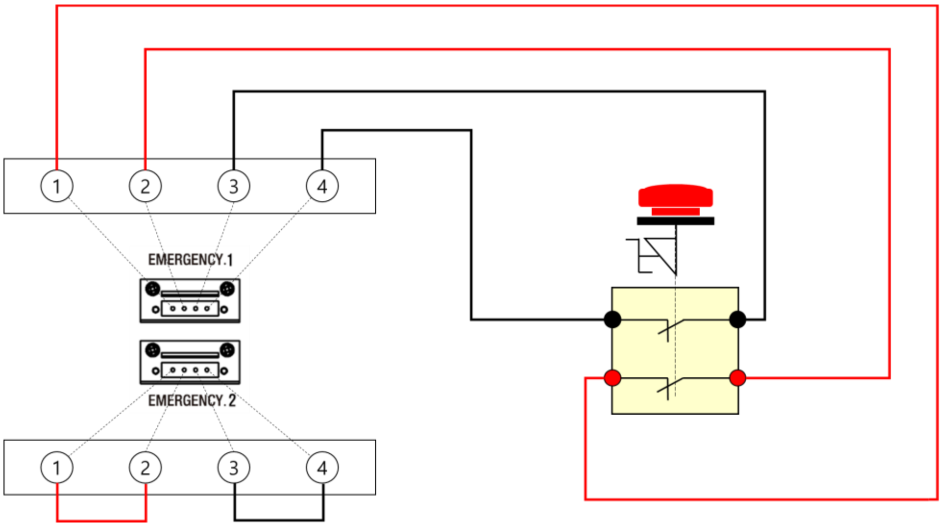
name	description
EMERGENCY. 1	It is connected with the default emergency stop cable.
EMERGENCY. 2	Additional emergency stop terminals provided.

Warning

The function related to emergency stop must be connected to the specified position. Failure to comply with this warning could result in a malfunction of the emergency stop in the event of an emergency, resulting in serious injury or property damage. The function should also be checked periodically for abnormalities.

- **Default configuration**

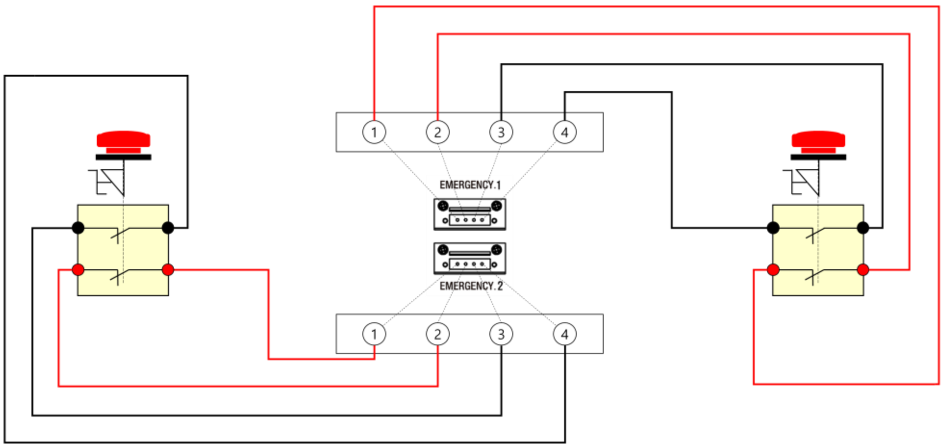
  The control box is shipped with the default emergency stop configuration at the factory. The initial configuration is as follows.



When EMERGENCY. 2 is not used, it must be short-circuited.

- **Additional emergency stop button**

  An additional emergency stop button can be connected to the other emergency stop terminal as follows.

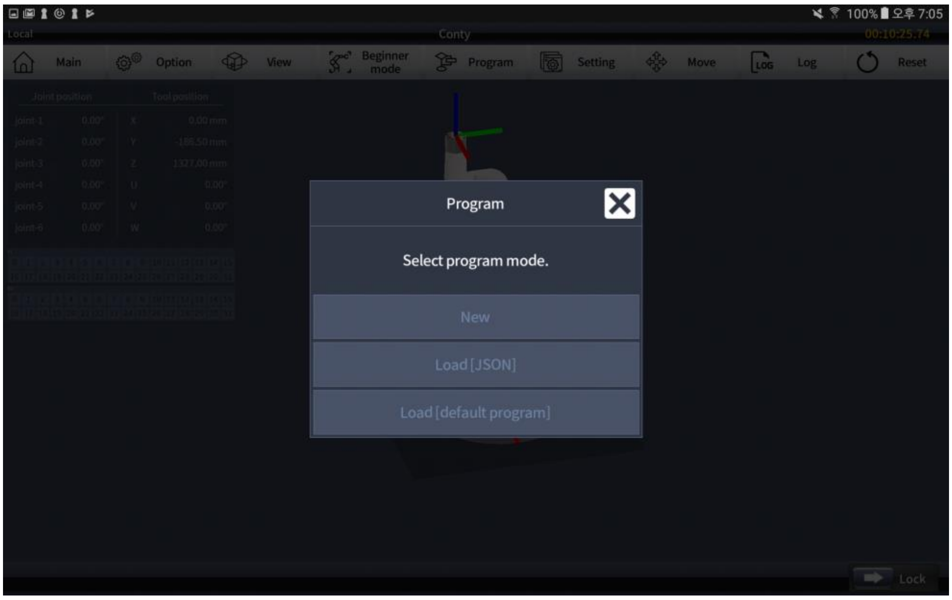


5 Programming

The process of adding instructions, or commands, which will be executed sequentially by the robot to perform intended operations automatically is called programming. For example, this allows the robot itself to grip objects and move them to another location, or to decide to take a number of behaviors based on sensor signals. Programming starts when you select Program on the home screen of Conty.

5.1 Start Program

In Start Program screen shown below, you can begin programming by creating a new program, by importing an existing program, or by loading and editing the program specified as the default program.

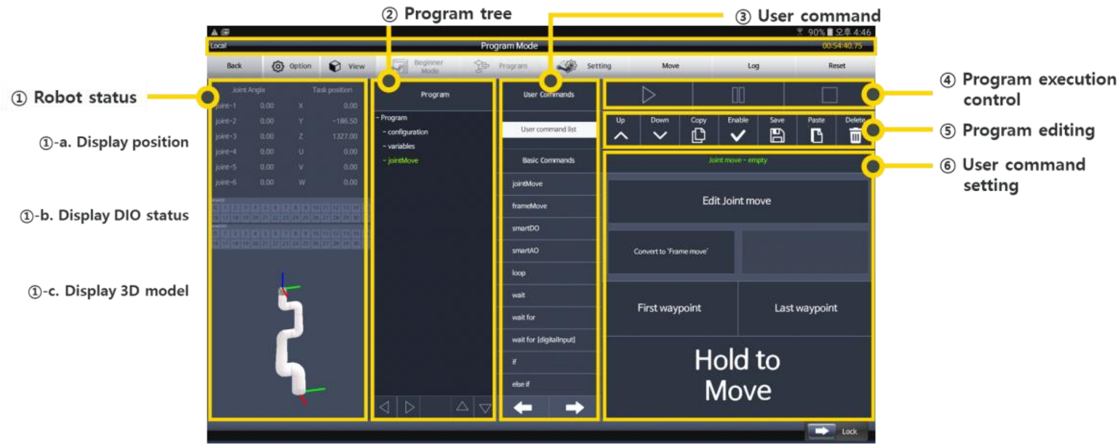


- **New**
  It creates a new program.
- **Load [JSON]**
  It loads a program created by Conty (of version 1.6.12 and the later).
- **Load [default program]**
  It loads one of the default programs stored in the control box. Refer to **Section 5.4 Program** for details of the default programs.

In this chapter, we will start a new program. Touch **New** to create a new program.

5.2 Programming Screen

The programming screen consists of the robot status window, the program tree window, the user command and setting window, and the program execution control and editing window. Each window has its own role as follows:



① Robot status

- a) The information on the joint position and the tool position of the robot are displayed in real time.
- b) Digital I/O status is displayed in real time.
- c) The robot motion is shown using the Conty's 3D renderer in real time with the specified target waypoints displayed.

② Program tree

- The program commands you have created are listed in tree format. When the program is executed, the commands in the program tree are executed in the order from top to bottom in principle.

③ User command

- a) In the user command list, you can edit the names of motions created by the user.
- b) The basic commands necessary for programming are shown in the basic command list and you can select them from the list.

④ Program execution control

- It gives you the ability to run, pause, resume, and stop the current program you have created.

⑤ Program editing

- It provides the ability to save the current program or edit commands in the program tree.

⑥ User command setting

- It shows the menu required for setting the selected command in the program tree.

5.3 Program Tree

Conty provides tree-based programming of robot operation.

The tree is the minimum unit of the program. A tree consists of a number of branches. Fixed branches are those provided by default in all programs, such as program setting and execution options, which can be edited only within a limited range, while free branches are those that can be freely created and edited using basic commands or application commands.

Fixed branch

It is a branch that is created automatically at program startup. You cannot add or delete the following commands in these branches, nor can their positions in the tree be changed.

- **Program**
  It allows you to save the current program as the default program. The default program is copied to the control box so that the program can be executed by the control box alone or as triggered by an external device, without executing Conty. The maximum number of the default programs is ten.
- **Configuration**
  It sets the program execution option, such as how to execute the program when collision against the robot is detected during program execution.
- **Variables**
  It declares the variables used in the program. There are five types of data and initial values are set for each.

Free branches

It is a branch created by the user, and commands can be added or deleted freely. The command can be repositioned arbitrary in the tree.

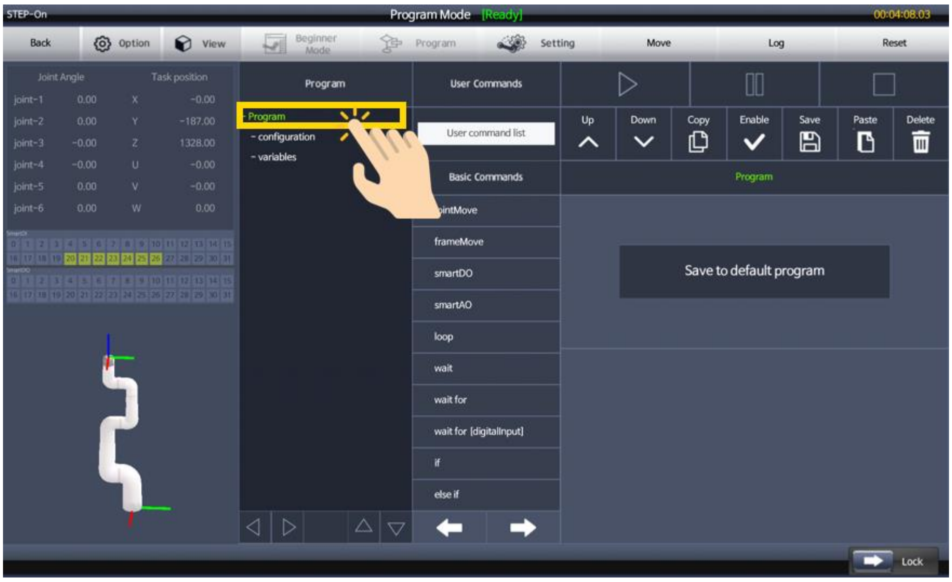
- **Basic commands**
  They represent the primitive instruction of the program tree. It implements a set of essential programming commands such as robot movement, input/output of various signals, and program flow control.
- **Application commands**
  They are application-specific commands which is a set of selectively provided commands according to a tool or a peripheral device specifically installed in the robot.
- **IndyCARE commands**
  They are IndyCARE-specific commands which is a set of commands for sending, to the data server, the data selected for monitoring in the configuration of the program tree.

Every branch contains at least one command, and some branches can hold a subtree. In this case, the subtree is called the child tree, and the tree containing the subtree is called the parent tree. Child trees belonging to the parent tree display its ownership visually by explicit indentation, and the state of the tree is displayed in color.

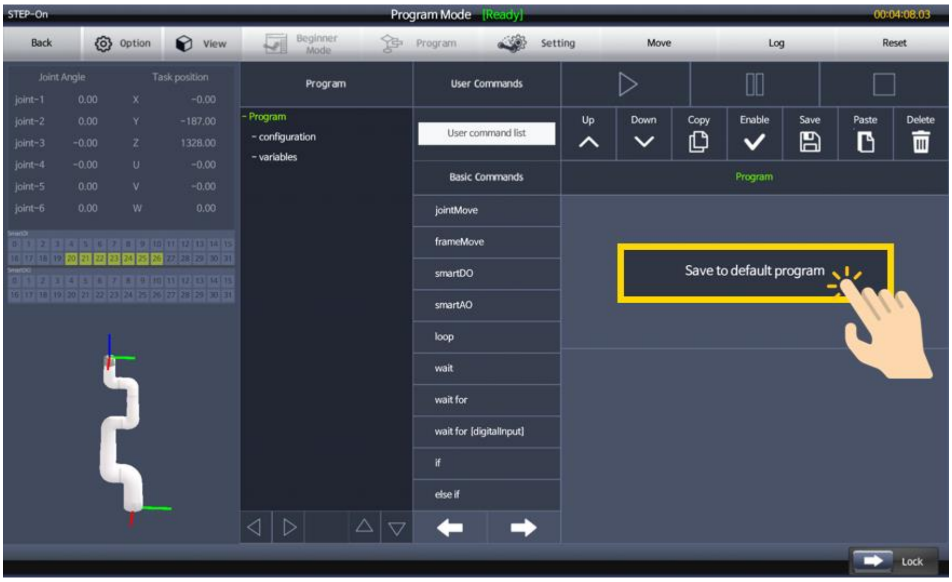
5.4 Program

It saves the current program as the default program. The default program is copied to the control box so that the program can be executed by the control box alone or triggered by an external device, without executing Conty. One can save the program as the default program as follows.

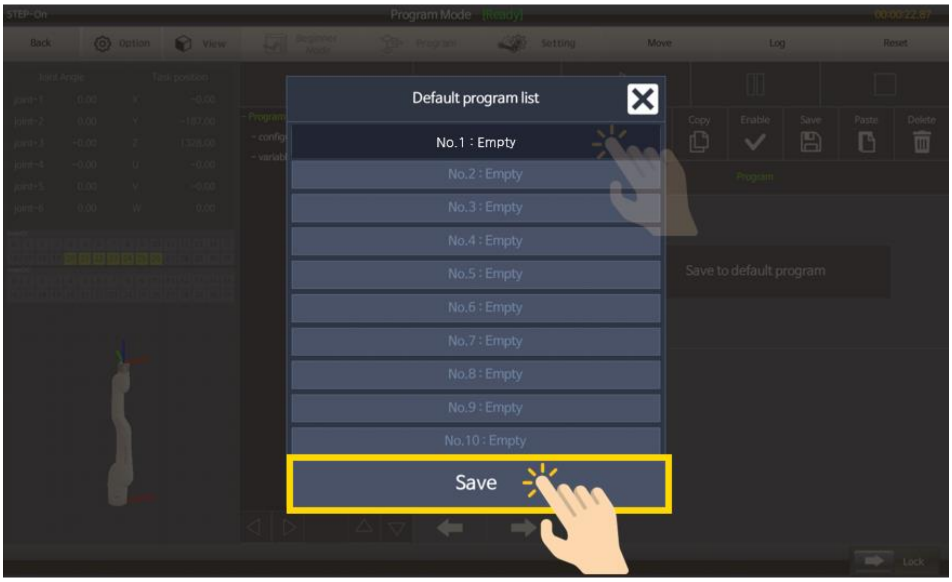
① In the program tree window, touch **Program**.



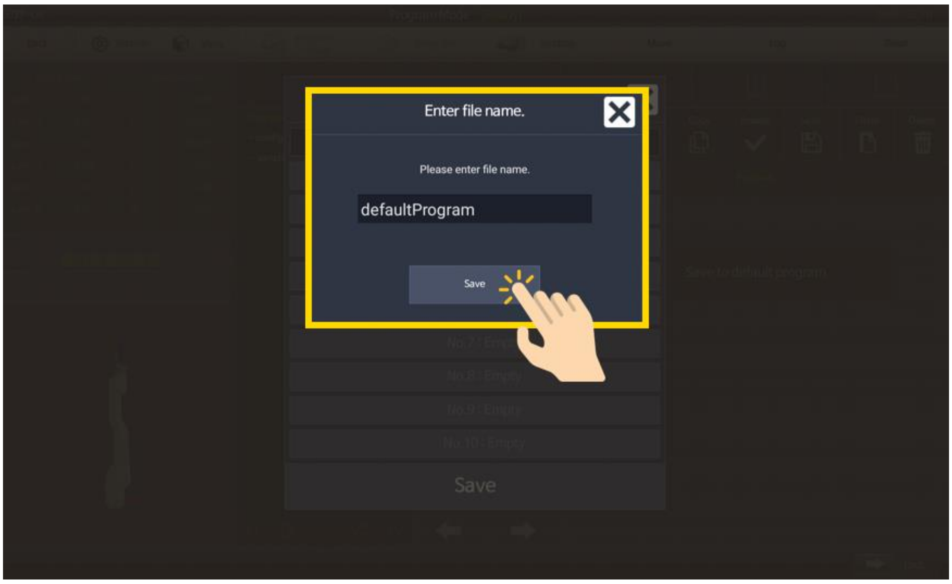
② Touch **Save to default program** in the menu on the right window.



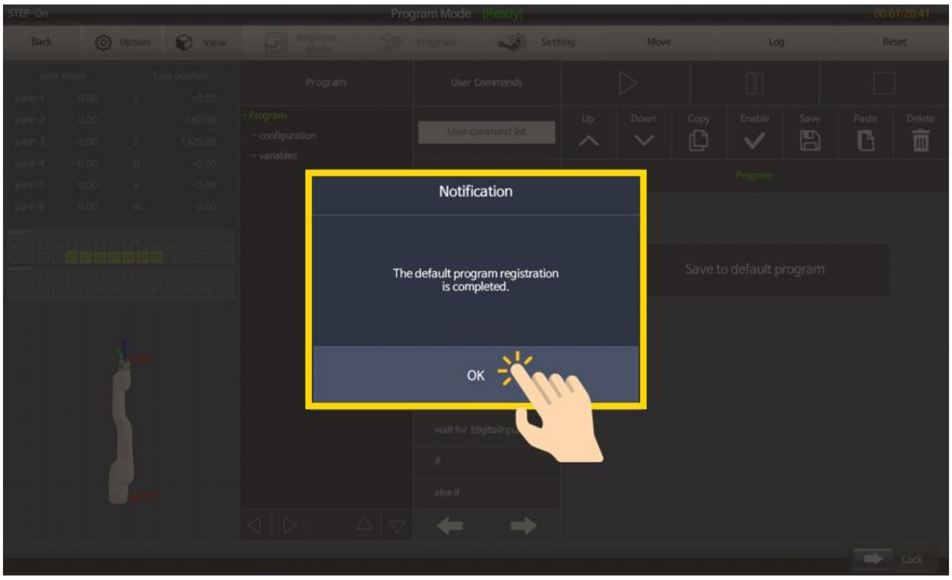
③ A list of default programs that are saved is displayed as follows. We will save the current program as the default program in the first slot. Select **No.1: Empty** and touch **Save**.



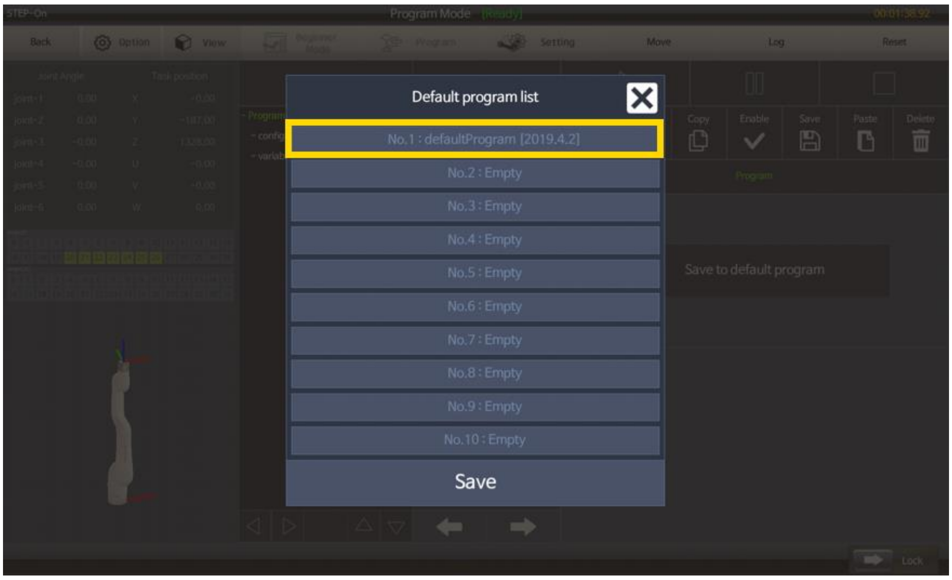
④ Enter the file name and touch **Save**.



⑤ If the message "**The default program resistration is completed**" is displayed, registration is completed normally. Touch **OK**.



⑥ If you touch **Save to default program** again on the right side of the screen, the basic program is displayed with the file name registered in the first slot as follows.

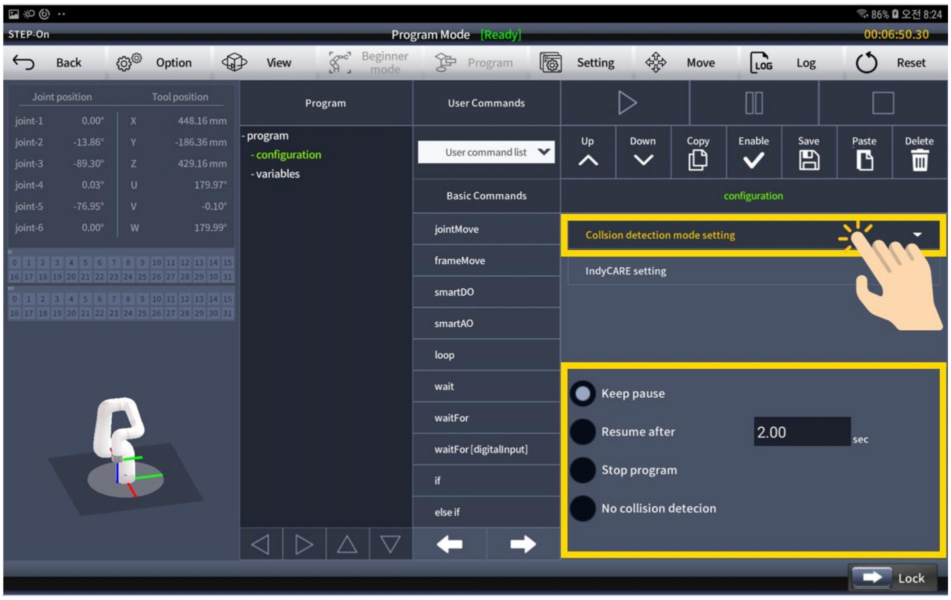


5.5 Configuration

It sets the options which activate only during program execution.

Collision Detection Mode

It sets the options when collision against the robot is detected during program execution. There are a total of four options.



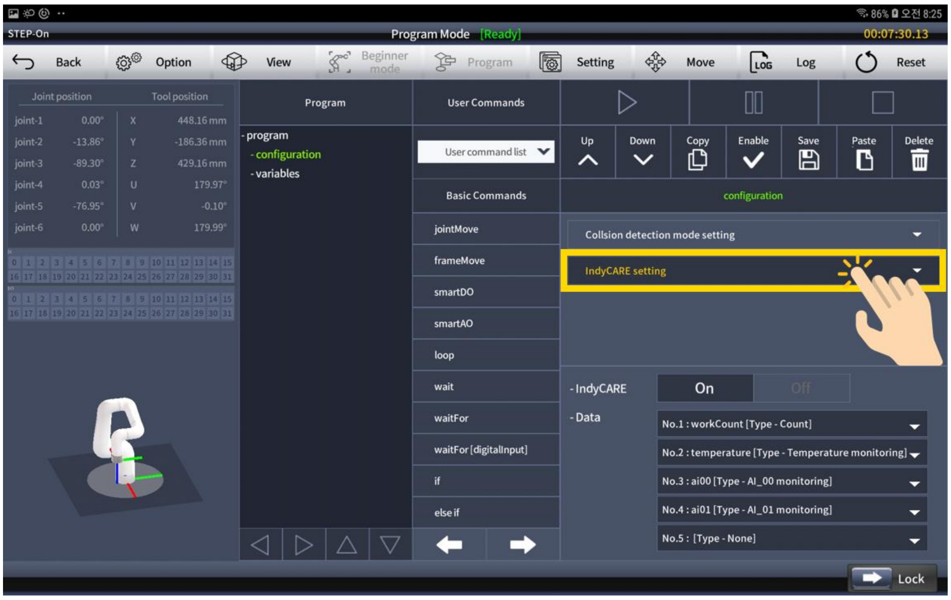
- **Keep pause**
  Upon collision detection, the program pauses while keeping stopped.
- **Resume after**
  Upon collision detection, it will pause and restart after the time set on the right field.
- **Stop program**
  Upon collision detection, the program stops running.
- **No collision detection**
  Turn off collision detection and run the program.

Danger

Do not turn off the collision detection function when you operate the robot in automatic mode in a workspace shared by human operators. If you turn off collision detection and use it, be sure to use a safety fence to prevent people from approaching it. In addition, you should refer to the relevant regulations of international standards and domestic laws and perform a risk assessment before use. For a detailed description of the risk assessment, see **Section 1.7 Risk Assessment**.

IndyCARE Setting

It sets the option for usage of IndyCARE.

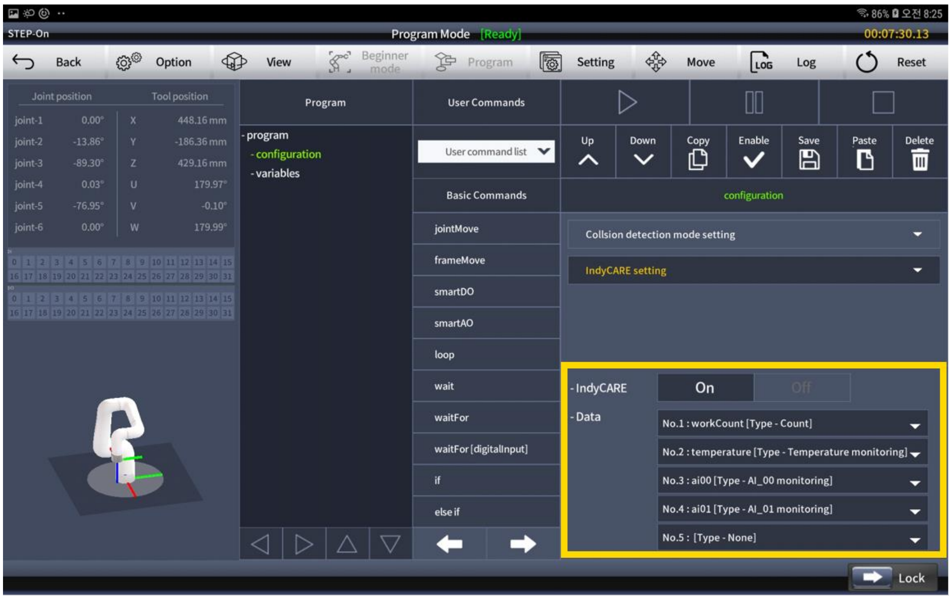


- **Enable/Disable IndyCARE**

  Touching **Enable** starts IndyCARE service, and touching **Disable** stops IndyCARE service,

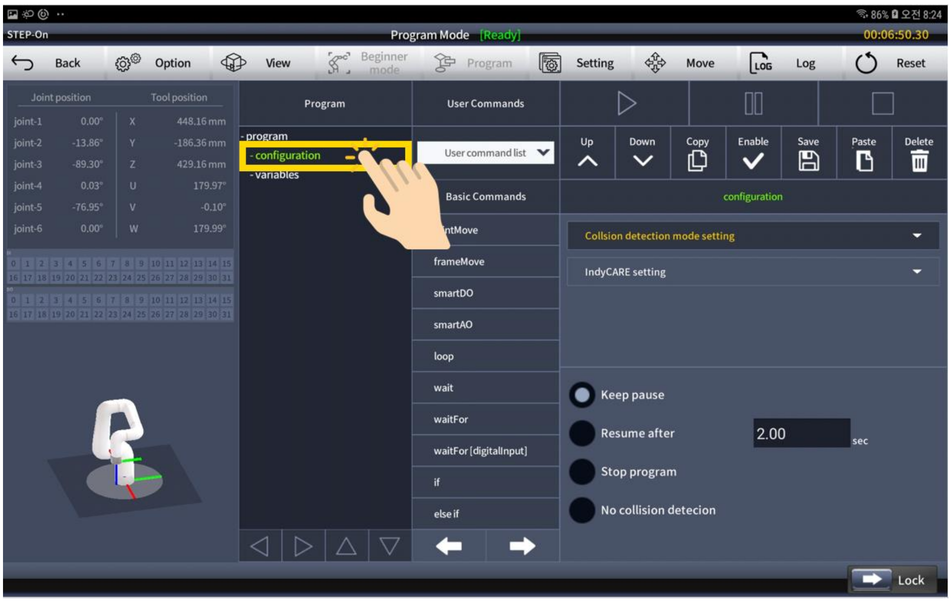
- **Setting Data**

  One can register and rename the data which will be monitored in IndyCARE service. Maximum number of data is five. One can determine the type of monitored data for indyCARE:Count or indyCARE:Monitoring command.



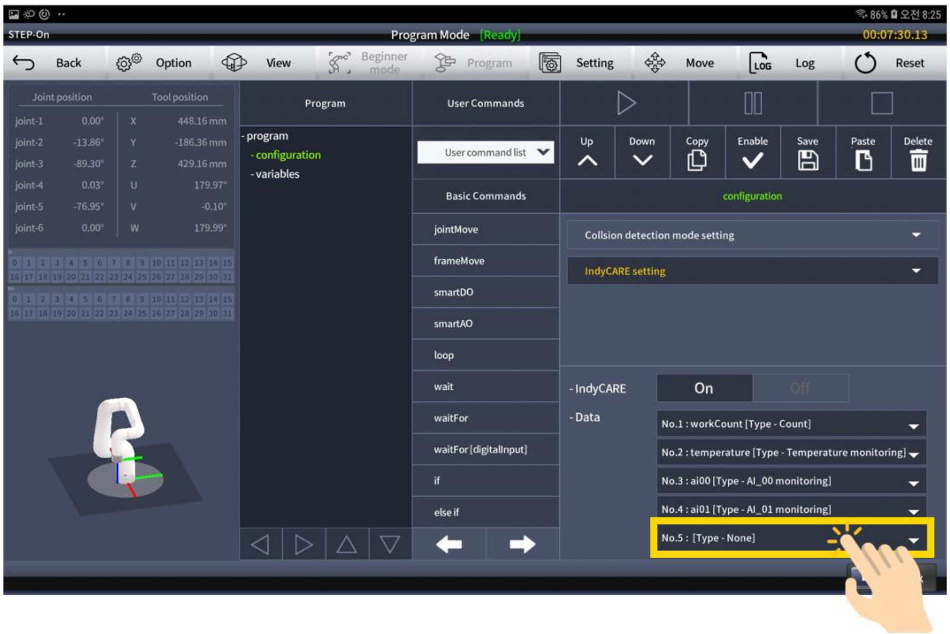
The following shows the steps to use IndyCARE service.

① Touch **configuration** in the program tree window.

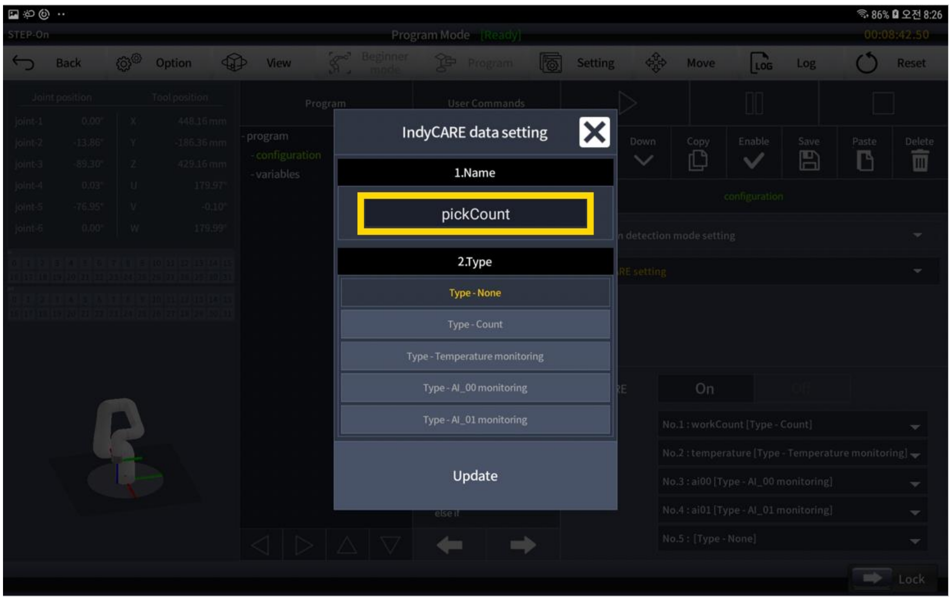


② Touch **IndyCARE setting** in the right configuration window, and touch **Enable** in IndyCARE option.

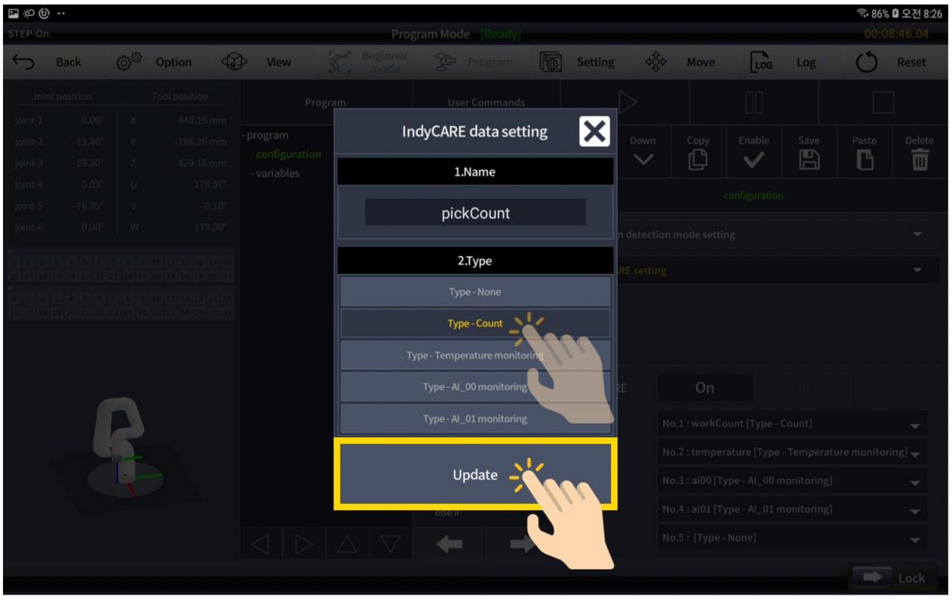
③ In order to register the data which will be monitored in IndyCARE service choose a suitable one in the five fields in **Data setting** option.



④ The following window appears for registering a data for monitoring. First, touch the field below **1. name** and fill in the name, say pickCount.



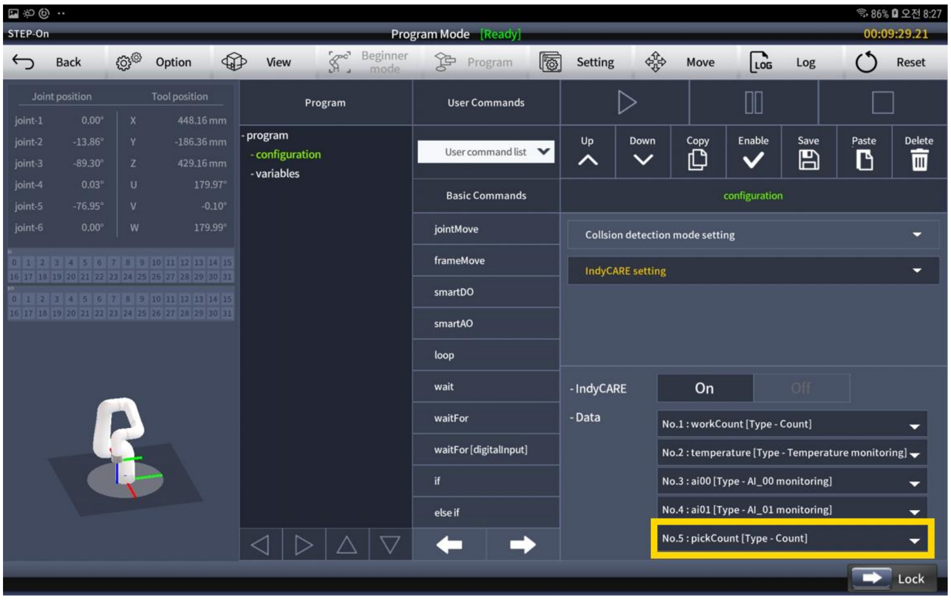
⑤ Next, choose the type for the data, and touch **Update**.



There are five predefined types for monitored data.

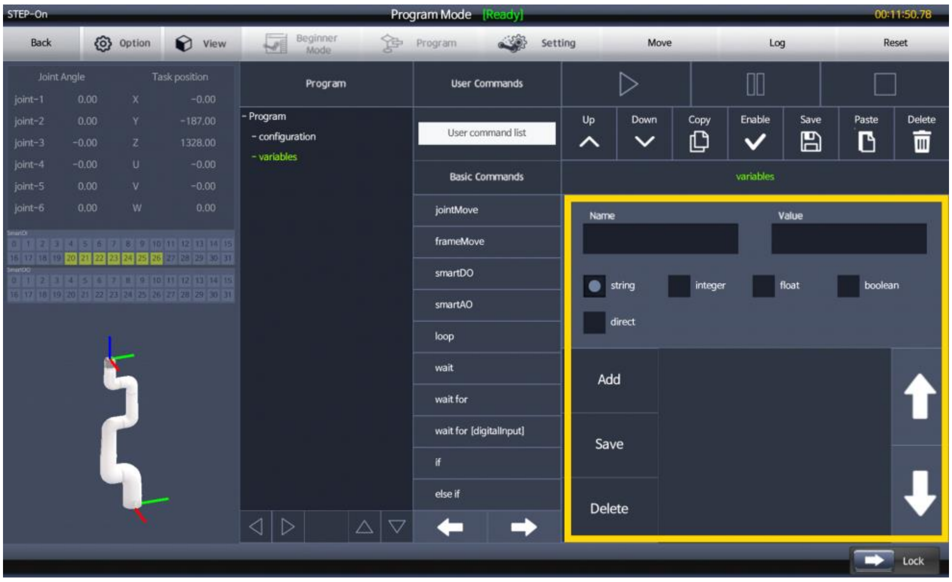
Data type	Description
Type-None	Data with that name is not used as monitoring data.
Type-Count	This represents the type for monitored data in IndyCARE:Count command, and the data of this type reserves the accumulated number by which this command has been used. They are useful to measure the productivitiy of the process involving the robot.
Type-Temperature monitoring	This represents the type for monitored data in IndyCARE:Monitoring command, and is used for saving the temperature of each joint of the robot. These data are usefule for monitoring robot status.
Type-AI_00 monitoring	This represents the type for monitored data in IndyCARE:Monitoring command, and is used for measuring and saving the signal input to the analog input port 1.
Type-AI_01 monitoring	This represents the type for monitored data in IndyCARE:Monitoring command, and is used for measuring and saving the signal input to the analog input port 2.

⑥ All setting is completed to use IndyCARE service. For detailed description of IndyCARE commands refer to **Sec. 5.9 IndyCARE Commands**.



5.6 Variables

It declares the variables used in the program. A variable in a program is a place to store information, and is used to set the condition of conditional statements such as **if** command in the program tree. It provides five types of data in total and sets initial values for each.



- **string**

  It represents string literals. It has a string value like "abcd".

- **integer**

  It represents integral numbers. It has an integer value between -32,768 and 32,767.

- **float**

  It represents floating-point numbers with a decimal point.

- **boolean**

  It represents Boolean variables. It has one of two values: true or false.

- **direct**

  It represents predefined memory type variable. There are M, B, W, I, L, F, and D variable types, each of which has a memory address between 000 and 999. For example, you can freely use a variable type like B100 and allocate necessary memory address as a variable. It is mainly used for interfacing with external devices such as PLC. In particular, the M variables are used when using Modbus TCP. Refer to **Indy Communication User Guide**, which is supplied separately.

5.7 Basic Commands

The basic commands are the primitive commands that make up the program tree. They consist of essential programming commands such as robot movement, input/output of various signals, and program flow control.

Motion Commands

The motion commands are used to move the robot to the position you have specified.

- **jointMove**

  The robot moves along a curved path to the target position.

Features

This motion is possible at every position inside the workspace.

- To reach the home position or to transfer from one position to the other position for different movements
- If the tool center point path is not important
- If you want to avoid singularity. Particularly, when the joint 2, 3, and 5 start at 0 degrees, the target position is 0 degrees, or it is desired to move across 0 degrees (a part of the singular points exist near these positions)

- **frameMove**

  The robot moves in a straight line to the target position.

Features

It is used when the tool center point path is important. Due to singularity regions it may stop with an alarm before reaching the target position.

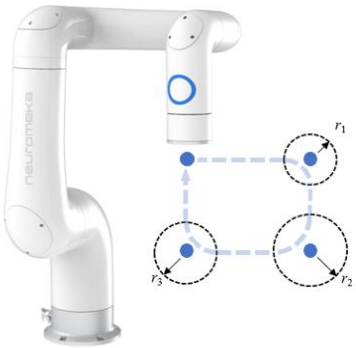
- If you need the robot to move along a straight path
- If you need to know the path of the robot, e.g. in a cluttered workspace

Caution

In the case of the six-axes robot, some joint of the robot is rapidly rotating as the robot approaches any of the singularity regions along the previously planned path. In order to prevent such malfunction, it will stop while generating an alarm when the robot approaches near singularity regions on the move. At this time, the robot may deviate from the planned path during the stopping process, so check the existence of the singularities through pre-tests before actual operation. If there is a singularity region during the path execution, it is necessary to modify the path, such as detouring the path by adding intermediate waypoints. If the modification cannot resolve the issue related with singularity regions the robot base installation position must be changed.

- **blending**

  The robot moves several waypoints to the final target position without stopping at intermediate waypoints by following a circular arc centered at the waypoint of the radius specified by the user. One can set in the blending option in the setting window of jointMove and frameMove.



Features

The robot starts the turn at the intersection of the current path and the circular arc of radius centered at the next waypoint, and ends the turn at the intersection of the next path and the same circular arc. For frameMove, the constant speed mode is provided additionally in the blending options.

- If you want to reduce travel time
- If you want to move all waypoints without stopping while maintaining the straight path segment maximally or move at constant speed

- **home**

  The robot moves to the home position preset by the user along an arbitrary curve.

Features

The robot moves to the home position preset by the user along an arbitrary curve.

- To move to home position
- When an alarm occurs

jointMove

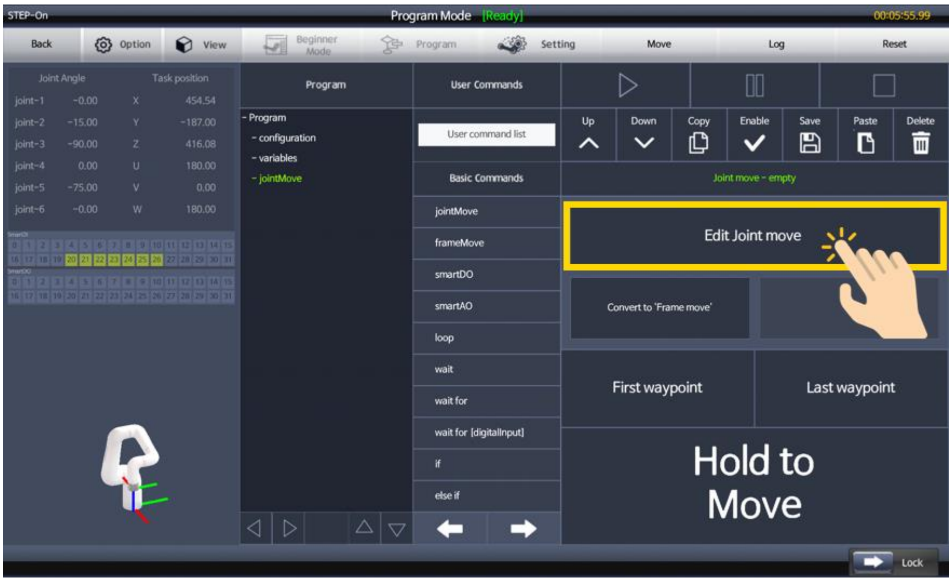
As shown in the following figure, we will move the robot across several waypoints using jointMove.

[Example]

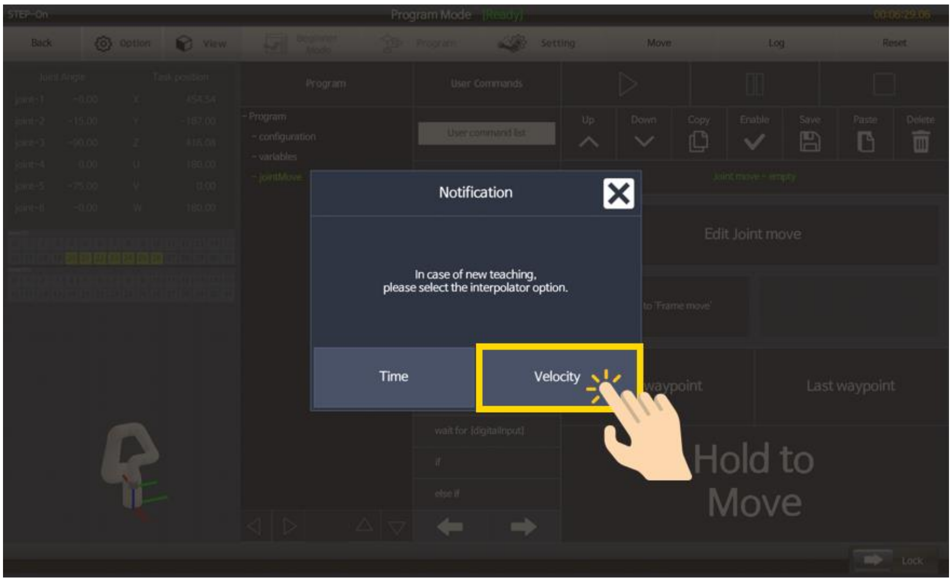
The robot is currently stationary at position 1, passes positions 2 and 3, and returns to position 1 again.

① On the Programming screen, select **jointMove** in the user command window and add it to the tree.

② Touch **Edit Joint move** on the right window.



③ Select the desired motion mode among the two modes.
(Take Velocity-based as an example.)



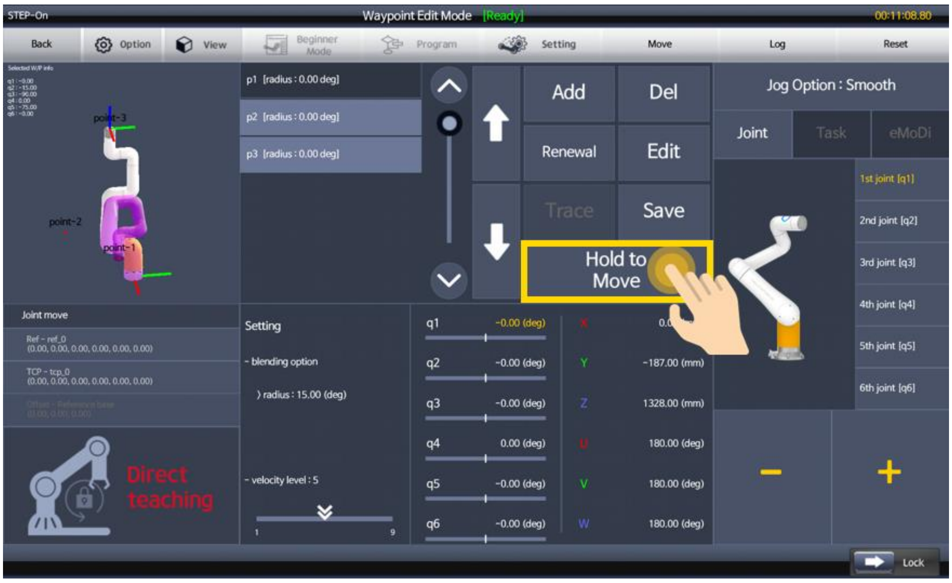
- **Time**
  The robot moves based on the time it takes to move to the target position.
- **Velocity**
  The robot moves based on the speed required to move to the target position.

④ Touch **Add** to add the current position as the first waypoint.

⑤ Move the robot to position 2 and select **Add** to add it as a second waypoint. (Refer to **Section 4.2 Basic Operations** for manual positioning of the robot.)

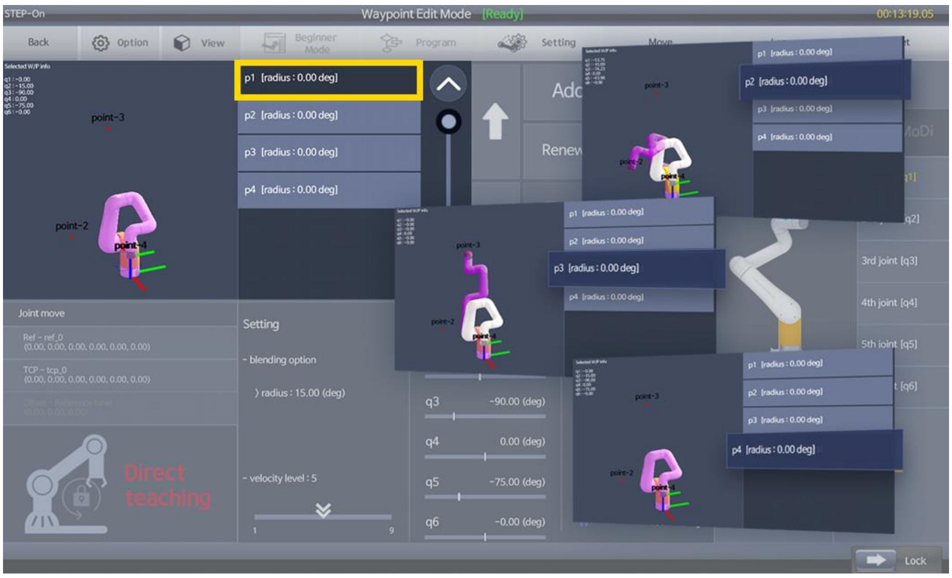
⑥ Add position 3 as the third way point in the same way as ⑤.

⑦ If you select the first waypoint and then press and hold **Hold to Move**, the robot moves to the first position. Keep pressing until you reach the target position.

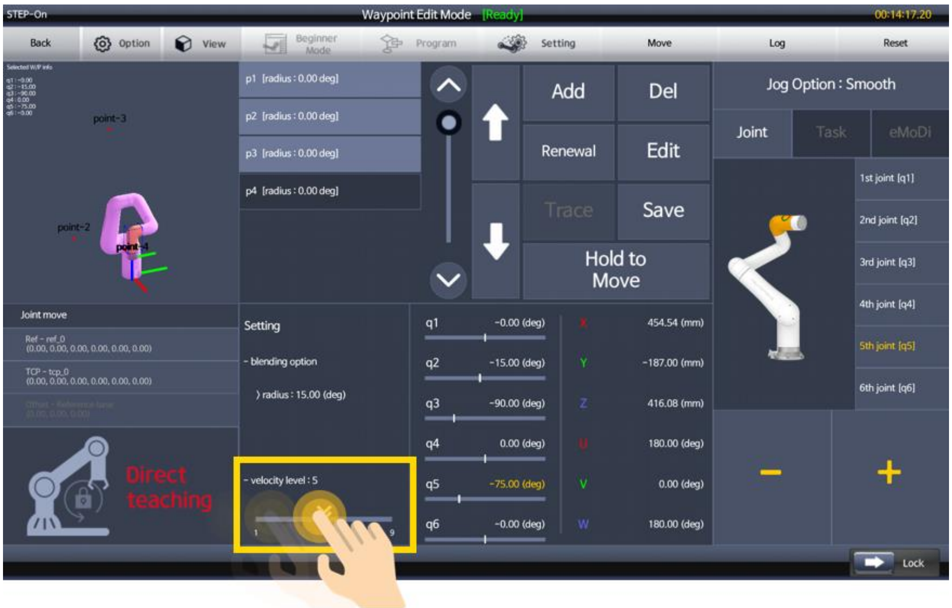


⑧ When the robot arrives at the first position, select **Add** to add it as a fourth waypoint. Note that, before adding the waypoint, select the third waypoint that is the last waypoint, and then select Add to add it after this waypoint.

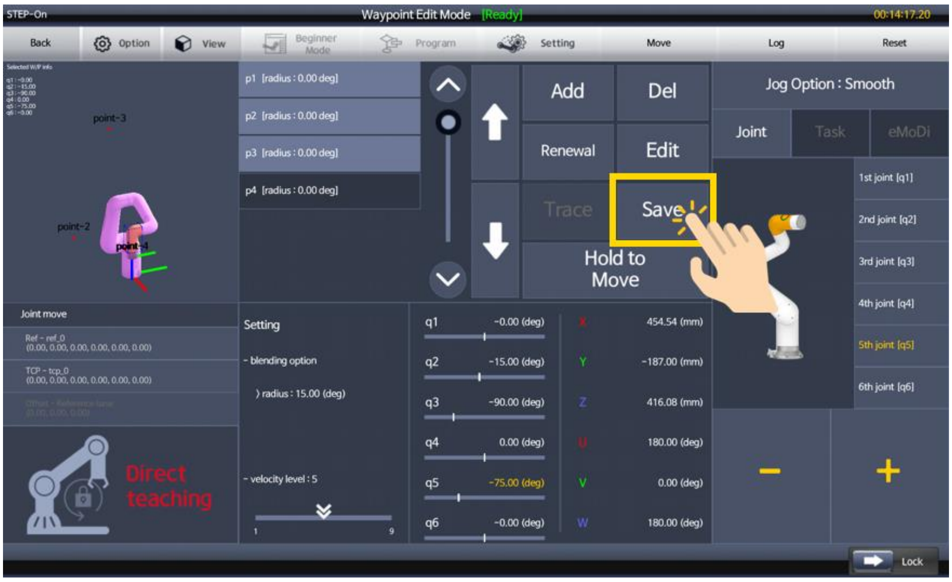
⑨ If you select each waypoint to make sure that all waypoint positions are set as desired, they will be displayed in purple on the left simulation window. Alternatively, just like ⑦, select the waypoint you want to check and press **Hold to Move**. Keep touching until you reach the target position.



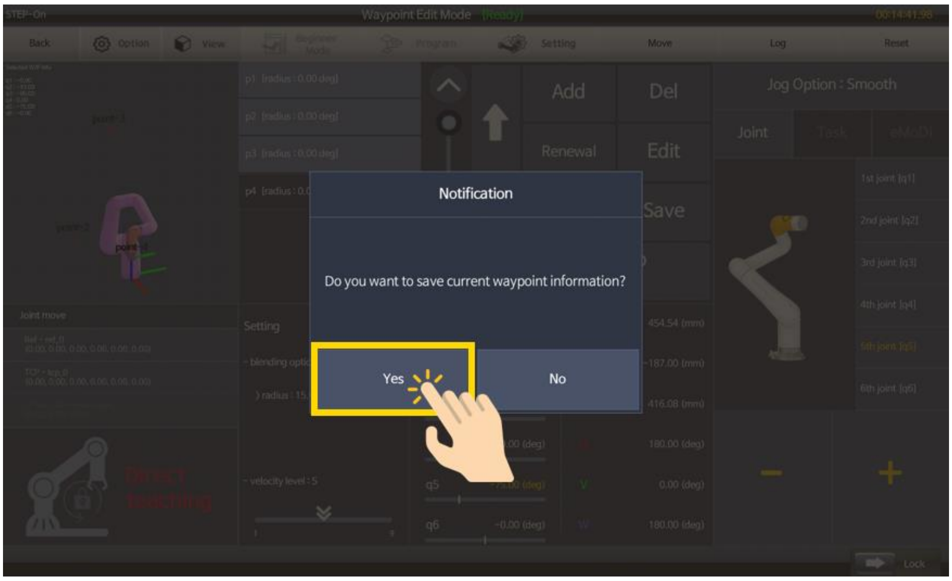
⑩ When you have finished checking the positions of all the waypoints, select the speed level in Setting in the bottom center window to set the travel speed. The speed level is selectable from level 1 to 9. The higher the number, the higher the speed. In this example, we will set the **speed level** to 5.



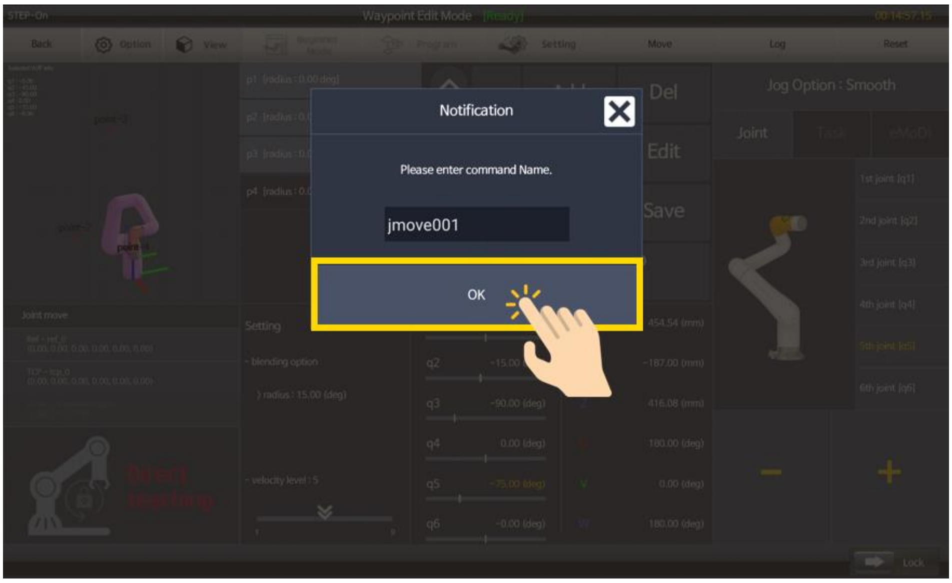
⑪ When all settings are complete, touch **Save**.



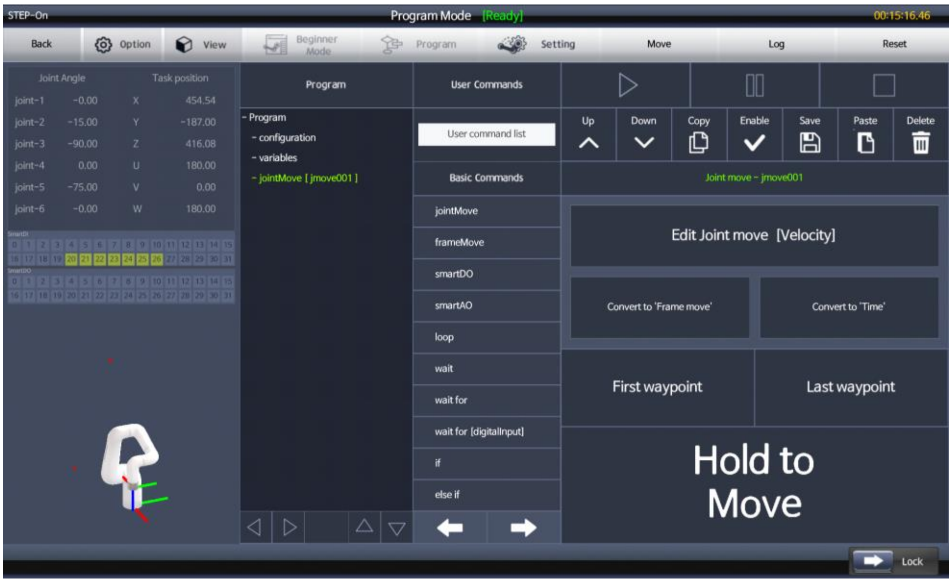
⑫ When the message "**Do you want to save current waypoint information?**" is displayed, touch **Yes**.



⑬ Finally, enter the motion name and touch **OK**.

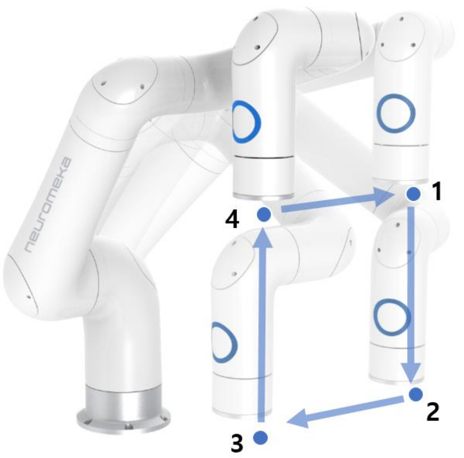


⑭ Now your jointMove setup is complete.



frameMove

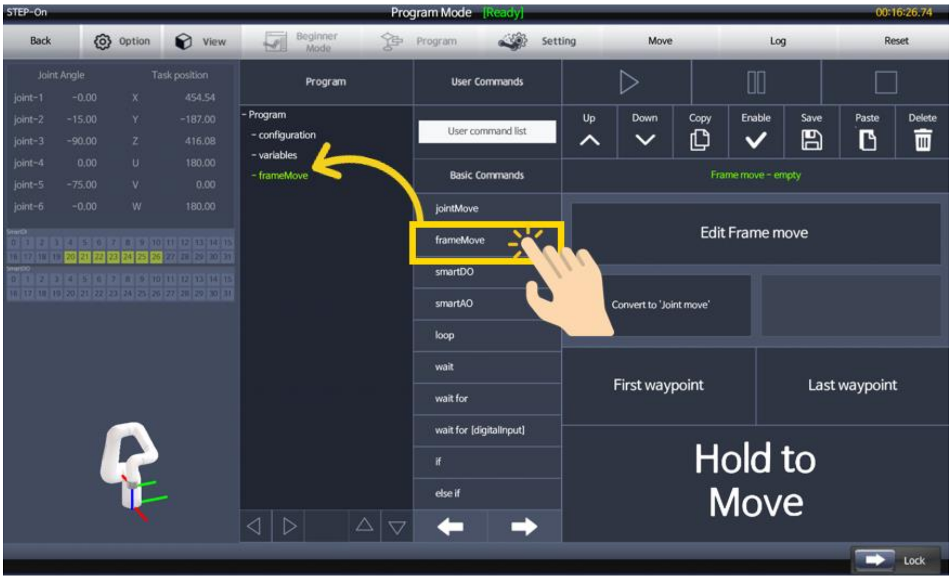
As shown in the following figure, we will move the robot across several waypoints using frameMove.



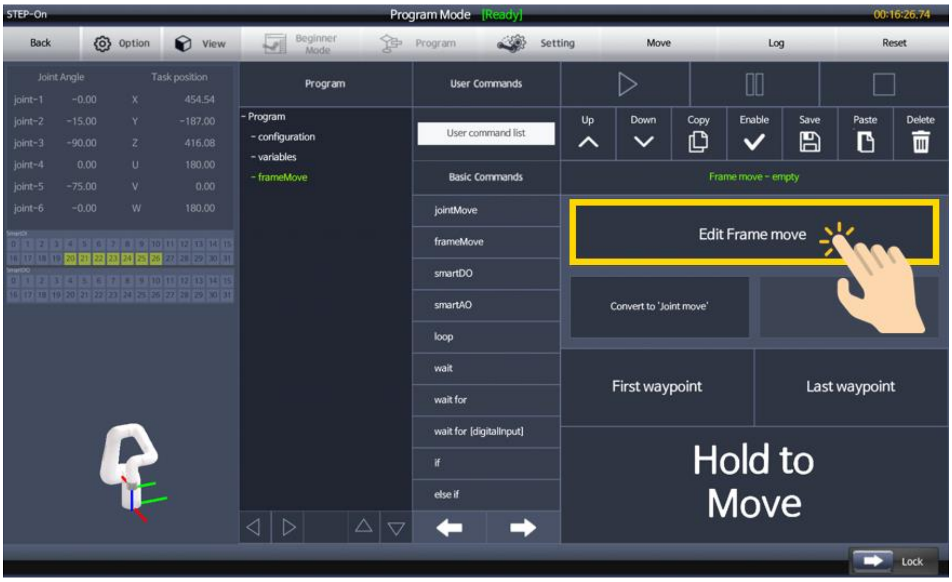
[Example]

The robot is currently stationary at position 1, passes position 2 to position 4, and returns to position 1 again, all along straight lines.

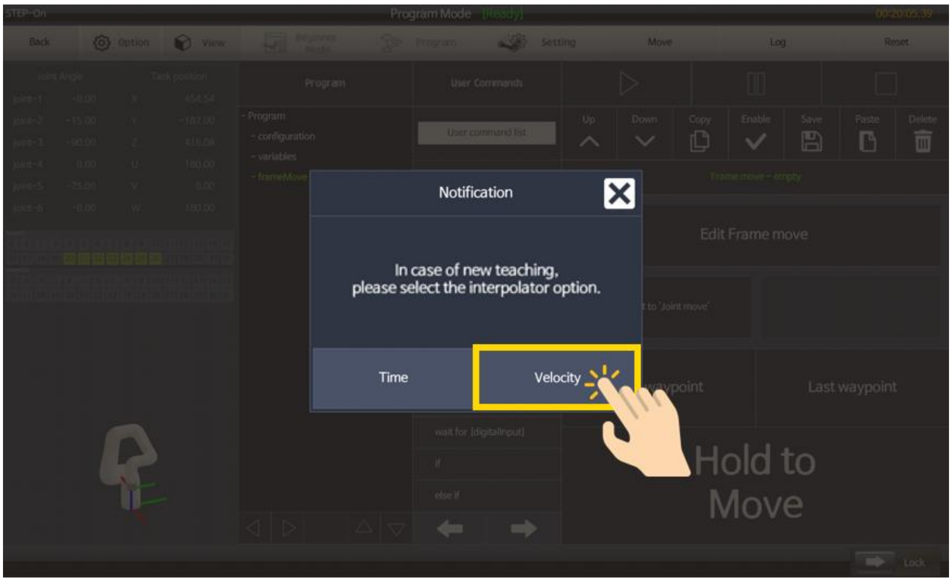
① On the Programming screen, select **frameMove** in the user command window and add it to the tree.



② Touch **Edit Frame move** on the right window.



③ Select the desired motion mode among the two modes.
(Take Velocity-based as an example.)



- **Time**
  The robot moves based on the time it takes to move to the target position.
- **Velocity**
  The robot moves based on the speed required to move to the target position.

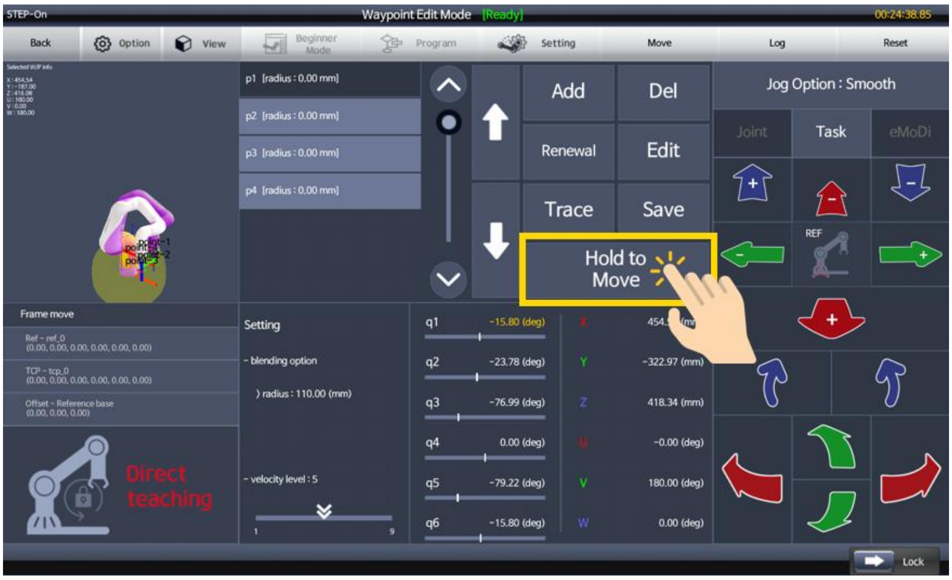
④ Touch **Add** to add the current position as the first waypoint.

⑤ Move the robot vertically down to position 2 and select **Add** to add it as a second waypoint. (Refer to **4.2 Basic Operations** for manual positioning of robot.)

⑥ Move it to position 3 horizontally and add it as a third waypoint in the same way as ⑤.

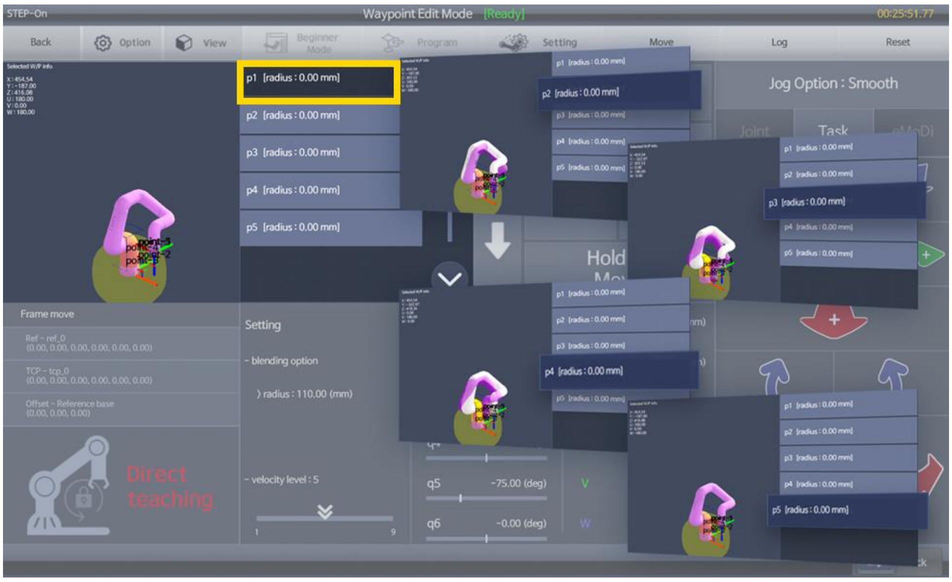
⑦ Move vertically to position 4 in the same manner as in ⑥, and add it as the fourth waypoint.

⑧ If you select the first waypoint and then press and hold **Hold to Move**, the robot moves to the first position. Keep pressing until the robot reach the target position.

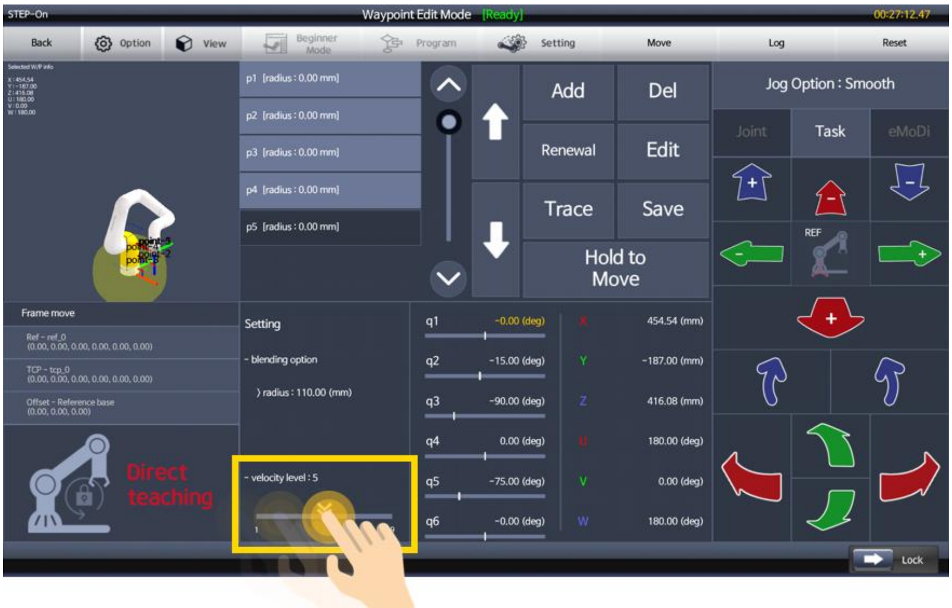


⑨ When the robot arrives in the first position, select **Add** and add it as the fifth waypoint. However, before adding the waypoint, select the fourth waypoint again as it is the last waypoint, and then select Add to add it after this waypoint.

⑩ If you select each waypoint to make sure that all waypoint positions are set as desired, they will be displayed in purple on the left simulation window. Alternatively, you can select the waypoint you want to check in the similar manner as ⑧ and press **Hold to Move**. Keep touching until the robot reach the target position.

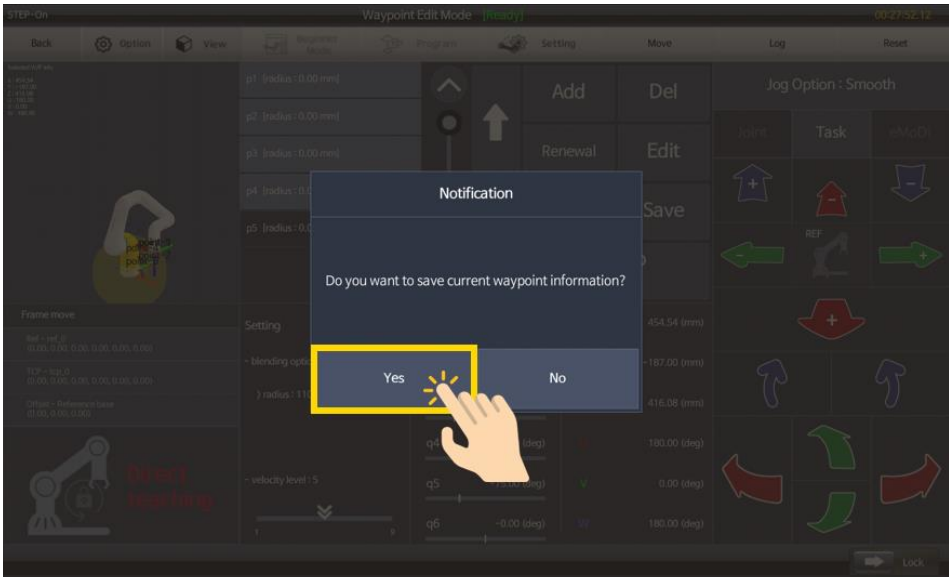


⑪ When you have finished checking the position of all waypoints and paths connecting them, select the speed level in Setting in the bottom center to set the travel speed. The speed level is selectable from level 1 to level 9. The higher the number, the higher the speed. In this example, we will set the **speed level to 5**.

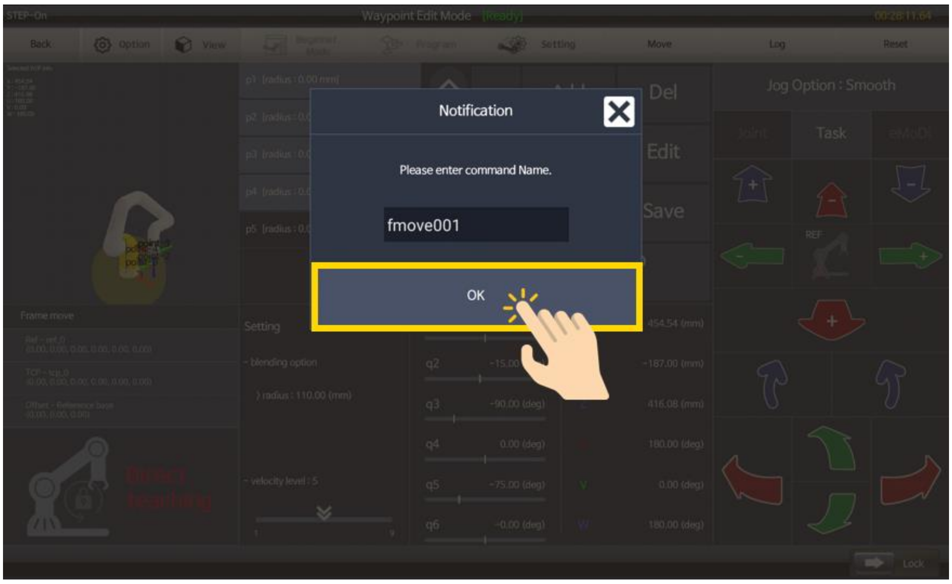


⑫ When all settings are complete, touch **Save**.

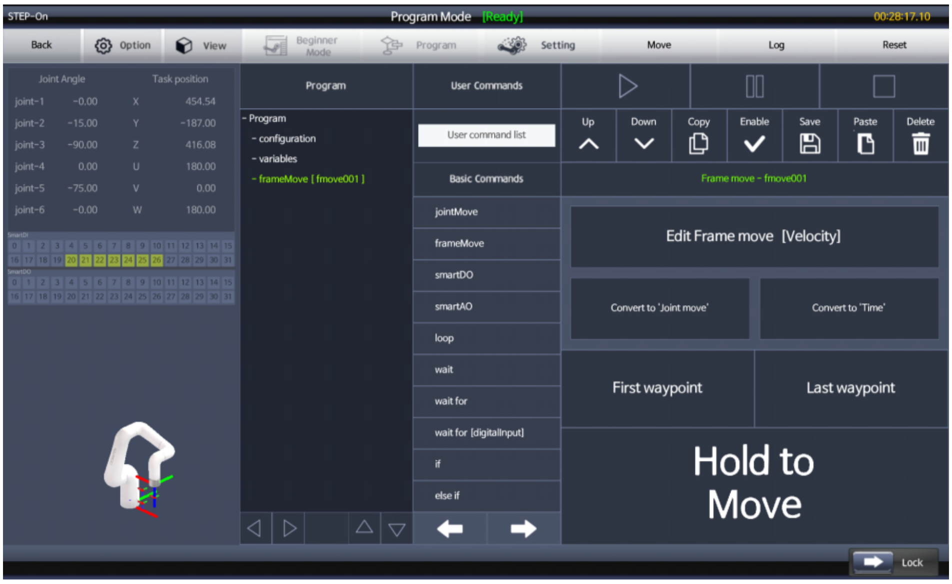
⑬ When the message "**Do you want to save current waypoint information?**" is displayed, touch **Yes**.



⑭ Finally, enter the motion name and touch **OK**.

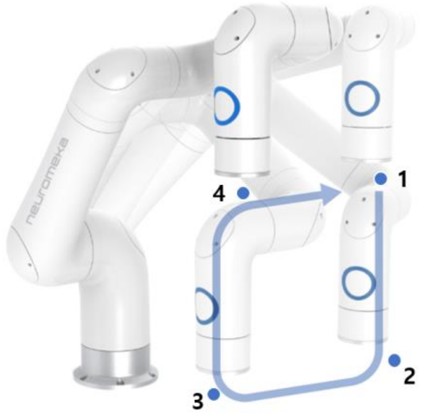


⑮ Now the frameMove setting is complete.



blending

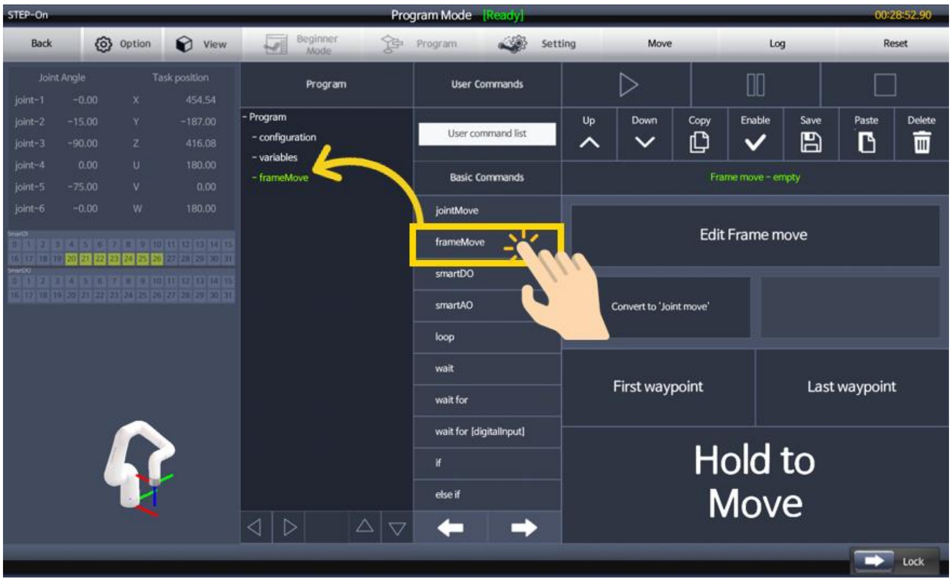
As shown in the following figure, we will move the robot across multiple waypoints using blended arcs.



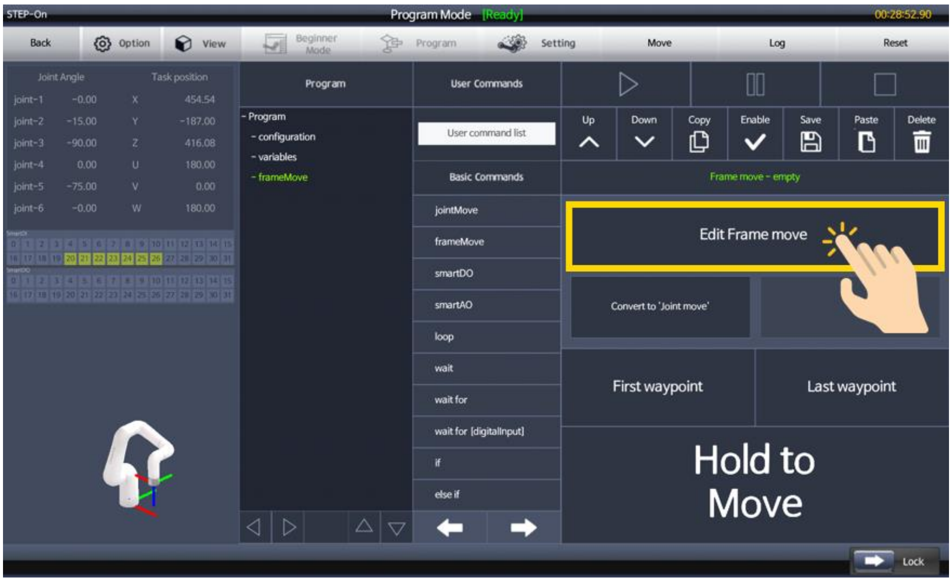
[Example]

The robot is currently stationary at position 1, passes position 2 to position 4, and returns to position 1 again, all along straight lines. Use blending to trace along blended arcs at intermediate waypoints without stopping.

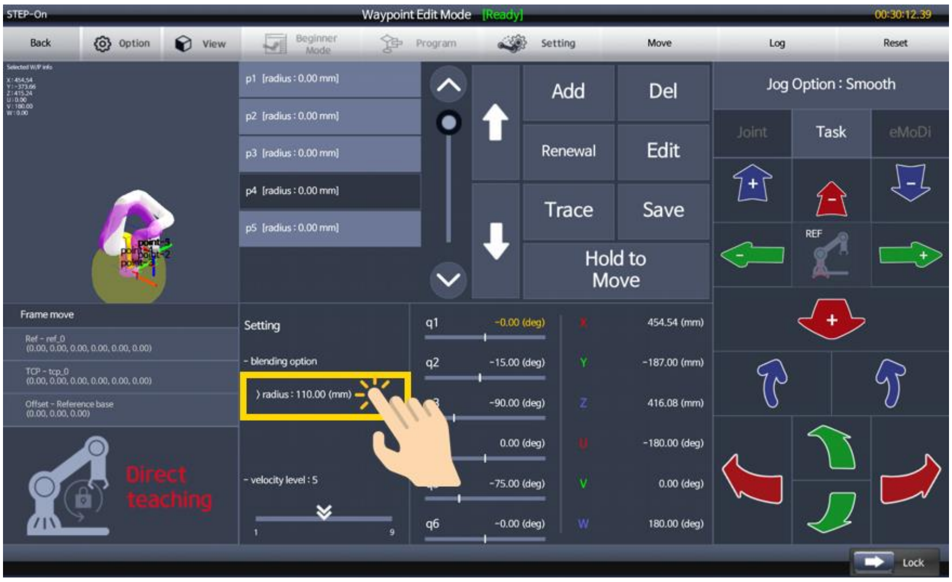
① On the Programming screen, select **frameMove** in the user command window and add it to the tree.



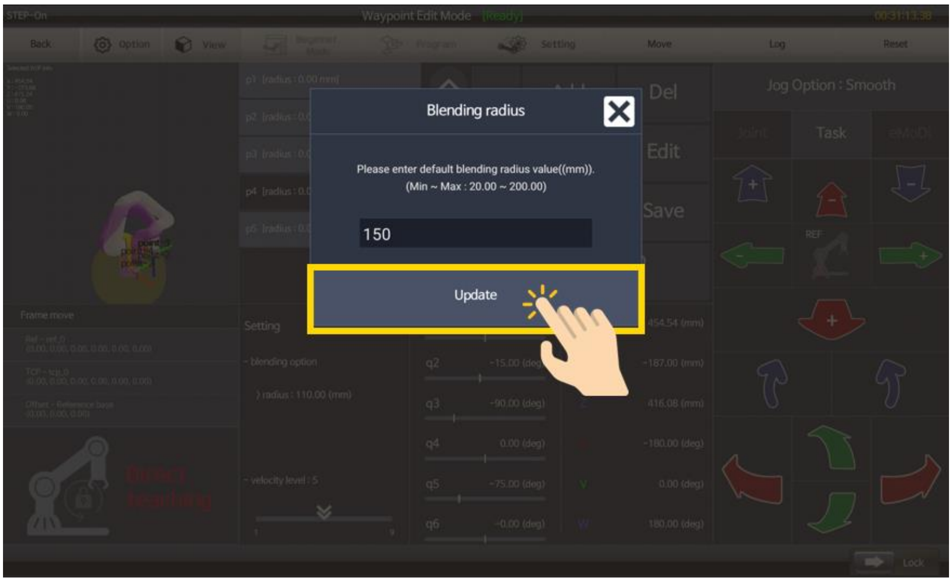
② Touch **Edit Frame move** on the right window. Follow the previous **frameMove example** in the exactly same way to create the waypoints along straight line segments.



③ When all waypoints have been set, touch the **radius** in Setting window in the center bottom to set the default blending radius value.



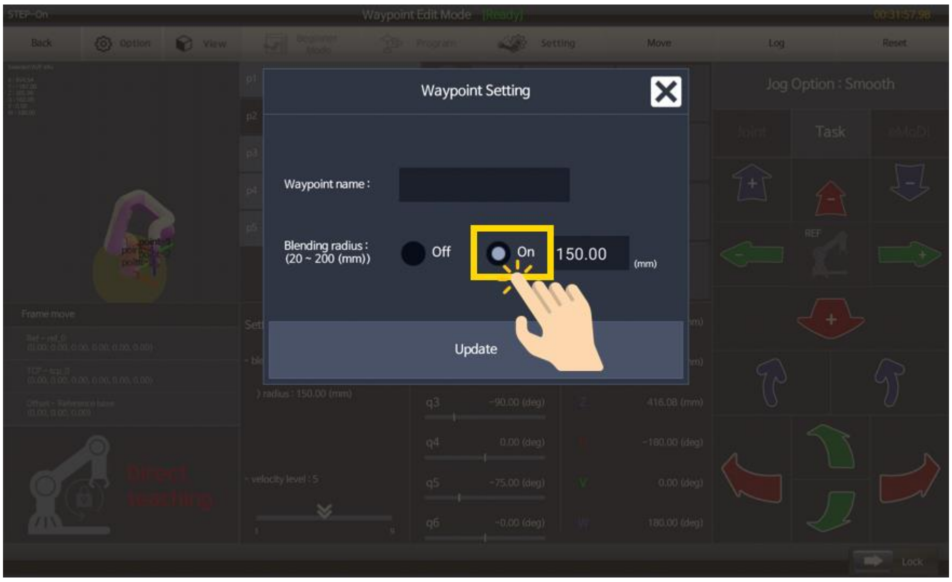
④ To set the radius value, enter "150" in the edit box and touch **Update**.
(The blending radius input unit is mm for frameMove, and deg for jointMove.)



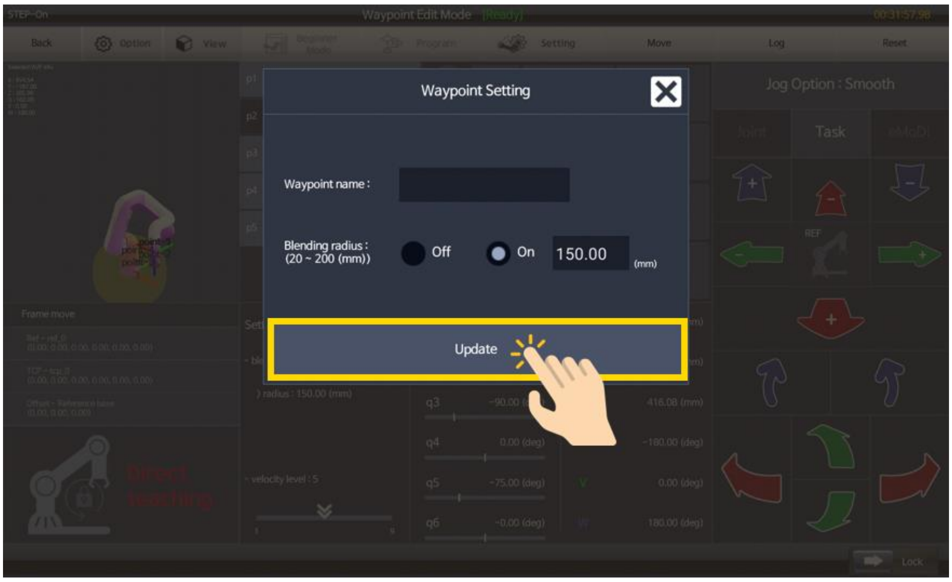
⑤ The changed radius information can be checked in Setting as below.

⑥ Select the second waypoint and touch **Edit**.

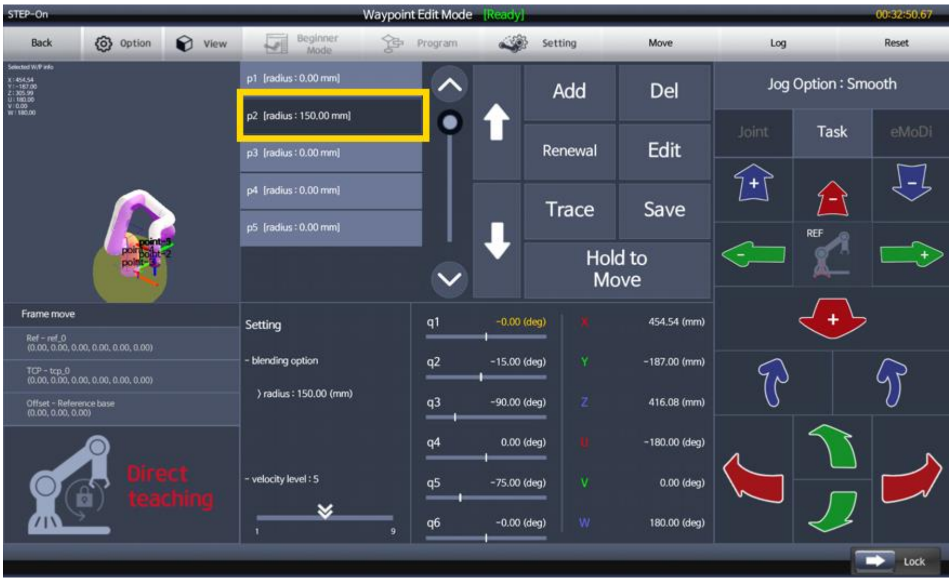
⑦ In the waypoint setting dialog select **On** in the Blending radius.



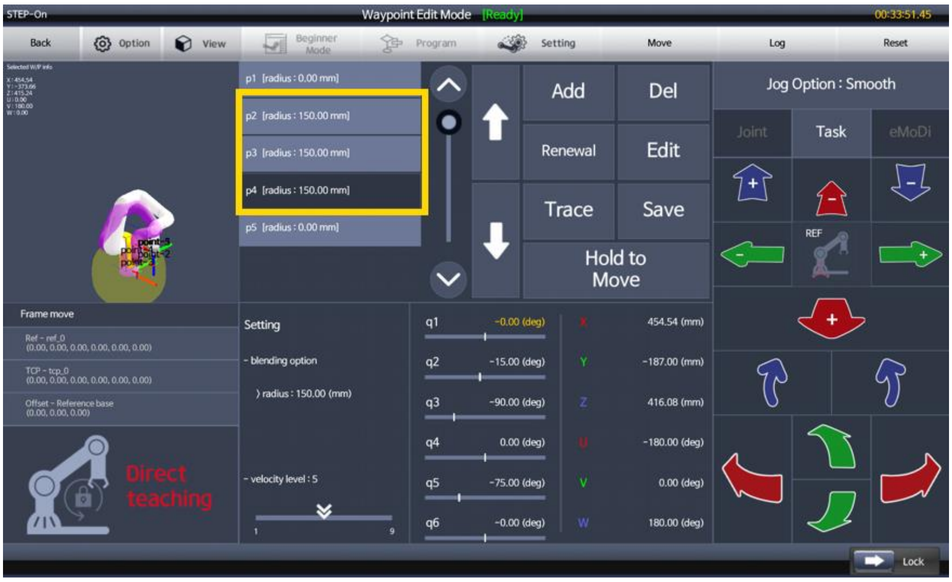
⑧ Upon touching the On button the radius value is automatically set to 150 (mm) in the right field. The radius value set in ③ ~ ⑤ is entered as the default radius of blending option. Touch **Update**.



⑨ Now the radius of the second waypoint blending has been changed.

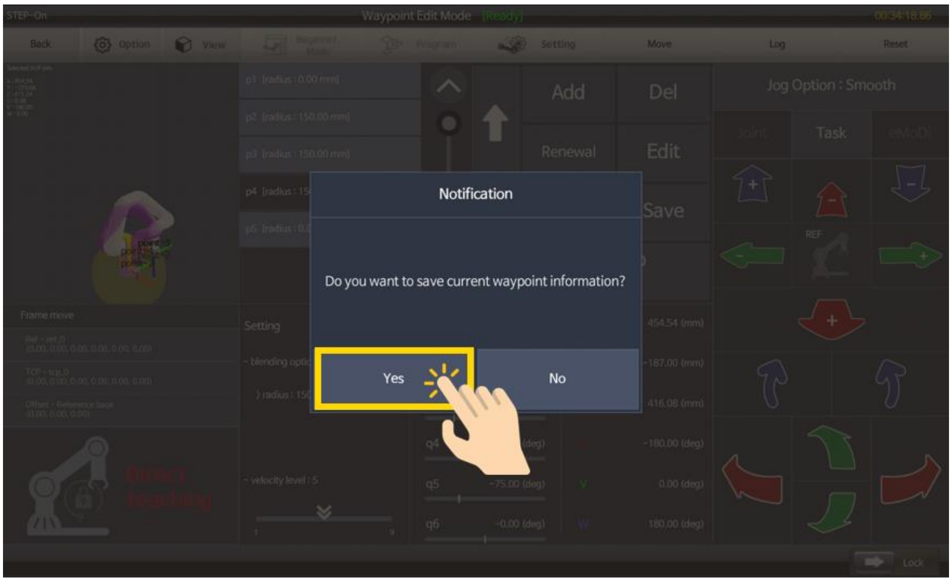


⑩ Change the radius to 150mm for the third and the fourth waypoints in the same way as ⑥~⑧.

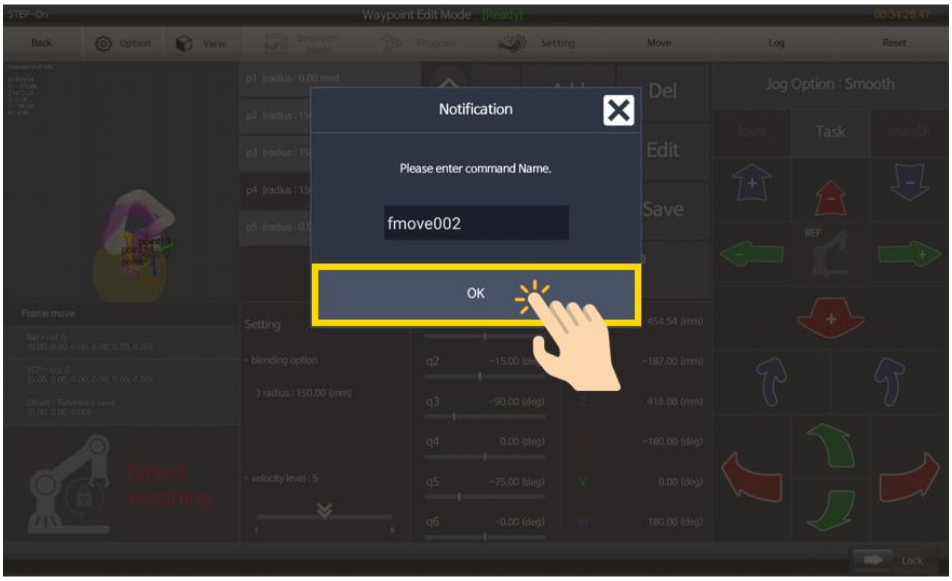


⑪ When all settings are complete, touch **Save**.

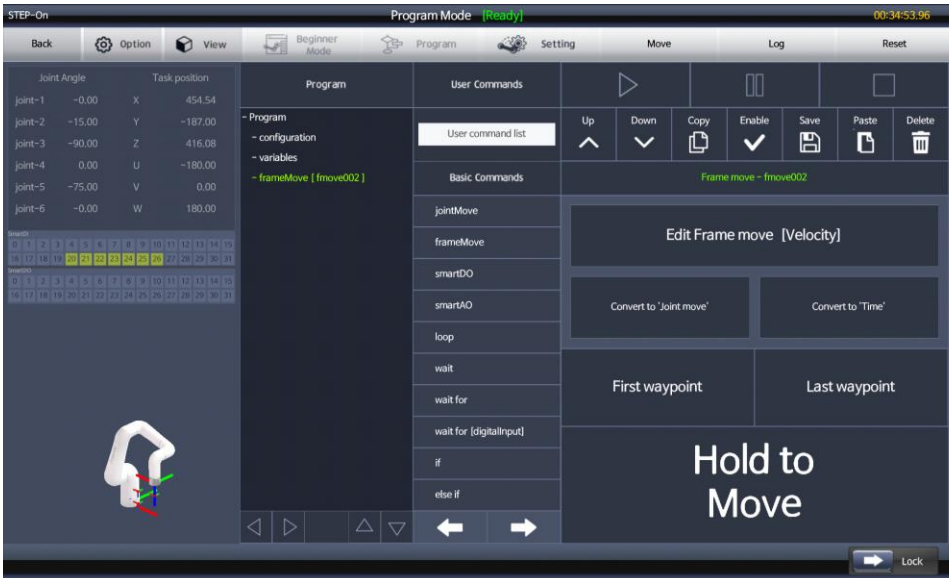
⑫ When the message "**Do you want to save current waypoint information?**" is displayed, touch **Yes**.



⑬ Finally, enter the motion name and touch **OK**.

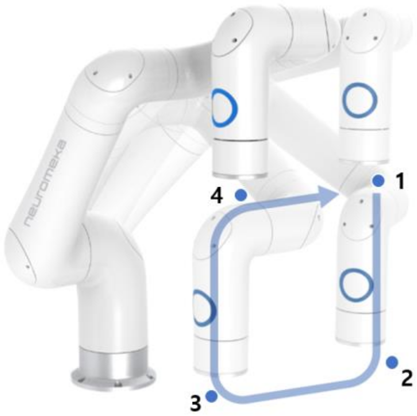


⑭ Now the setting for the blending of frameMove is completed.



blending (constant speed mode)

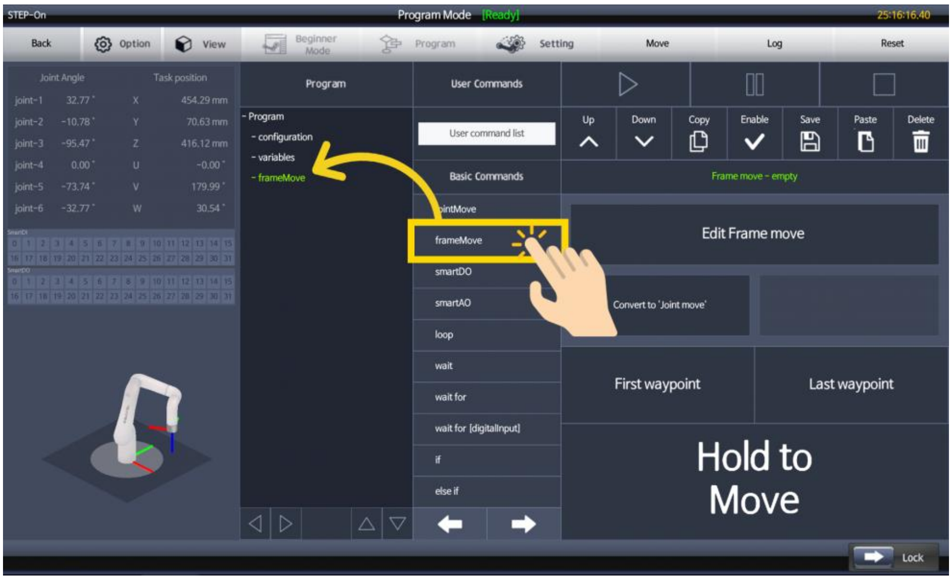
As shown in the following figure, we will move the robot across multiple waypoints with constant speed using constant speed mode.



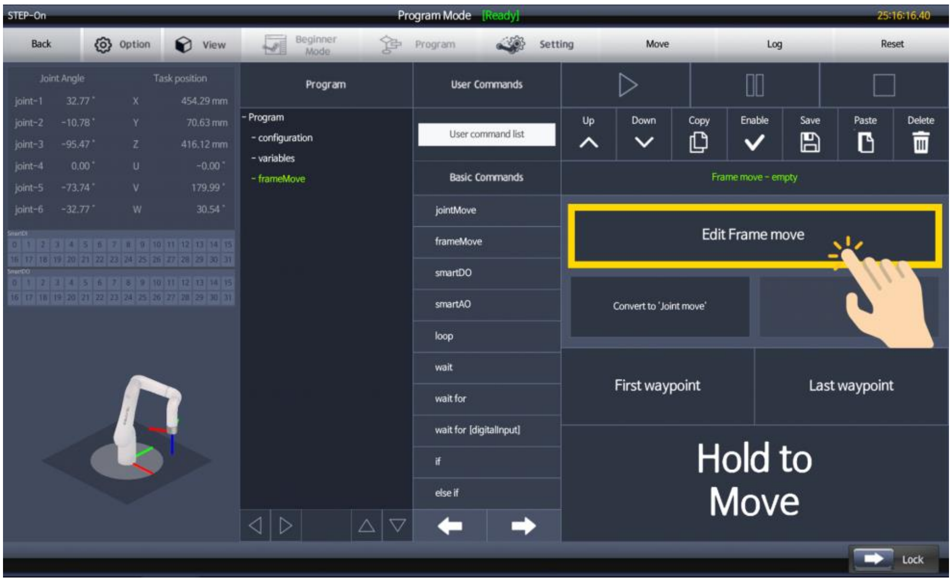
[Example]

The robot is currently stationary at position 1, passes position 2 to position 4, and returns to position 1 again, all along straight lines. The speed is kept constant while tracing the blended arc.

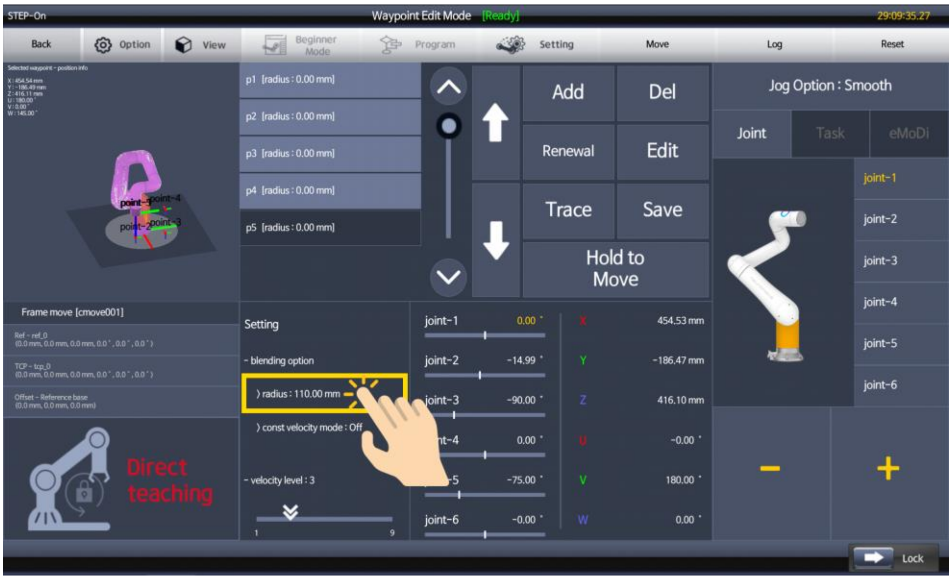
① On the Programming screen, select **frameMove** in the user command window and add it to the tree.



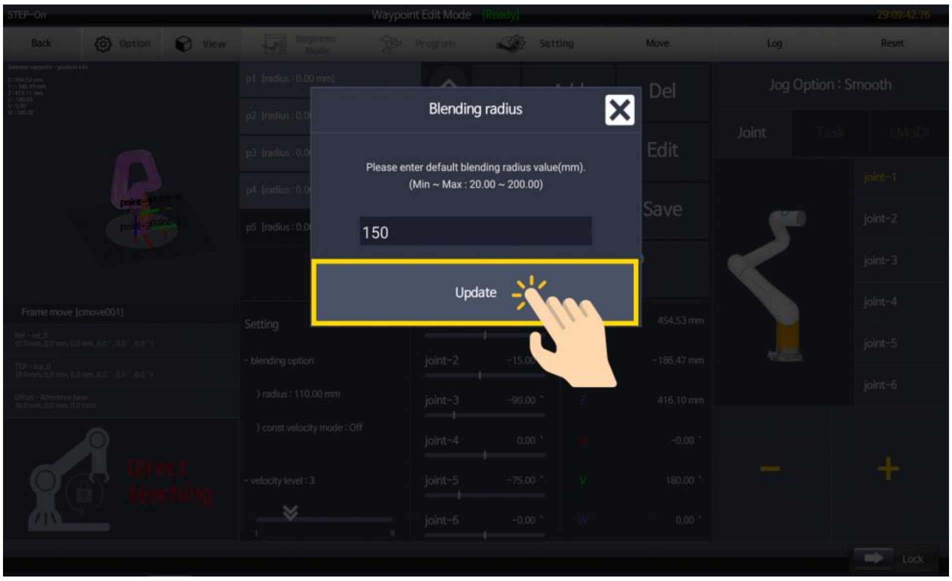
② Touch **Edit Frame move** on the right window. Follow the previous **frameMove example** in the exactly same way to create the waypoints along straight line segments.



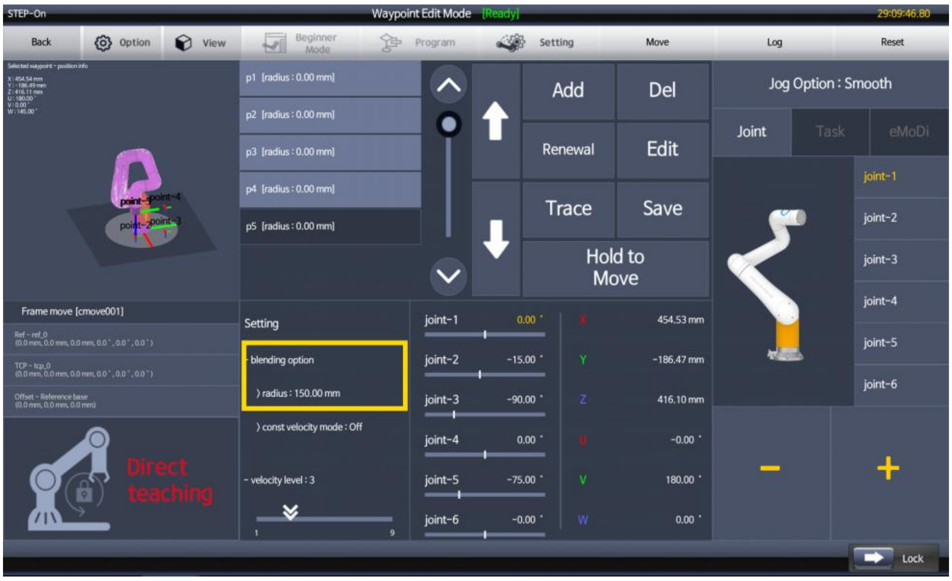
③ When all waypoints have been set, touch the **radius** in Setting window in the center bottom to set the default blending radius value.



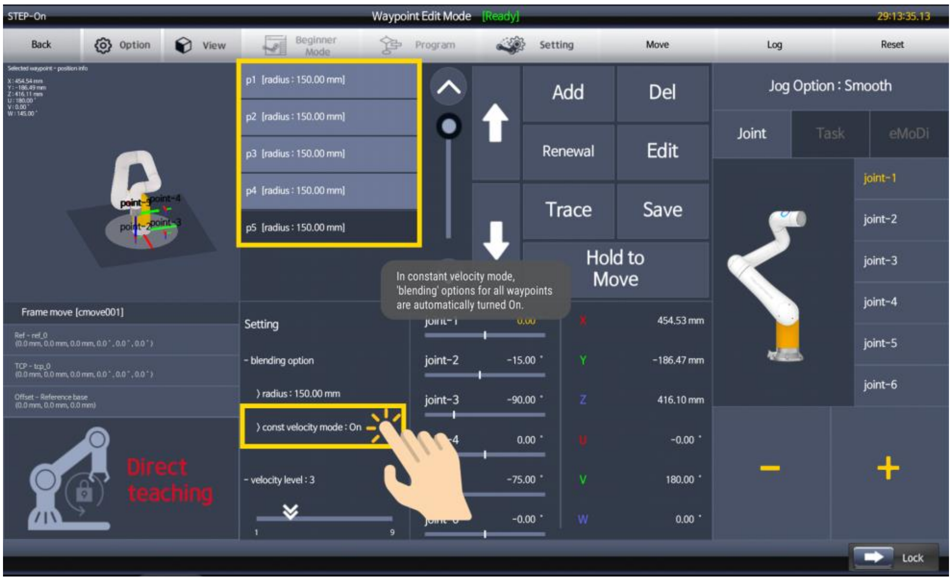
④ To set the radius value, enter "150" in the edit box and touch **Update**. (The blending radius input unit is mm for frameMove.)



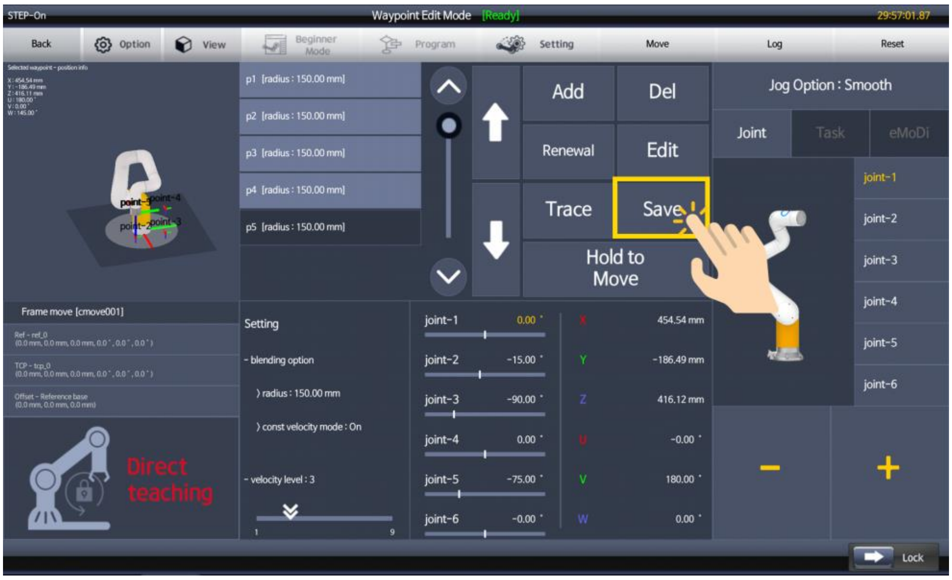
⑤ The changed radius information can be checked in Setting as below.



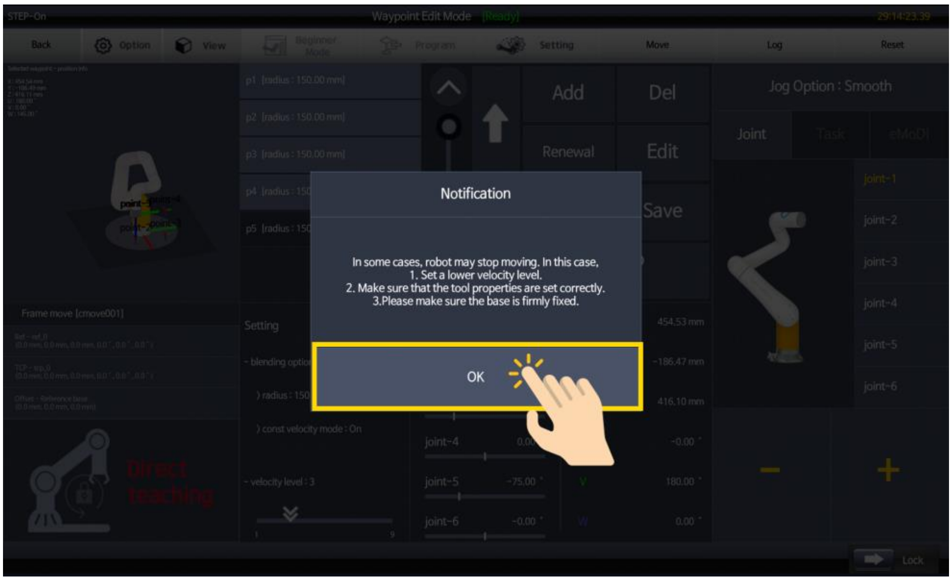
⑥ You can turn on or off the constant speed mode each time you touch 'Constant Speed Mode' in the lower setting window. When the constant-speed mode is turned on, the blending option is automatically turned on for all waypoints with the blending option off, and the default blending radius is reflected. For those waypoints where the blending option is already turned on the blending radius is maintained.



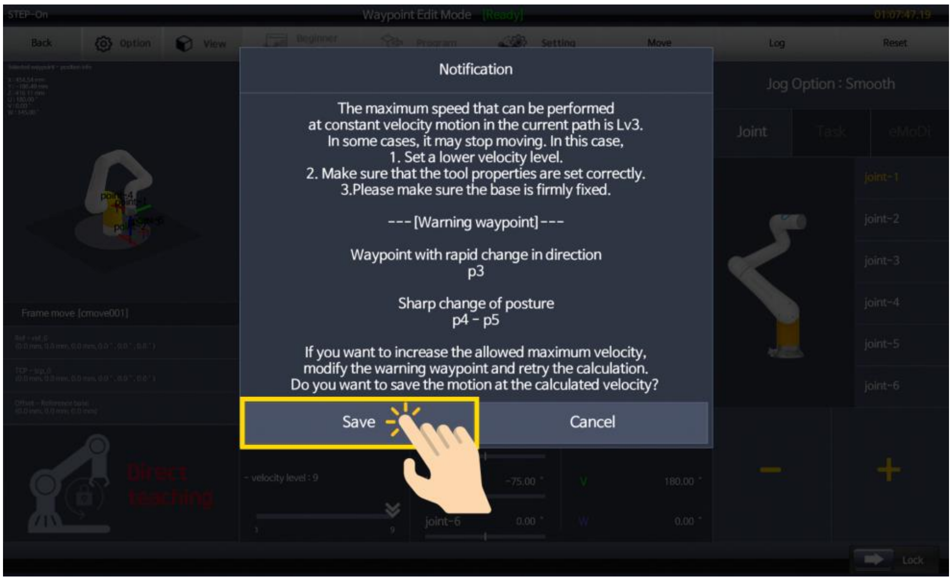
⑦ When all settings are complete, touch **Save**.



⑧ The notification message for constant speed mode is displayed as follows. Touch **OK**.



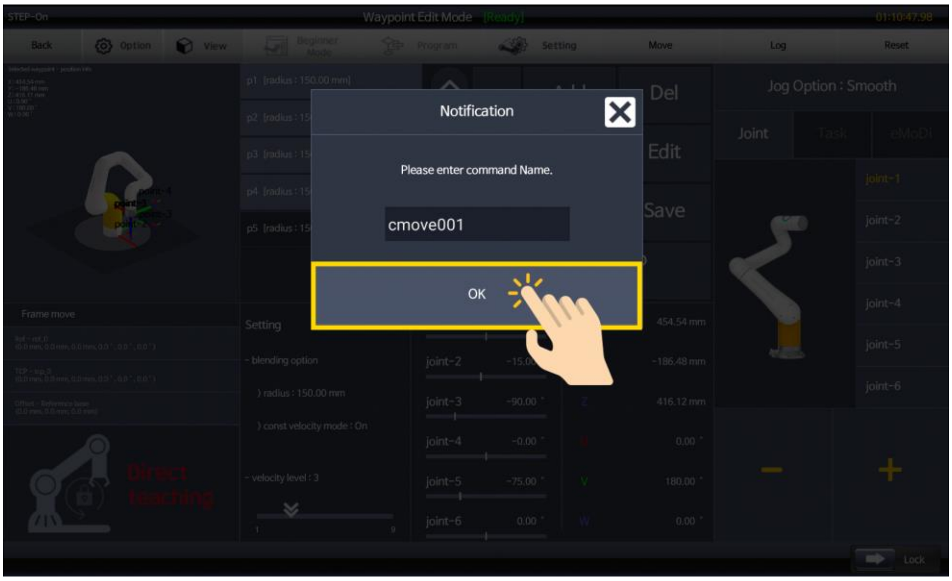
If the robot cannot execute constant speed motion by the user-specified speed due to exceeding the robot specifications (maximum joint torque, maximum joint speed, etc.) required to move at the constant speed, the maximum speed at which constant-speed motion can be performed is recommended with path segments hard to trace by constant speed. Touch **Save** to alter the travel speed with the recommended speed, or touch **Cancel** to change the movement condition.



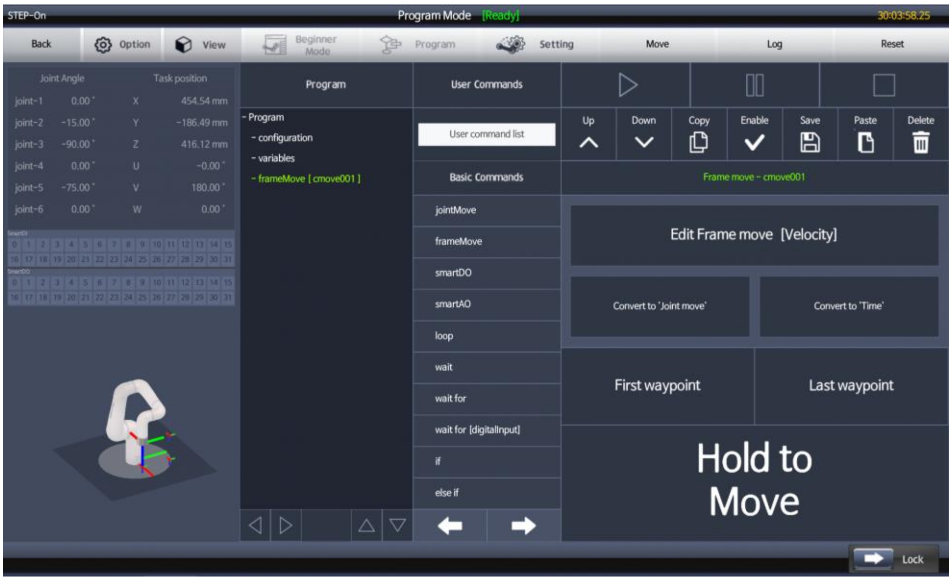
Caution

Even if the constant speed mode is executed at the recommended speed, the robot may stop with the motor state error occurring during movement. In this case you need to lower the speed or change the waypoints.

⑨ Finally, enter the motion name and touch **OK**.



⑩ Now the setting for the blending of frameMove is completed.



Caution

When frameMove is executed in the constant speed mode, collision may be falsely detected when there is severe direction change. In this case, use the new feature for auto-tuning of collision detection threshold to adapt the collision detection threshold to the motion. Please refer to **Section 6.2 Options** for a detailed explanation.

home

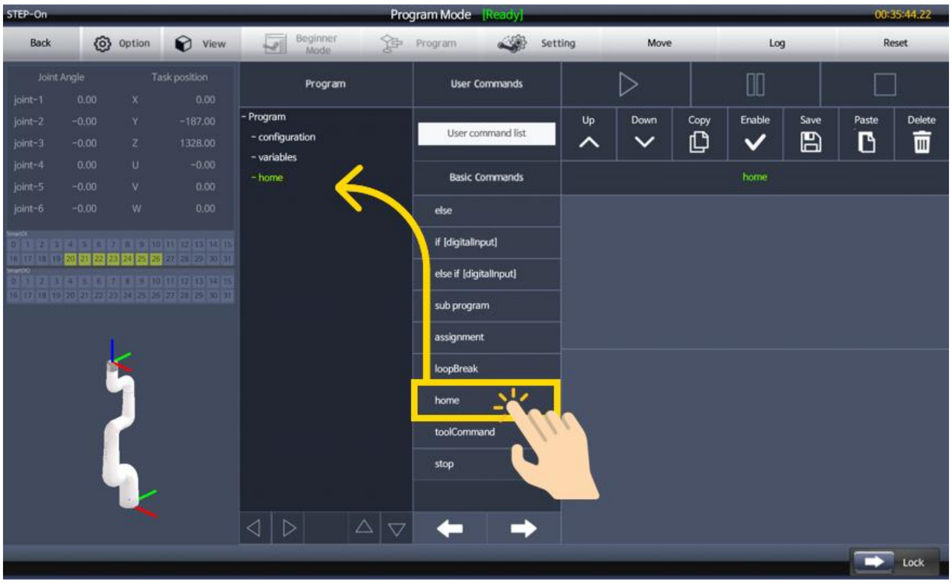
Let's move to home position using the **home** command as shown in the following figure.

[Example]

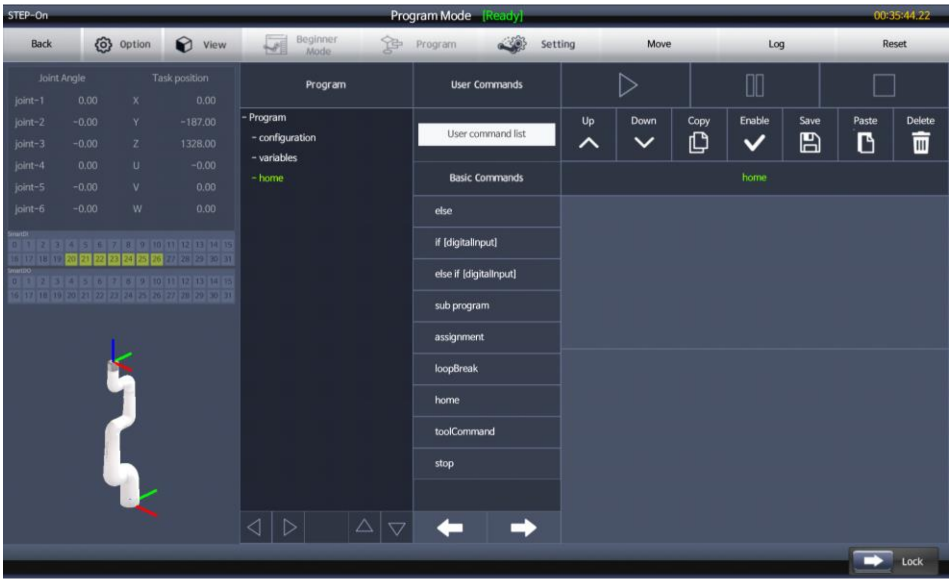
The robot moves from the current zero position (position 1) to the home position (position 2).

① Move the robot first to the zero position. Refer to **Section 4.2 Basic Operations** for details on how to move the robot to zero position.

② On the Programming screen, select **home** in the user command window and add it to the tree.



③ Now your home movement setup is complete.



Program Flow Control Commands

Program flow control commands are used to execute a part of program repeatedly according to the condition set by the user, to wait for execution of the following commands, or jump to another branch depending on the conditional result.

- **loop**

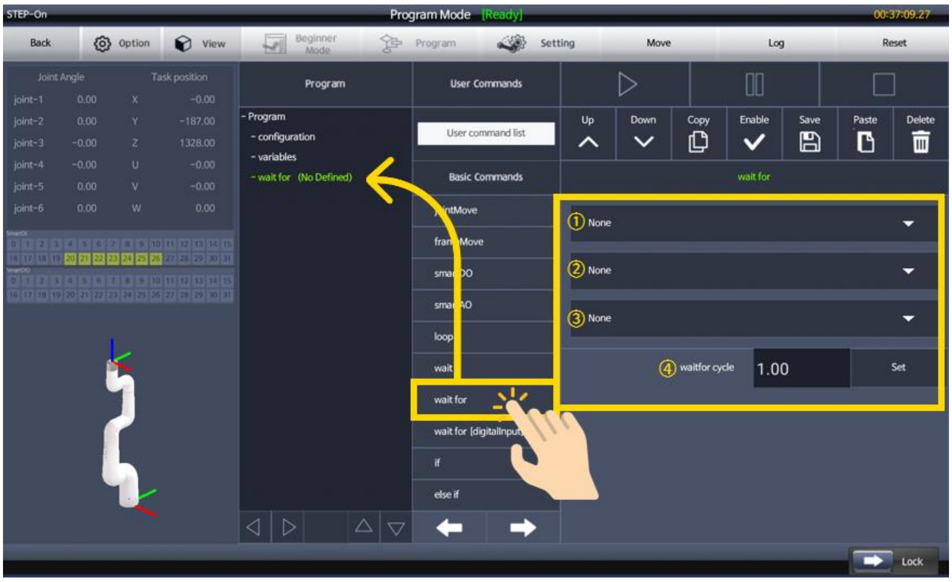
  It repeats the commands in the child tree according to the condition set by the user.

- **wait**

  It waits for the next command execution by the time duration specified by the user.

- **wait for**

  It waits for the next command execution until the condition set by the user is satisfied. The condition in the program is expressed as the binary relational operation, consisting of the left-hand side variable or an analog input signal port, the relational operator, and the right-hand side condition value for comparison, as shown in the following figure.



① Variables declared in variables or channels of the analog signal inputs of the control box are displayed. It is the reference value required for relational operation.

② Relational operators are displayed. They are used to compare two values, e.g. whether one is greater than or less than the other.

Relational operator	Description	True	False
= =	The two are equal.	100 == 100	100 == 50
!=	The two are different.	100 != 50	100 != 100
<	The left-hand side is less than the right-hand side.	50 < 100	200 < 100
< =	The left-hand is less than or equal to the right-hand.	50 <= 100	200 <= 100
>	The left-hand side is greater than the right-hand side.	100 > 50	100 > 200
> =	The left-hand side is greater than or equal to right-hand side.	100 > 50	100 >= 200

③ Set the condition value to compare with the reference value. If you select input, you can enter the value yourself. Or a variable declared in variables can be chosen.

④ waitfor cycle

Set the time duration corresponding to one cycle for evaluating the relational operation. For example, if 0.1 second is entered, the relation operation is calculated once every 0.1 second.

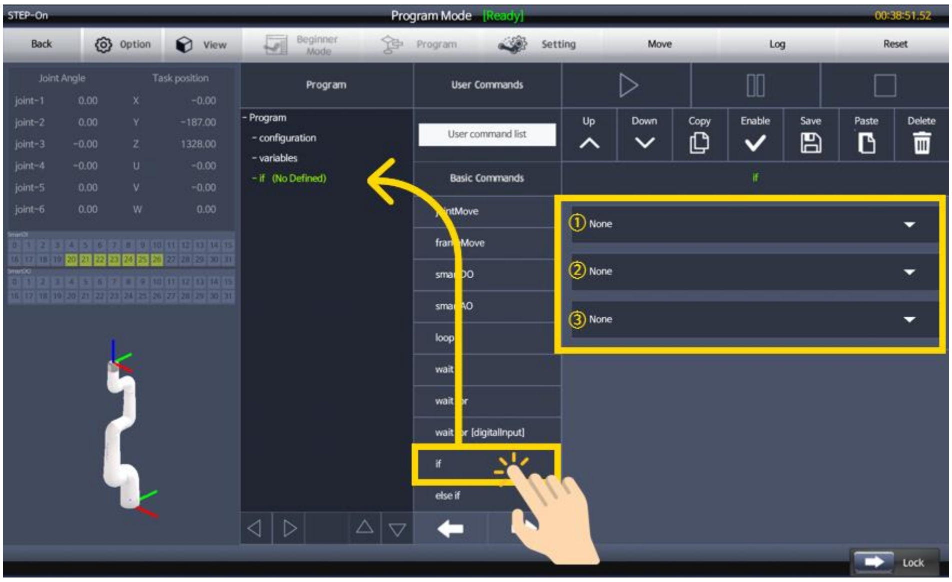
Now all the settings for the **wait for** command are completed. Later, when the program runs, the program waits without executing the next command until the relational operation result becomes true.

- **wait for [digitalInput]**

  It waits for the next command execution until the condition set by the user in terms of the digital signal input of the control box is satisfied. In the setting window, select the condition for the desired input port and set the time duration for one cycle of relational operation. Multiple ports can be selected.

- **if**

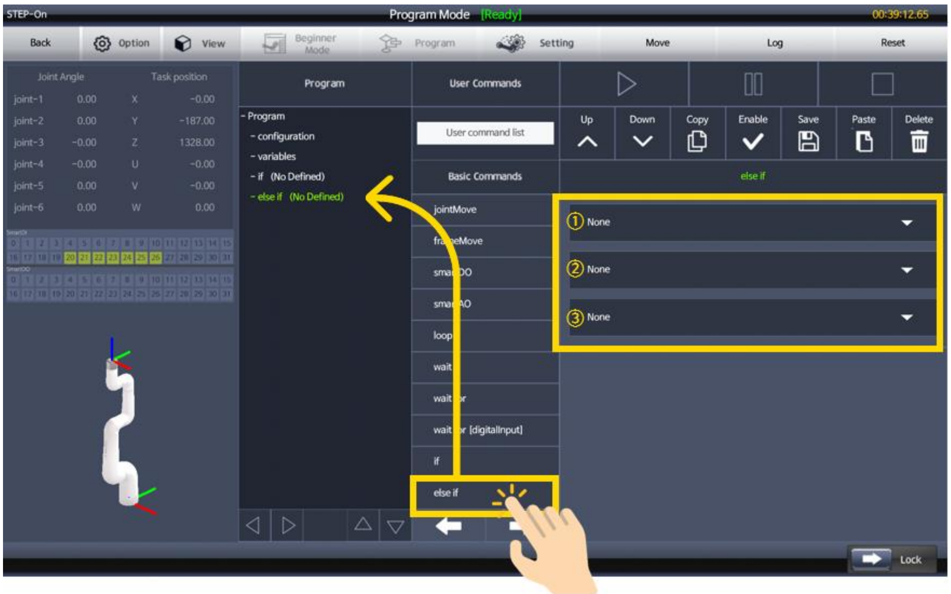
  If the condition set by the user is satisfied, execute the commands in the child tree, otherwise execute the following command.



Set the ① reference value, ② relational operator, and ③ condition value required for the conditional expression. They have exactly the same meaning as the **wait for** command setting only except that now the time duration for one cycle of relational operation does not exist. See the **wait for** command for details.

- **else if**

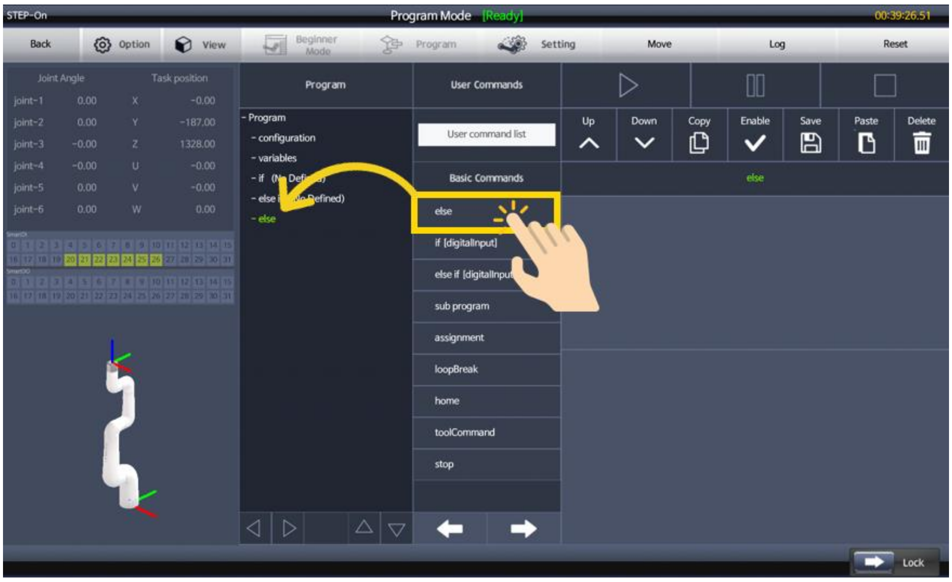
  Add another condition when the condition set in the previous **if** command is not satisfied. If this condition is satisfied, execute the commands in the child tree, otherwise execute the following command. It cannot be used alone, but should be accompanied with the previous **if** command.



  The setting method is the same as the **if** command.

- **else**

  Executes the following command when all conditions set in the previous **if** and **else if** commands are not satisfied. It cannot be used alone, but only after the **if** command is used first. No setup is required.



- **if [digitalInput]**

  If the digital signal input of the control box meets the condition set by the user, execute the commands in the child tree, otherwise execute the following command. On the setting window, set the condition for the desired input port. Multiple selection is possible.

- **else if [digitalInput]**

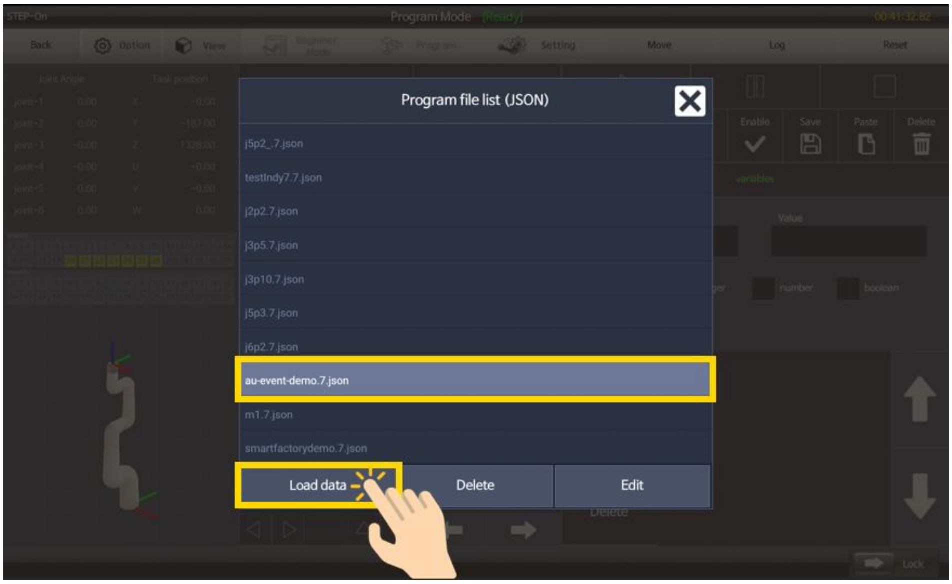
  Adds another digital signal input condition when the condition set in the **if** command is not satisfied. If this condition is satisfied, execute the commands in the child tree, otherwise execute the following command. It cannot be used alone, but only if the **if** command is used first.

- **subprogram**

  It loads the previously saved program tree into the current program tree.

  ① Touch **sub program** in the basic command list.

  ② Select an existing program and touch **Load data**.

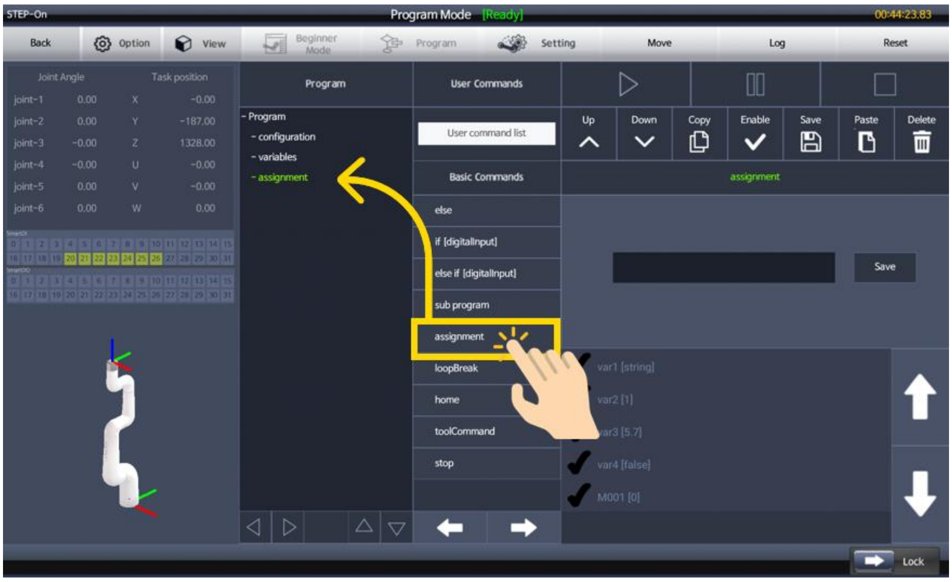


This will add the loaded program tree in the program tree you are currently creating, as follows:

- **assignment**

  It is used to set new values for those variables declared in variables. It cannot be used if there are no variables declared in variables.

  ① Touch **assignment**. Note that variables must have been declared in **variables** command beforehand.

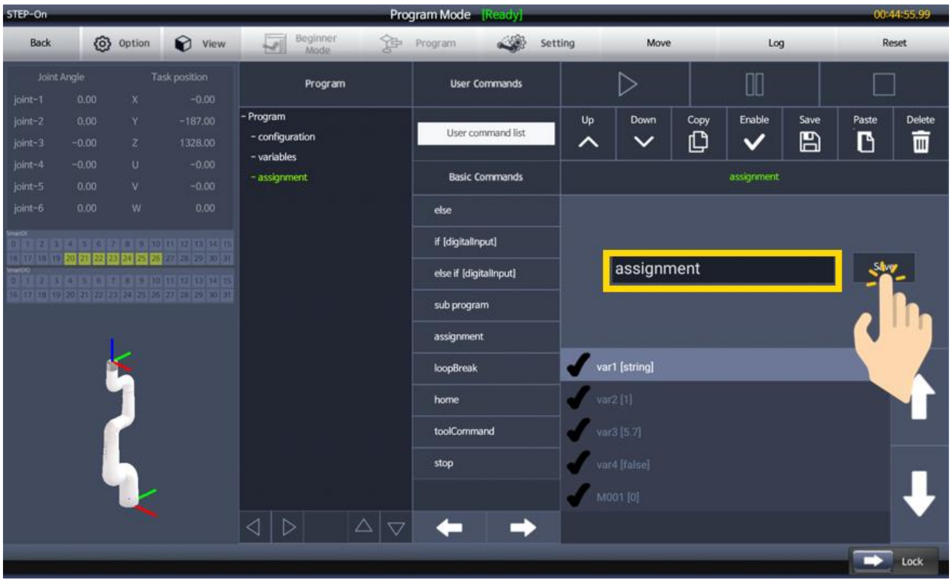


For example, let us suppose that var1, var2, through var5 have been declared respectively as string, integer, real, boolean, and direct variables. Refer to the **variables** command to see how to declare variables.

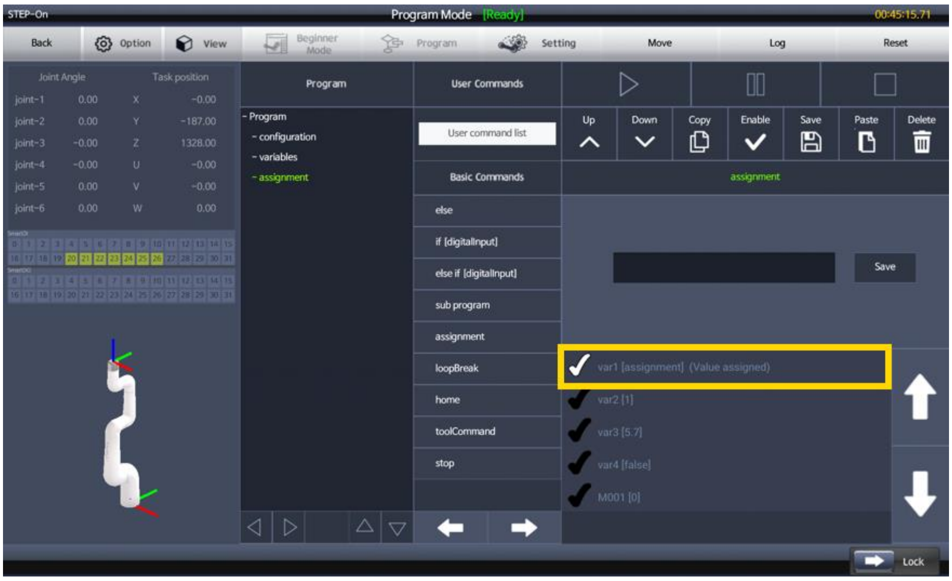
② Let's change the value of the string variable var1 from the current value "string" to, say, "assignment". On the right window, touch var1 in the variable list.

The current value of var1 is displayed in the upper field.

③ Clear the current value "string", enter the new value "assignment" and touch **Save**.



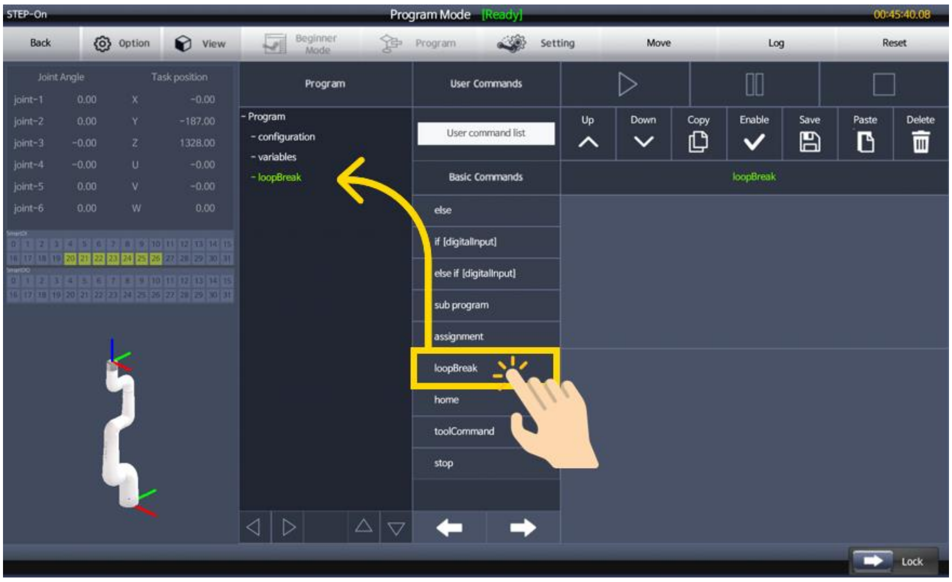
④ If the value changed normally and saved successfully, the left check mark of var1 is displayed in white as follows. The changed value will be displayed along with a tag of '(Value assigned)'.



Other variables can be changed in a similar way.

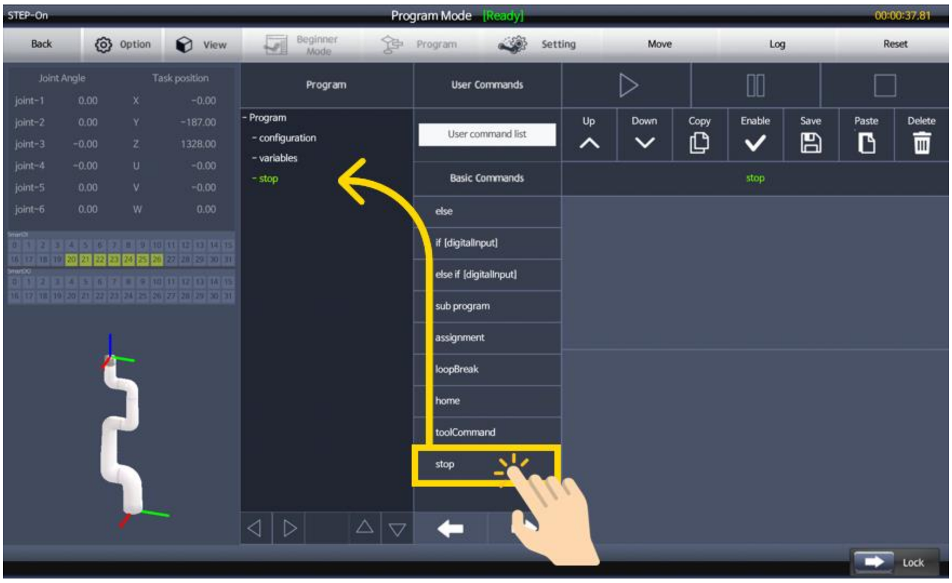
- **loopBreak**

  It stops loop iteration by the **loop** command and executes the following command. It is usually used inside the conditional command e.g. **if**. No setup is required.



- **stop**

  It stops program execution. No setup is required.



Signal I/O Commands

Signal I/O commands are used to control the input and output of digital and analog signals connected to the I/O terminals of the control box or the endtool port of the arm.

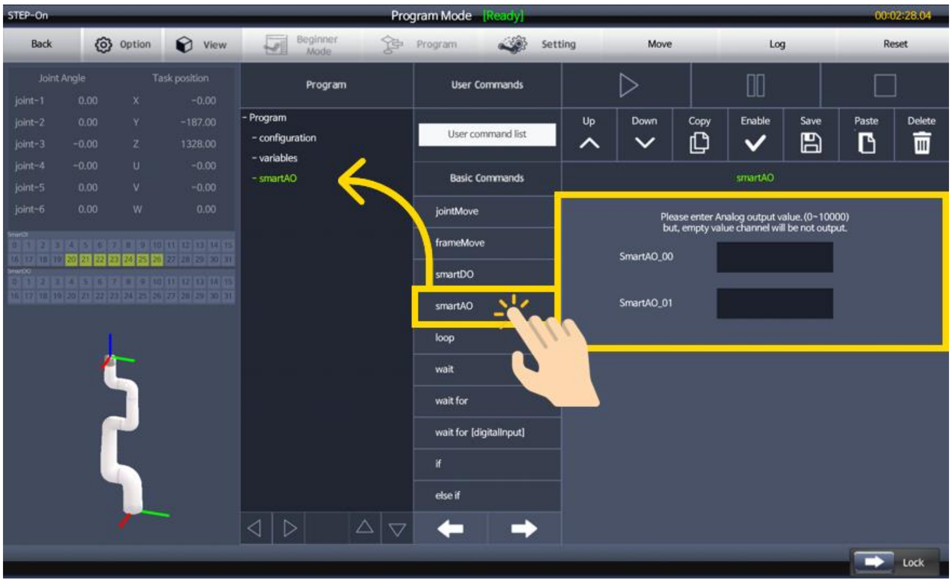
- **smartDO**

  It controls the digital signal output of the control box.

  You can select the port and set the desired condition for the port in the right setting window.

- **smartAO**

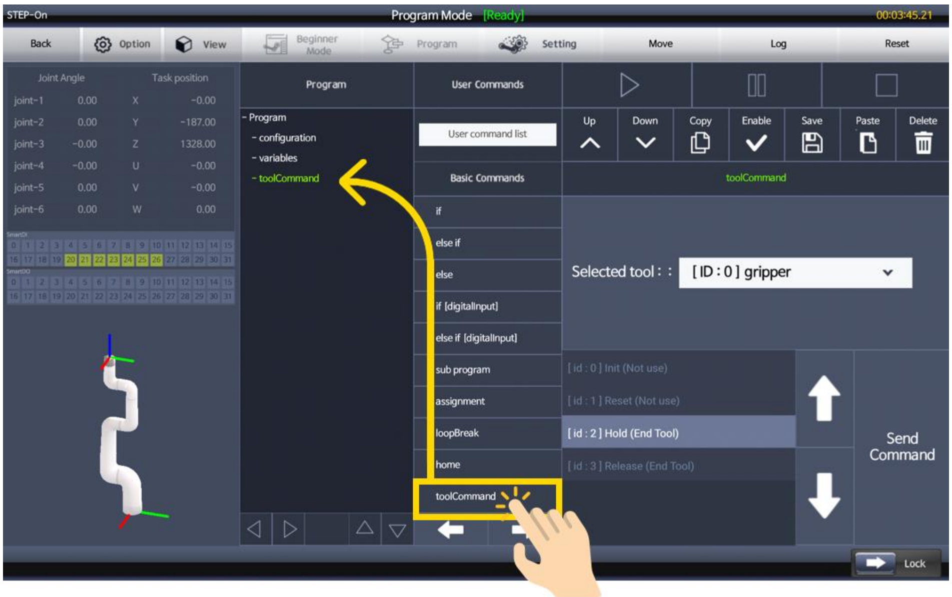
  It controls the analog signal output of the control box.



  In the right setting window, enter the analog output value to the desired port among an integer value between 0 and 10,000. Note that 0 corresponds to 0.0V and 10,000 corresponds to 10.0V.

- **toolCommand**

  It controls the digital signal output of the endtool port.



When you select a pre- registered tool, the tool commands that can be executed by the tool are displayed. Select a tool command from the list. Refer to **Section 6.1 Robot Settings** for details on how to register a tool.

5.8 Application Command

An application command defines a set of process-specific instructions optimized for the process executed by the tool. Basic commands such as robot motion, signal input/output, and program flow control are combined in accordance with the process sequence and provided as a sort of macro command in each application command. Unlike basic commands, these commands are displayed in the program tree only when the user selects a tool.

Pick and Place

Pick and place commands are used by the robot to pick or place an object with the gripper.

- **pick**

  The robot picks the object at the specified position.

Process sequence

① Move to a vertical position of the object

② Open the gripper when it is closed

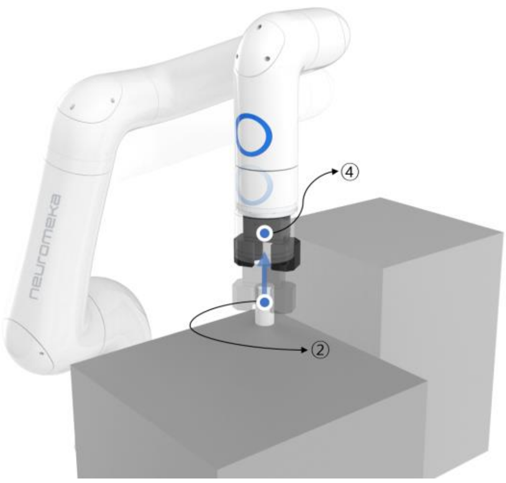
③ Approach to object position to grip the object

④ Close the gripper to grip the object

⑤ Grip the object and retreat to the vertical position

- **place**

  The robot places the object at the specified position.



공정순서

① Move to a vertical position of the object

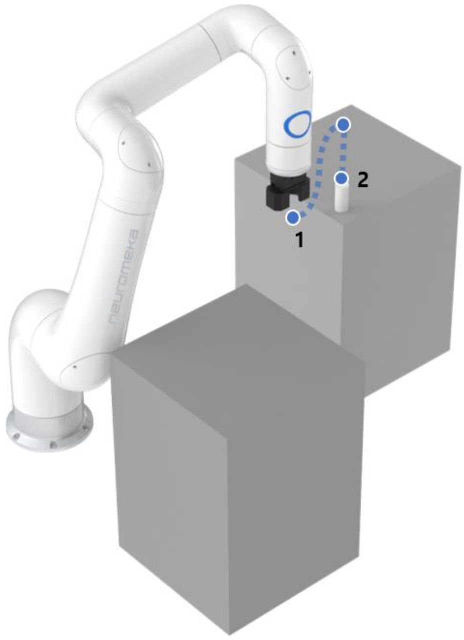
② Approach to the position for placing the object

③ Open the gripper to release the object

④ Release the object and retreat to the vertical position

pick

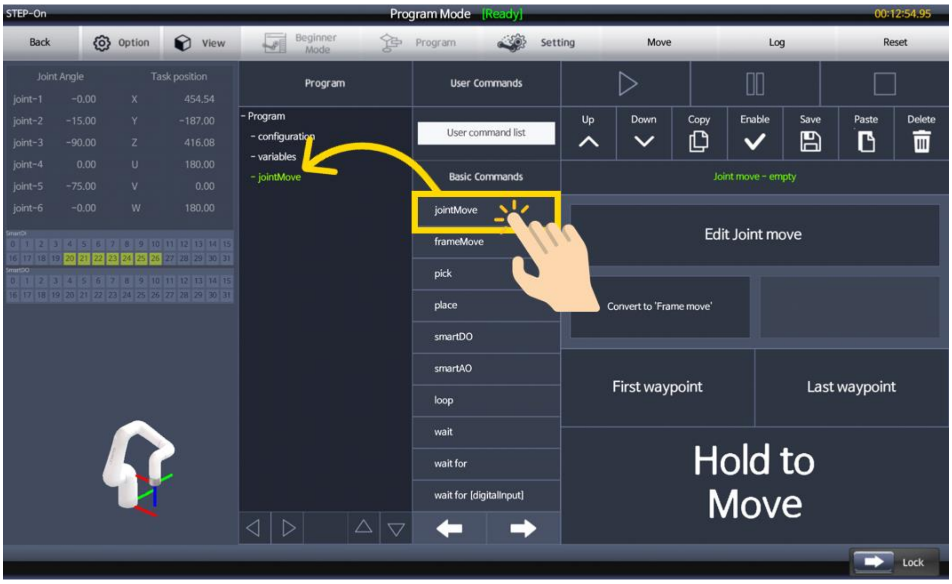
Let's pick an object in one position using **pick** command.



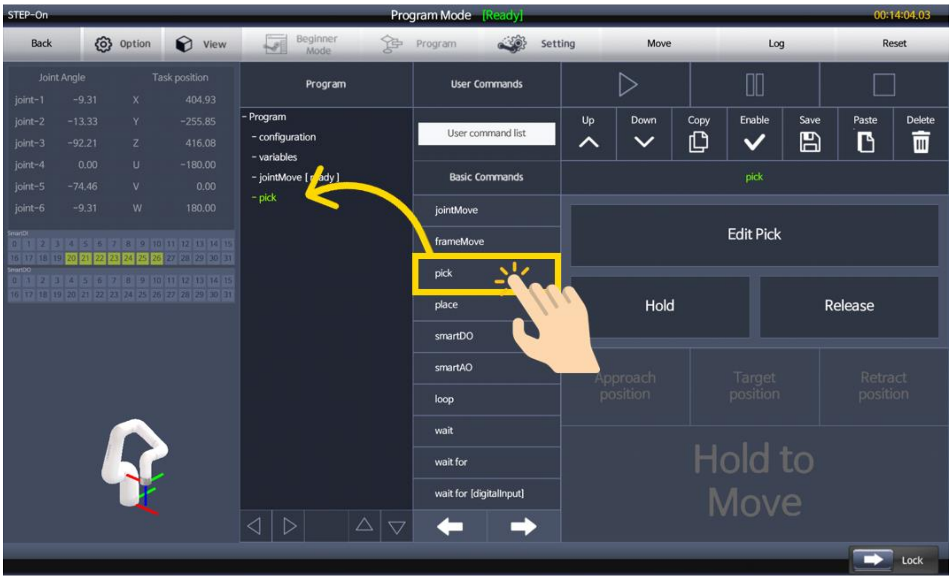
[Example]

The robot is currently stopped at position 1, approaches the object vertically in position 2, retreats back vertically, and returns to position 1 again.

① On the program screen, add **jointMove** to set the current position to the first movement position. See the **jointMove** command for a detailed explanation.



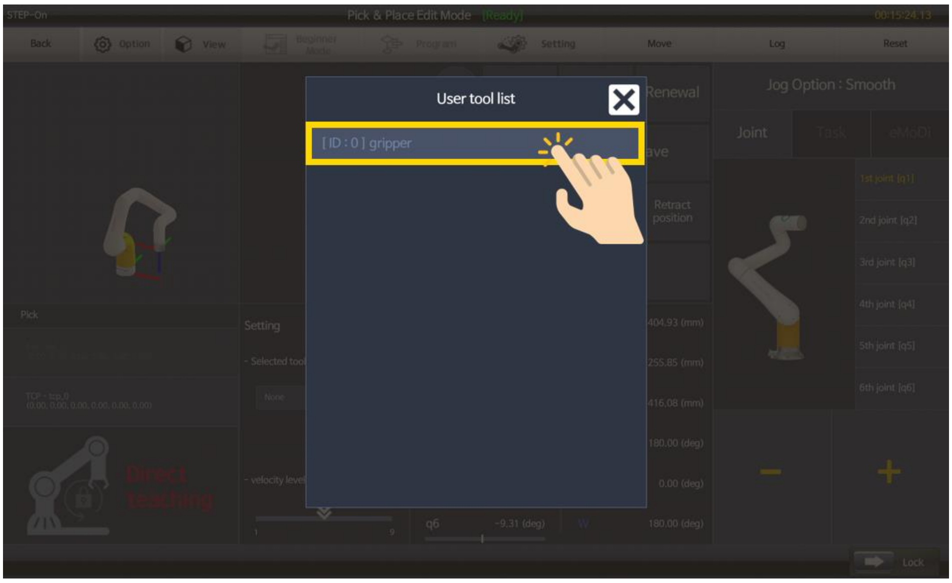
② On the Program screen, touch **pick** to add it in the tree. If the pick command is not displayed in the user command list at this time, it implies that the tool for the pick and place process is not properly set. Set the tool in Setting. Refer to **Section 6.1 Robot Settings** for details on tool setting.



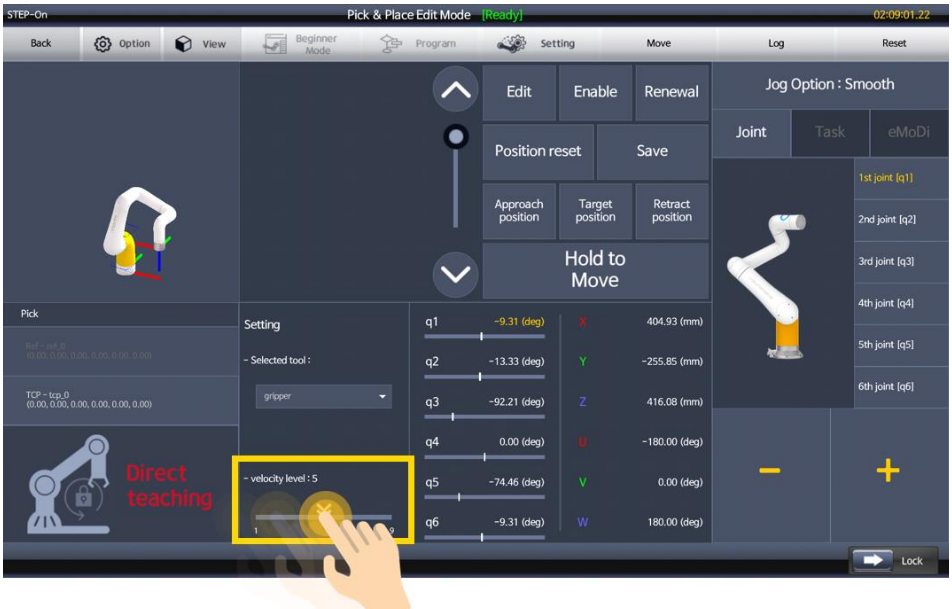
③ Touch **Edit Pick** on the right window. If the current gripper is closed, you have to release it by touching **Release** below on the window.

④ Touch the arrow on the right of the **Selected tool field** in Setting window in the center bottom.

⑤ Select the tool from the User tool list of pre-registered tools.

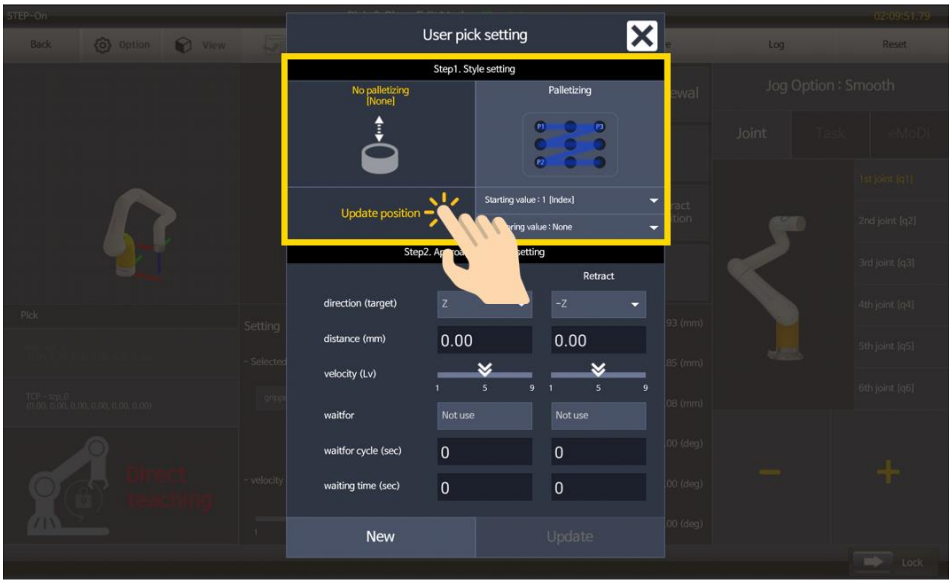


⑥ Set the **velocity level** in the Setting window at the bottom center. This is the speed of movement to the position before picking the object and the robot moves in the joint space to avoid singularities.

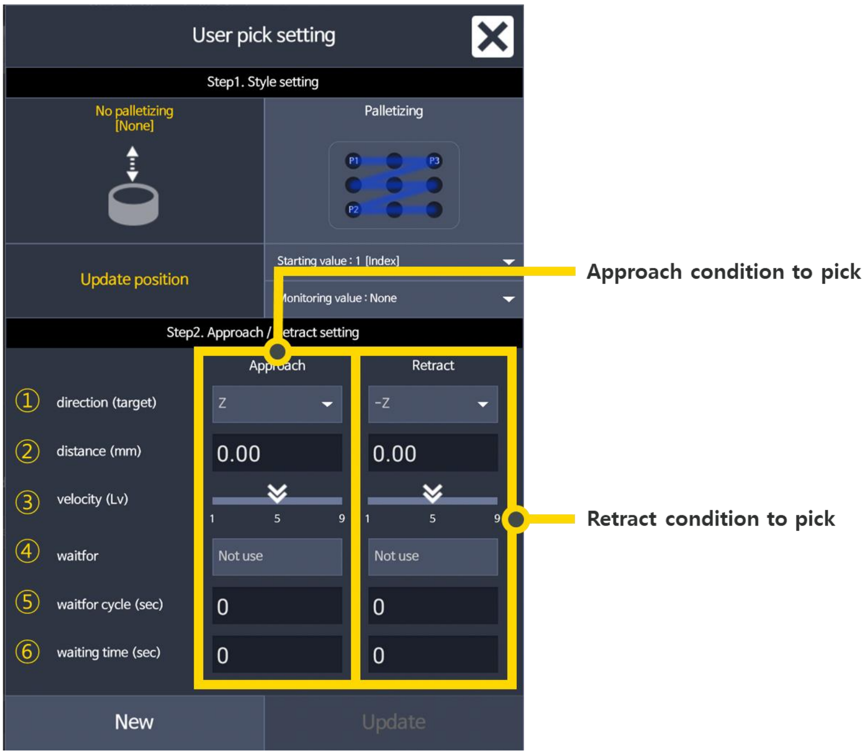


⑦ Use direct teaching or jog move to move the robot to the grip position and then touch **Edit**. This position is the target position in the pick and place commands.

⑧ Touch **Update position** on the left to save your current position. This position is saved as the position to hold the item.

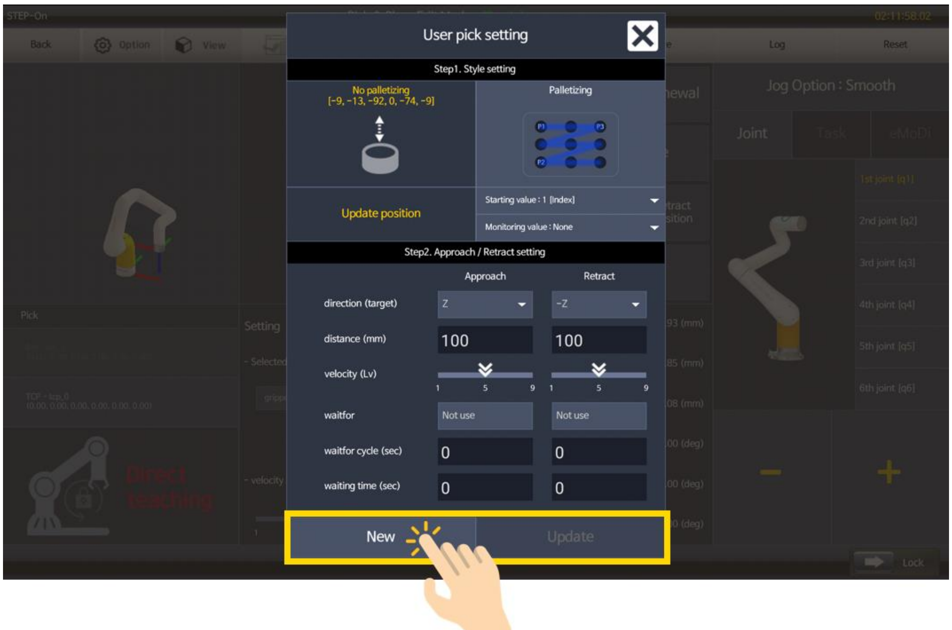


⑨ Set the conditions for picking the object. Each condition is as follows.



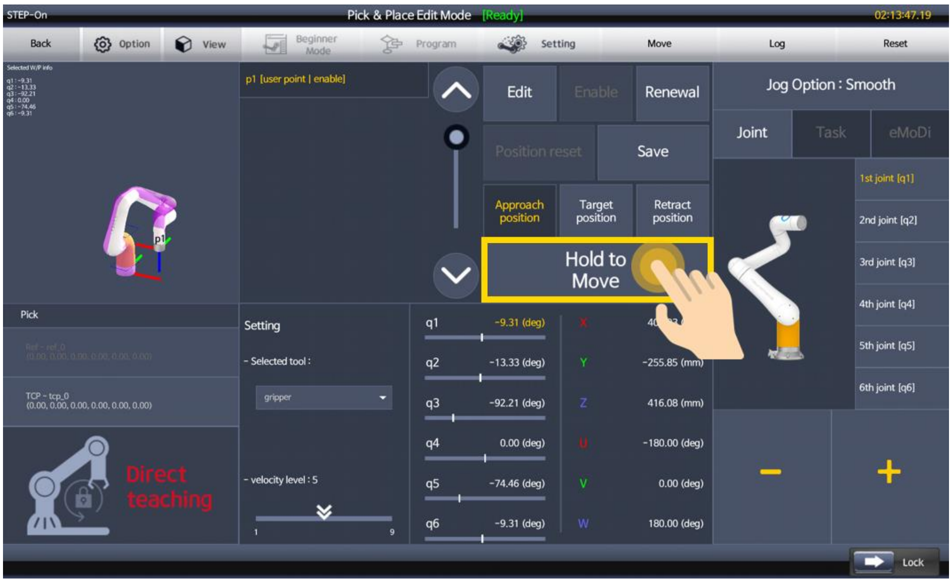
- **direction (target)**
  It sets the approach and retraction direction with respect to the tool coordinate system in the current robot position.
- **distance (mm)**
  It sets the approach or retraction distance from the position where the object is to be gripped.
- **velocity (Lv)**
  It sets the speed in approaching to the grip position and retracting from the grip position
- **waitfor**
  Before approaching to the grip and after retracting to the grip position, the robot waits until the signal input set by the user comes in. It sets the user signal here.
- **waitfor cycle (sec)**
  It sets the time duration to periodically check the set user signal. In other words, if you enter 0.1 second, it confirms whether the user signal is input once every 0.1 second.
- **waiting time (sec)**
  Before approaching to the grip and after retracting to the grip position, the robot waits for the amount of time set by the user. It sets the waiting time here.

⑩ Touch **New**. If you have made any changes to existing information, touch **Update**.



⑪ Check the movement positions to make sure that the positions to pick the object are set correctly. If you select one of the approach position, the target position, and the retract position, the robot will be displayed in purple at the position selected in the left simulation window.

Alternatively, press and hold **Hold to Move**, and the actual robot will move to the selected position.



In this way, you can check the position of each movement.

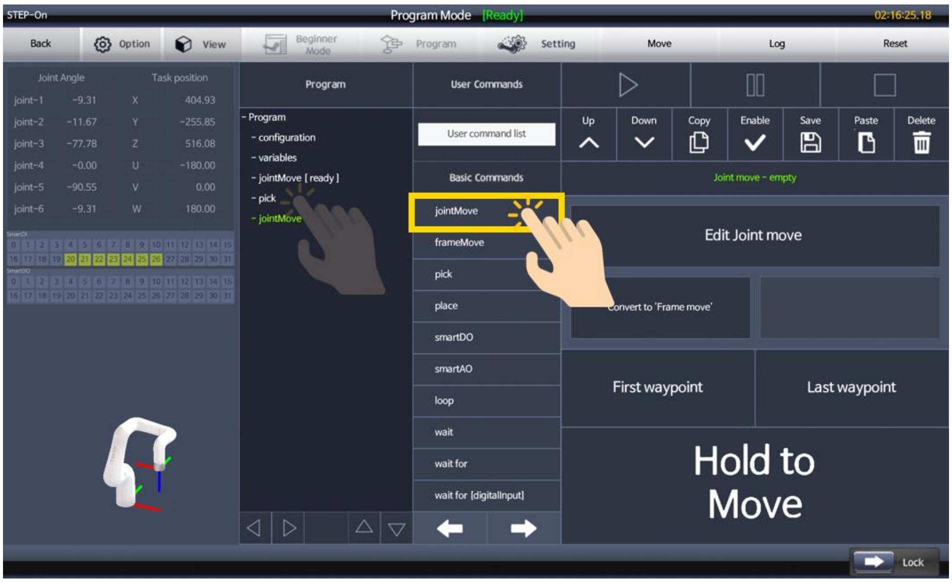
⑫ When all settings are complete, touch **Save**.

Now the setting for pick is complete.

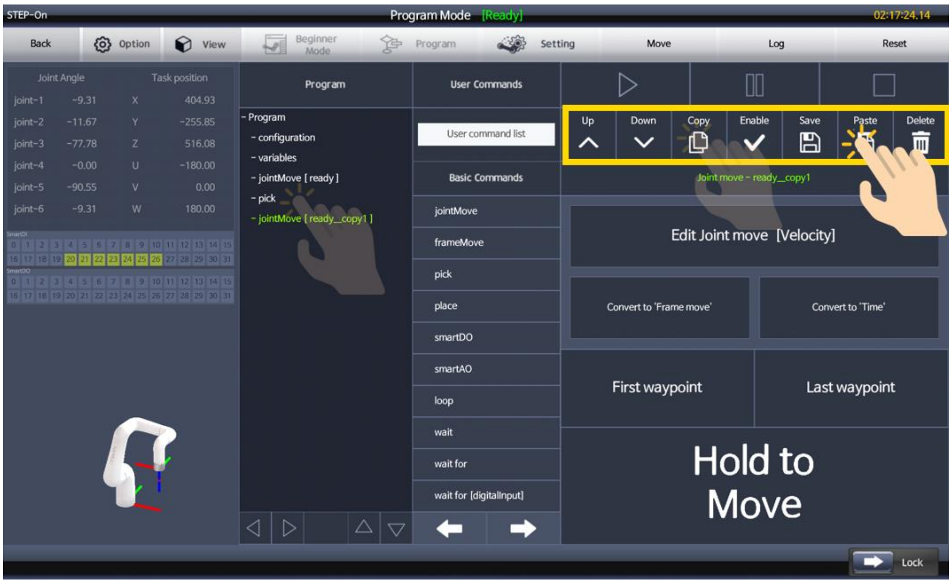
⑬ Move to the first movement position again. Select the first **jointMove** in the program tree and touch the **First waypoint** on the right window. The robot is virtually displayed in purple in the selected position.

You can easily move to the first position by pressing and holding **Hold to Move**, until the robot reaches the selected position.

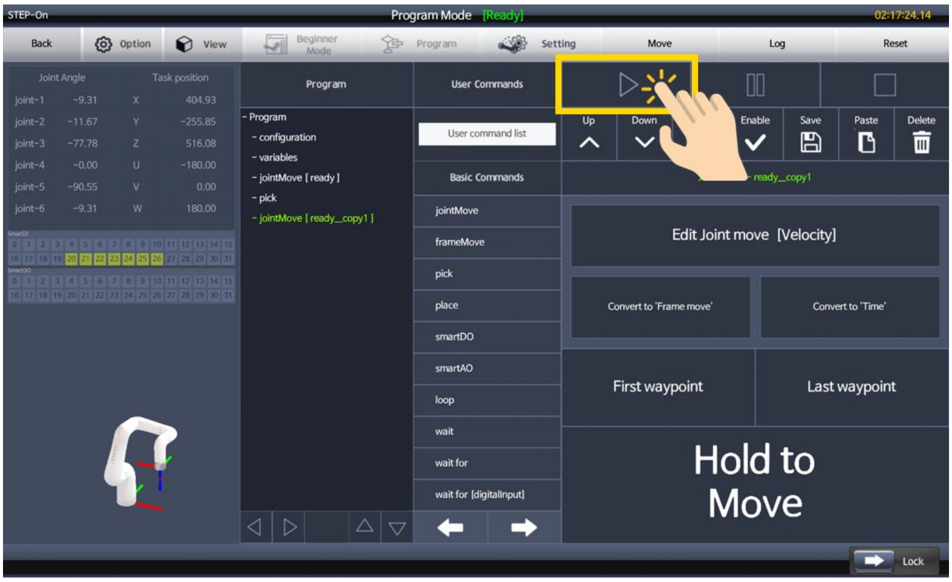
⑭ On the program screen, add **jointMove** to set the current position to the last movement position. Note that you must first touch Pick in the program tree and add jointMove to add the jointMove command to the line following pick.



Alternatively, you can copy and paste the first jointMove in the program tree. You must copy the first jointMove and then touch pick in the program tree first to paste the jointMove command on the line following pick.

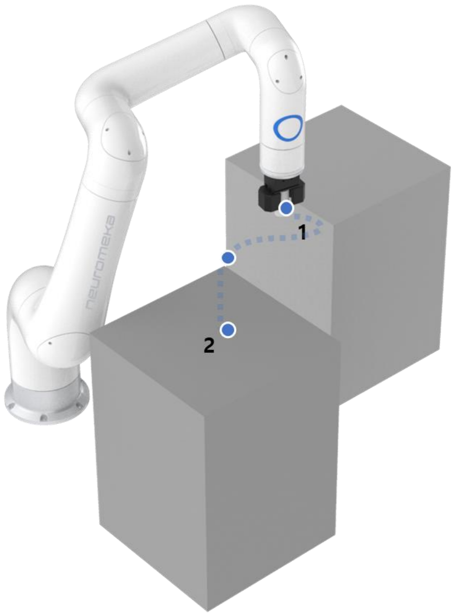


⑮ Your program is complete. Touch the program start (▷) in the program execution window of the program screen to try to run the program.



place

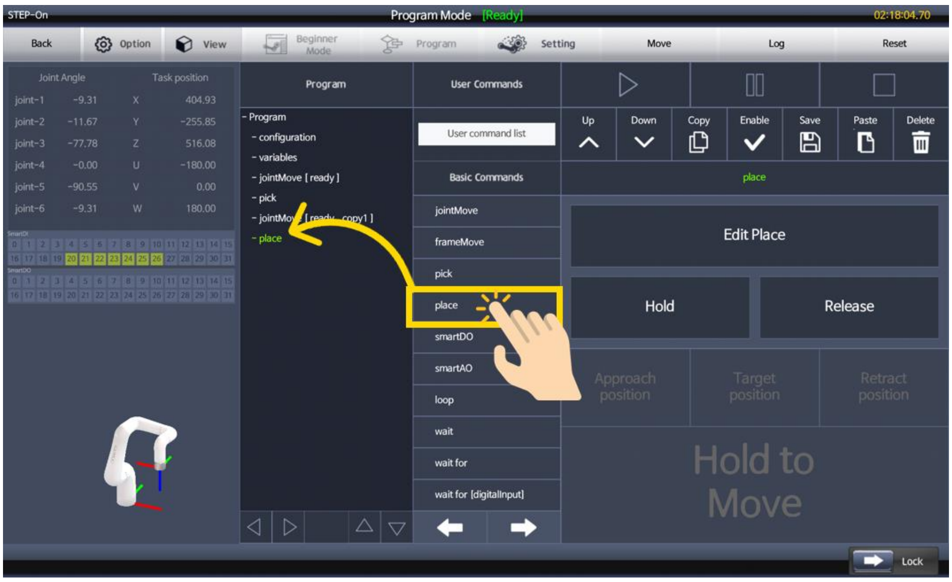
We will use the **place** command to place the object that has been picked up in a different position. We will continue to add in the program written earlier.



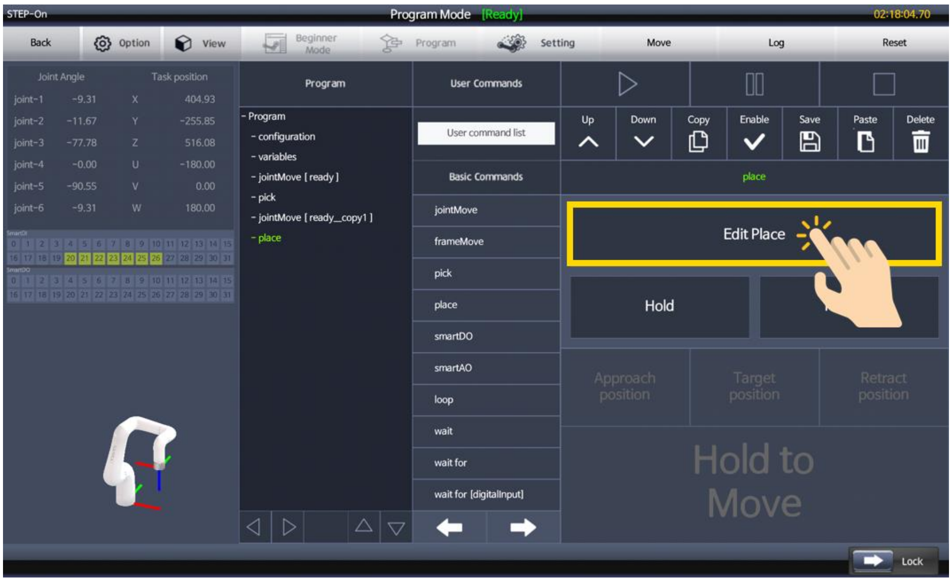
[Example]

The robot now is stationary at position 1, approaches vertically downward to position 2 where it places object, and retracts vertically upward, and returns to position 1.

① On the program screen, touch **place** and add it in the tree. Note that this has to be carried out with the object gripped using the gripper. If you have not picked it yet, pick it up again and proceed.

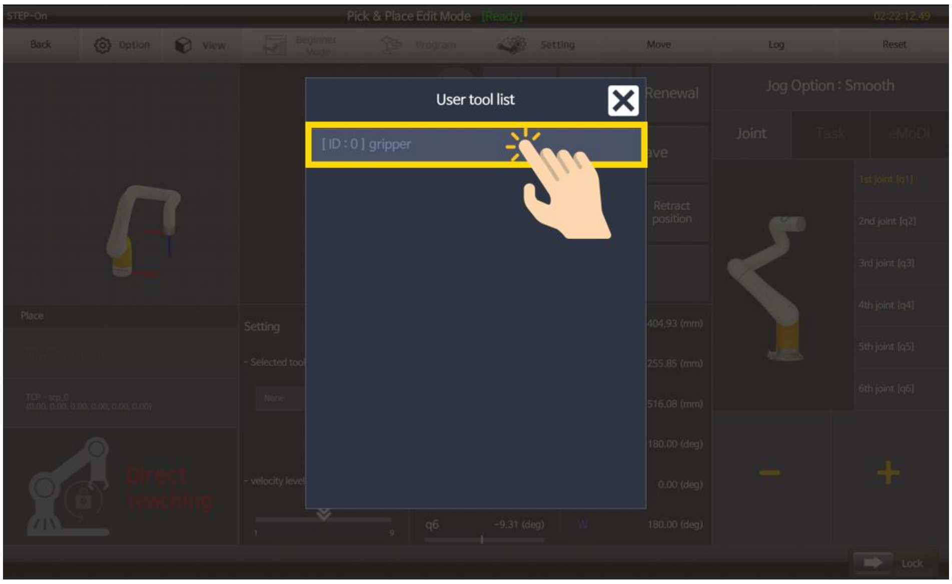


② Touch **Edit Place** on the right window.

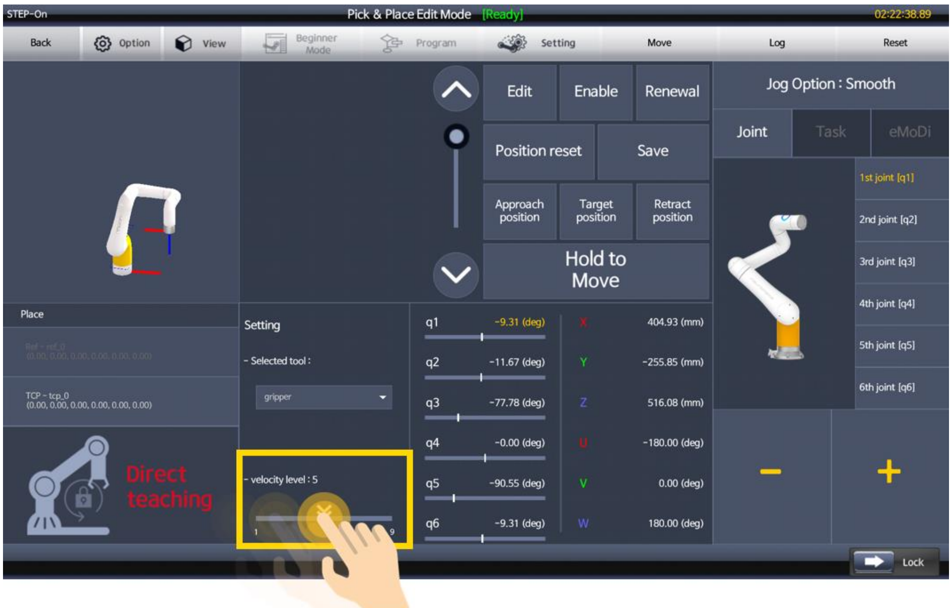


③ Touch the arrow in the **Selected tool** field in the Setting window in the center bottom.

④ Select the tool from the User tool list of registered tools.

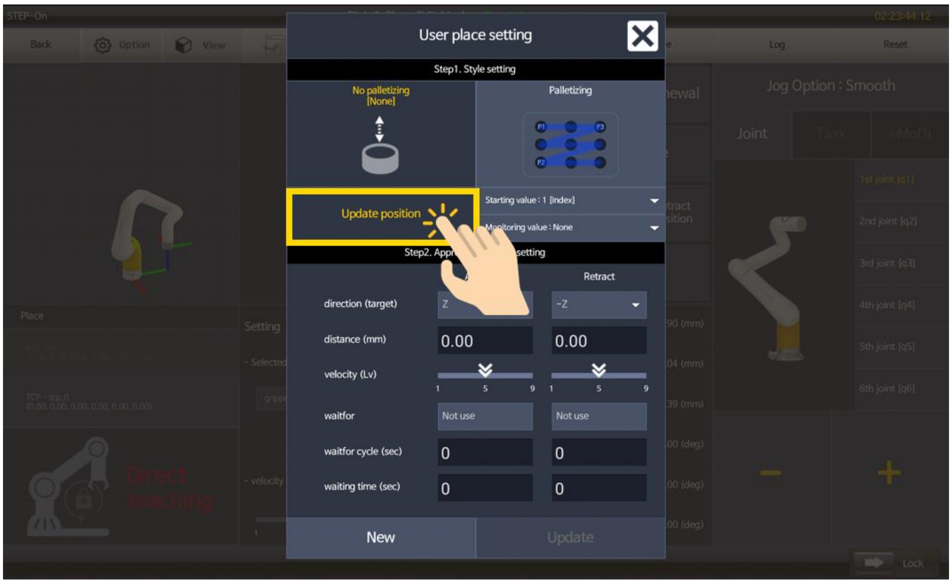


⑤ Set the **velocity level** in the Setting window at the bottom center. This is the speed of movement to the position before the place process and the robot moves by jointMove to avoid singularities.

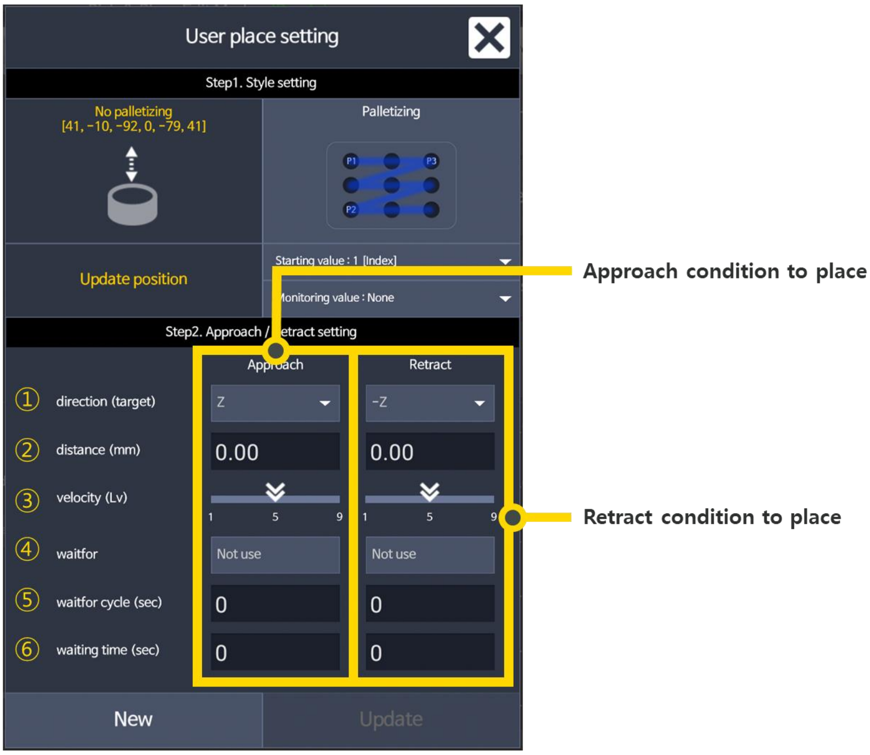


⑥ Use direct teaching or jog to move the robot to the position where you want to place the object, then touch **Edit**.

⑦ Touch **Update position** on the left to save your current position. It is saved as the position to place the object. This position is the target position in the pick and place commands.



⑧ Set the conditions for placing the object. Each condition is similarly described as in setting **pick** conditions.



- **direction (target)**
  It sets the approach and retraction direction with respect to the tool coordinate system in the current robot position.

- **distance (mm)**
  It sets the approach or retraction distance from the position where the object is to be released.

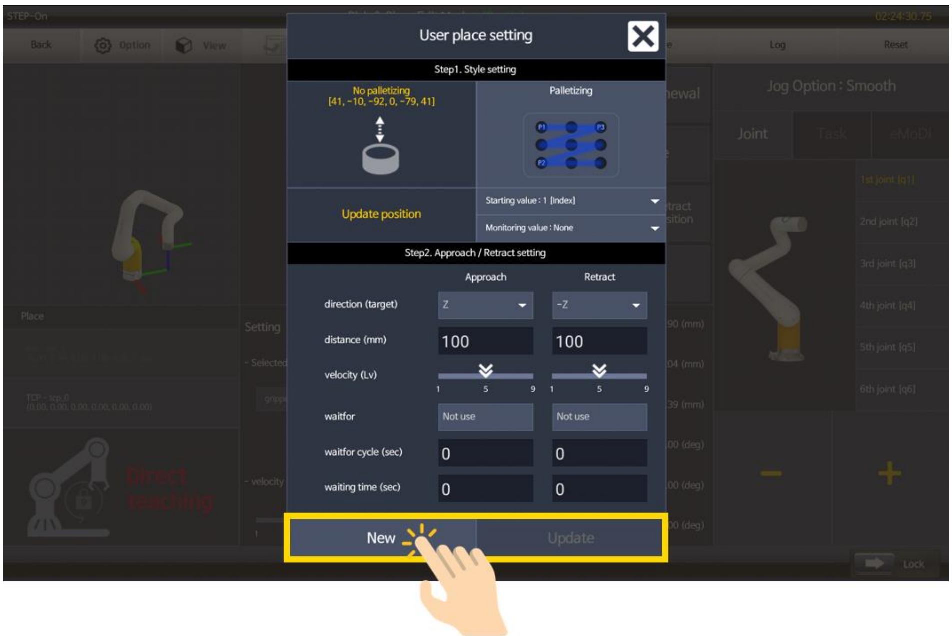
- **velocity (Lv)**
  It sets the speed in approaching to or retracting from the release position.

- **waitfor**
  Before approaching to and after retracting from the release position, the robot waits until the signal input set by the user comes in. It sets the user signal here.

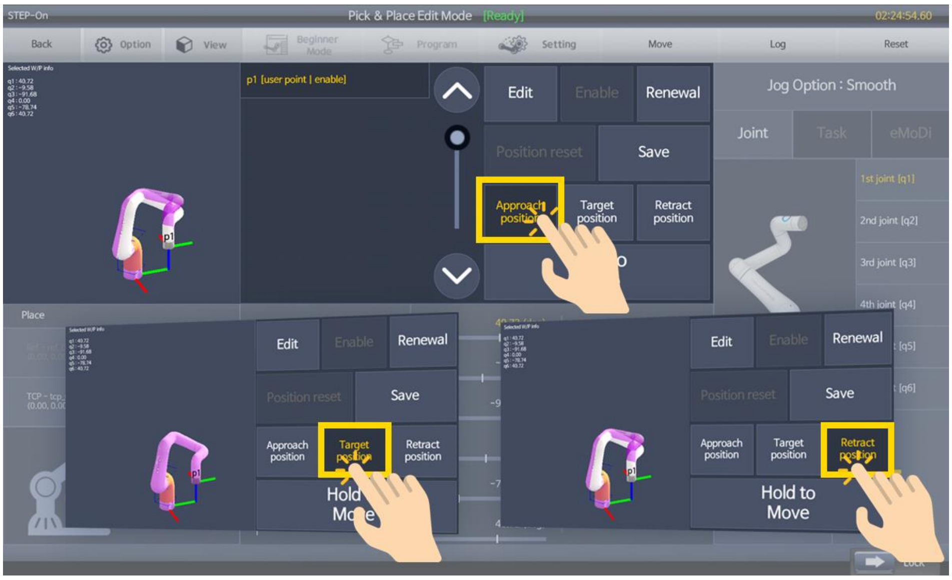
- **waitfor cycle (sec)**
  It sets the time duration to periodically check the set user signal. In other words, if you enter 0.1 second, it confirms whether the user signal is input once every 0.1 second.

- **waiting time (sec)**
  Before approaching to and after retracting from the release position, the robot waits for the amount of time set by the user. It sets the waiting time here.

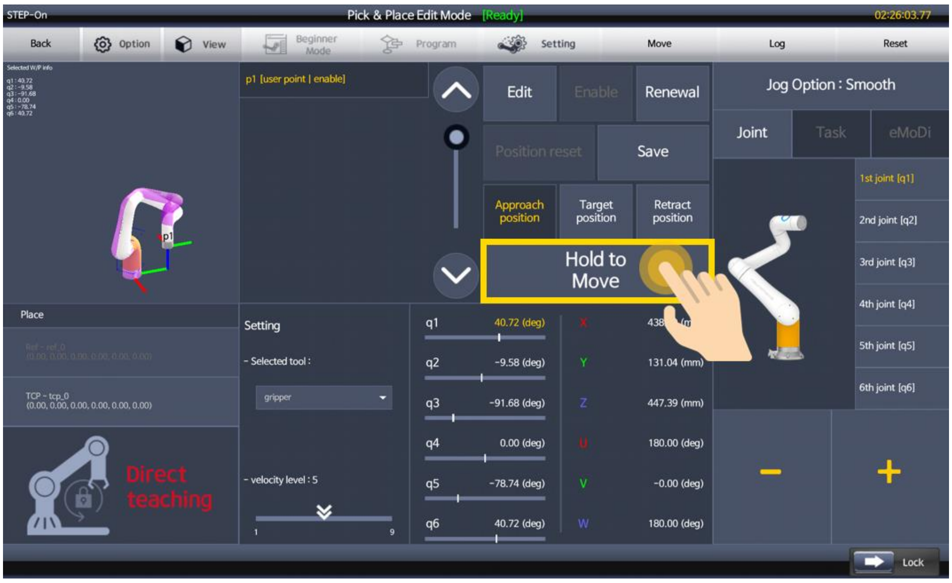
⑨ Touch **New**. If you have made any changes to existing information, touch **Update**.



⑩ Check the movement positions to make sure that the positions to pick the object are set correctly. If you select one of the approach position, the target position, and the retract position, the robot will be displayed in purple at the position selected in the left simulation window.



Alternatively, press and hold **Hold to Move**, and the actual robot will move to the selected position.

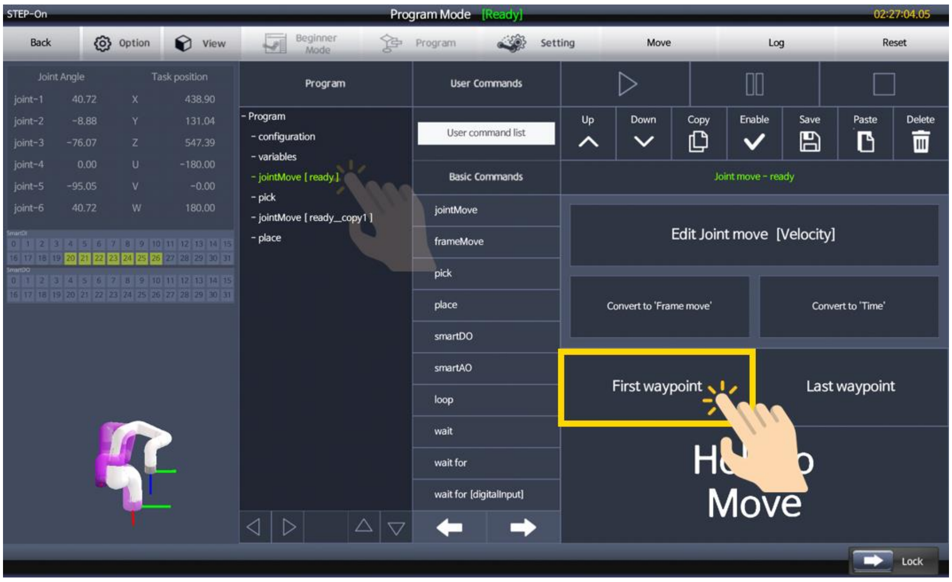


In this way, you can check the position of each movement.

⑪ When all settings are complete, touch **Save**.

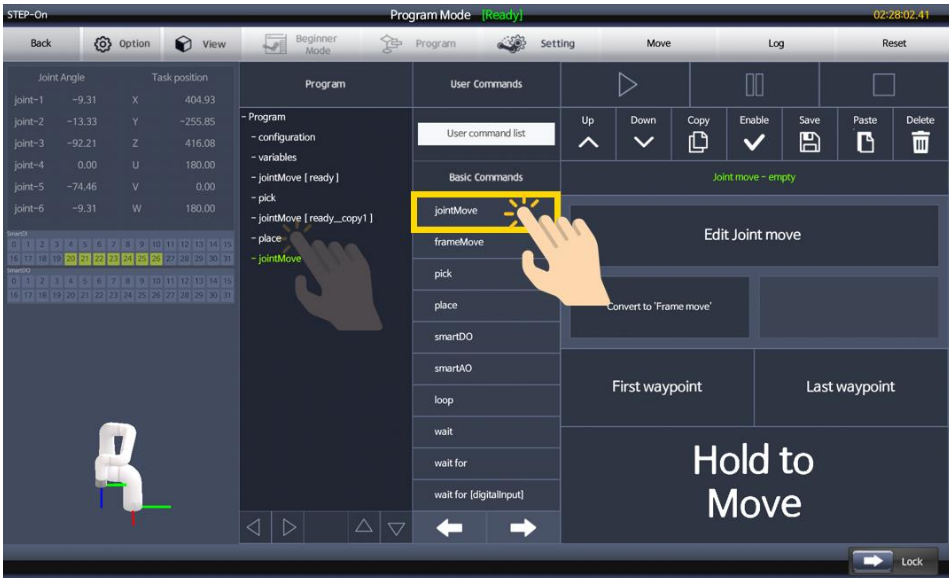
Now the settings for place is complete.

⑫ Move to the first movement position again. Select the first **jointMove** in the program tree and touch the **First waypoint** below in the same window. The robot is virtually displayed in purple in the selected position.

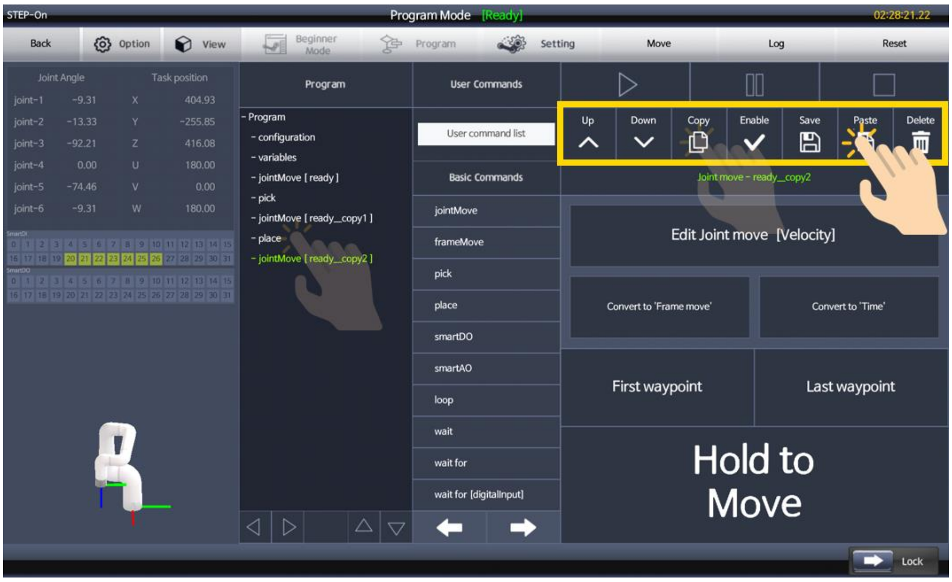


⑬ You can easily move to the first position by pressing and holding **Hold to Move**, until the robot reaches the selected position.

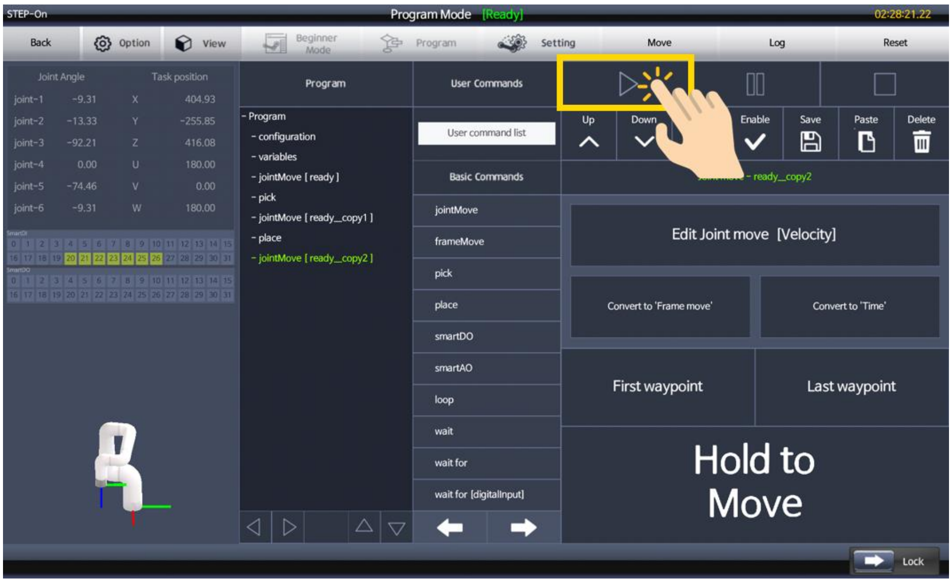
⑭ On the program screen, add **jointMove** to set the current position to the last movement position. You must first touch Place in the program tree and add jointMove to add the jointMove command to the line following place.



Alternatively, you can copy and paste the first jointMove in the program tree. You must copy the first jointMove and touch place in the program tree first to paste the jointMove command on the line following place.



⑮ Your program is complete. Touch the program start (▷) in the upper right corner of the program screen to try to run the program.

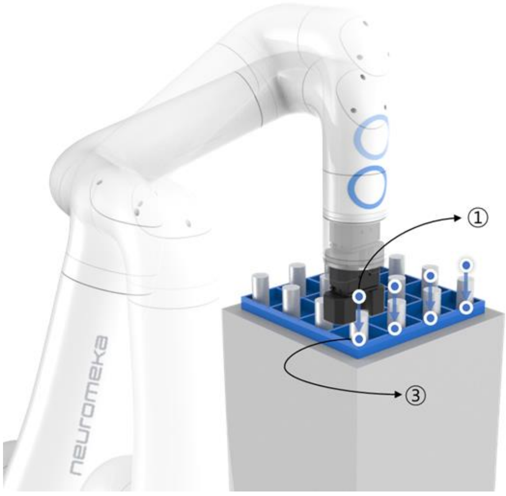


Palletizing

The palletizing command is a kind of repetitive pick and place process that is used to pick and place objects on a pattern basis.

- **pick (palletizing)**

  The robot picks many objects one-by-one at a specified position by a certain pattern.

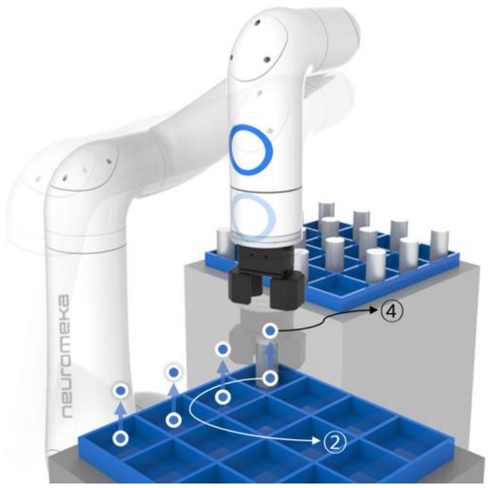


Process sequence

① Move to a vertical position of an object
② Open the gripper when it is closed
③ Approach to the position to grip the object
④ Close the gripper to grip the object
⑤ Grip the object and retreat to the vertical position
⑥ Repeat as many times dictated by the palette pattern with set positions

- **place (palletizing)**

  The robot places many objects one-by-one at a specified position by a certain pattern.



Process sequence

① Move to a vertical position of an object
② Approach to the position for placing the object
③ Open the gripper to release the object
④ Release the object and retreat to the vertical position
⑥ Repeat as many times dictated by the palette pattern with set positions

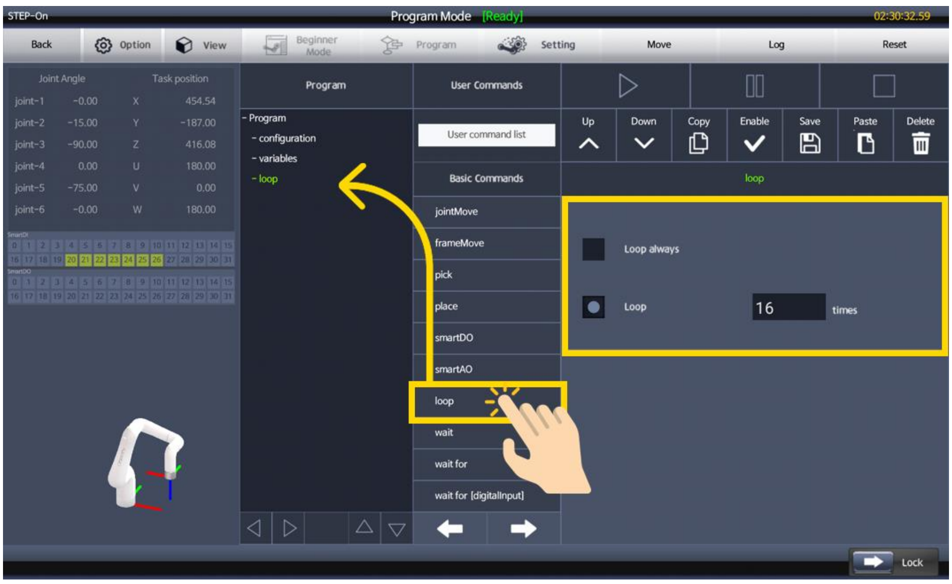
pick (palletizing)

Let's pick objects in a palette that has a certain pattern of rows and columns, as shown below.

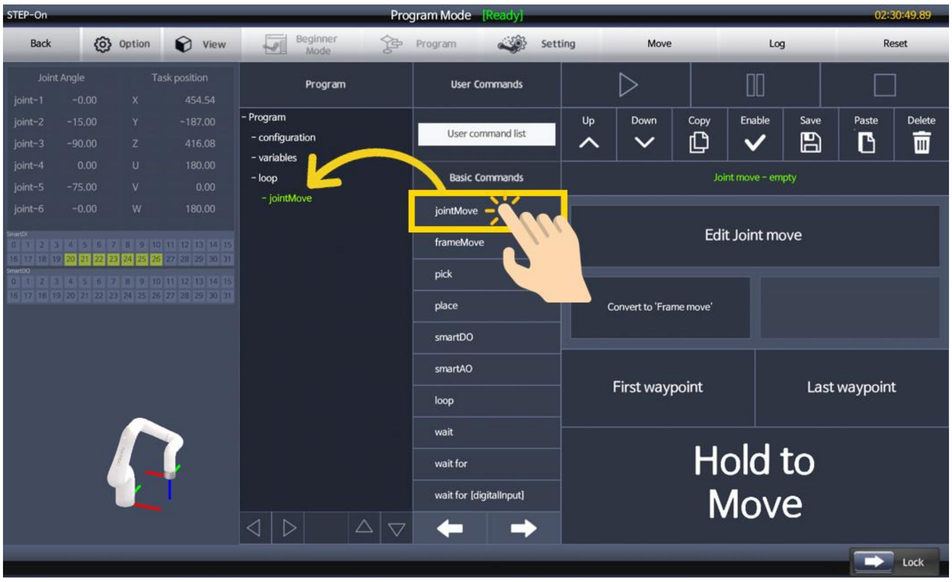
[Example]

The robot is currently stopped at position 1. All objects placed in the pallet in position 2 are approached vertically, gripped using the gripper, and retracted vertically. Then the robot moves back to position 1 again.

① The pick command will repeatedly pick one of the objects in the palette for each run with a certain pattern. Therefore, you need to use loop to pick all the objects that are located in multiple positions in the palette. Add a **loop** in the Program screen and set the number of repetitions in the loop setting window. In this case, since there are sixteen objects in the pallet, we will enter 16 to repeat that many times.



② On the program screen, add **jointMove** to set the current position to the first movement position. See the **jointMove** command for a detailed explanation.

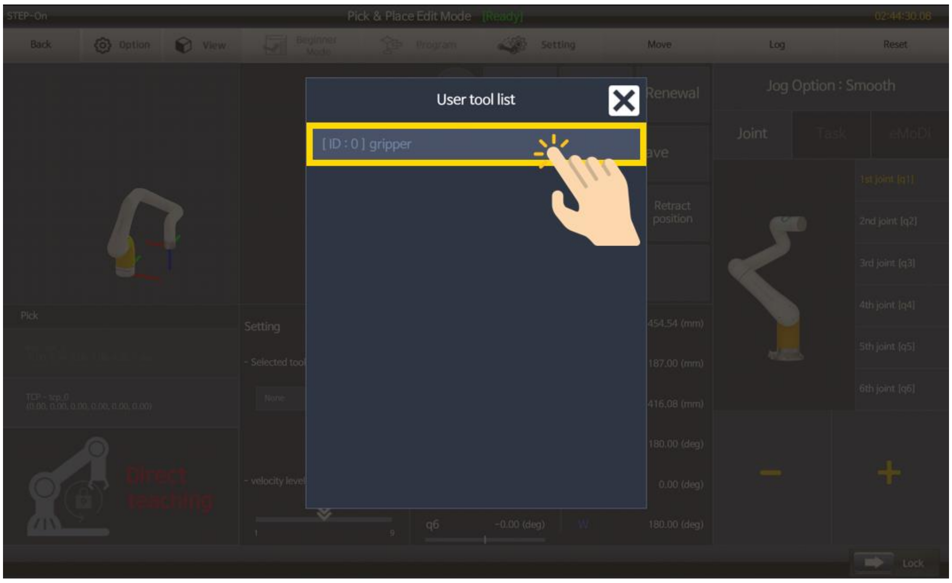


③ On the Program screen, touch **pick** to add it in the tree. If the pick command is not displayed in the user command list, it implies that the tool for the pick and place process is not set. Set the tool in Setting. Refer to **Section 6.1 Robot Settings** for details on tool setting.

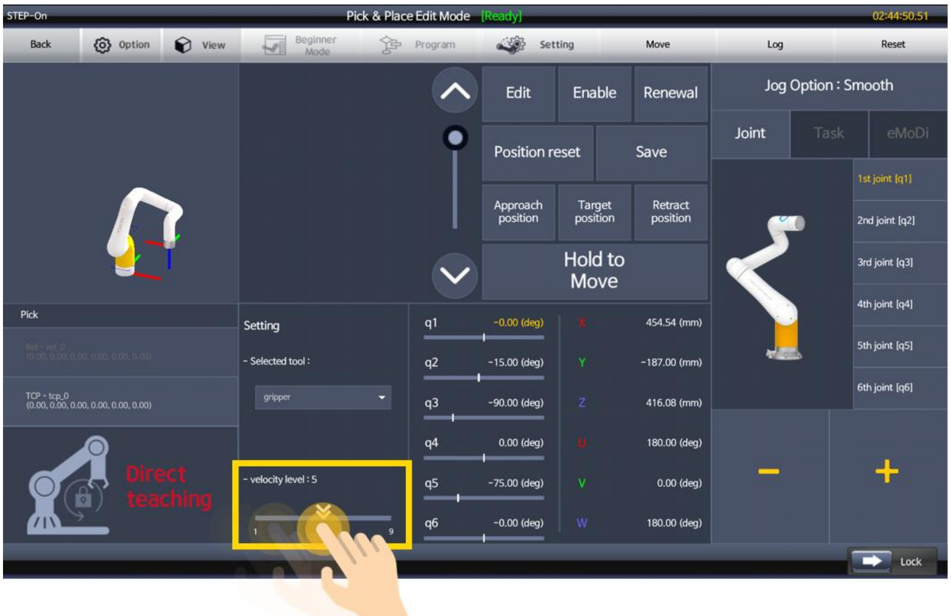
④ Touch **Edit Pick** on the right window. If the current gripper is closed, you have to open the gripper before editing by touching **Release** below on the same window.

⑤ Touch the arrow in the **Selected tool** field in the Setting window in the center bottom.

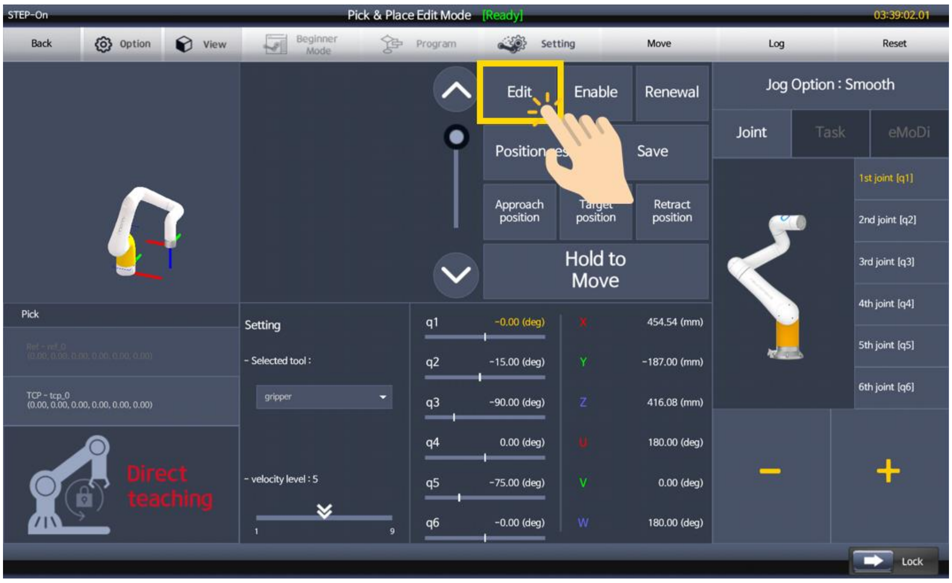
Select the tool from the User tool list of registered tools.



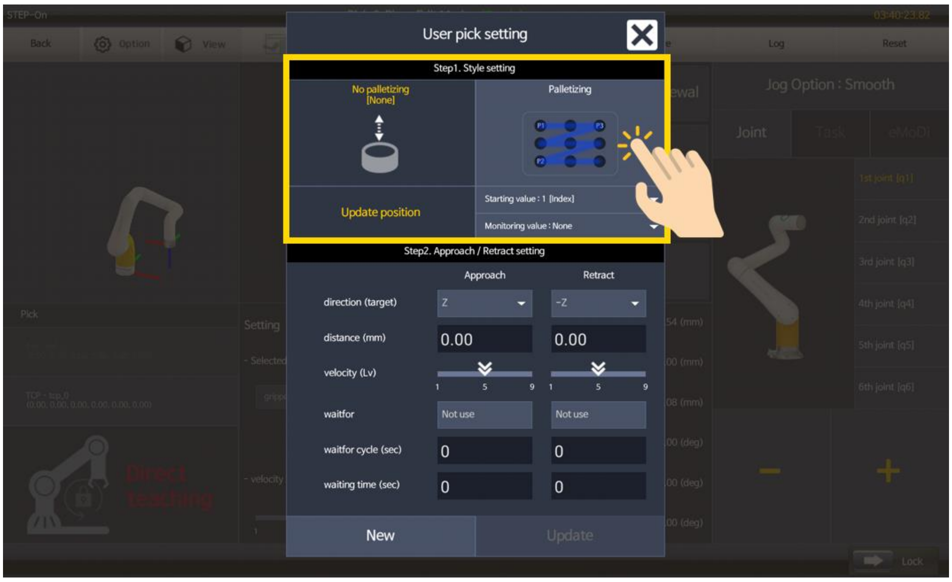
⑥ Set the **velocity level** in the Setting window. This is the speed of movement to the position before picking the object and the robot moves in the joint space to avoid singularities.



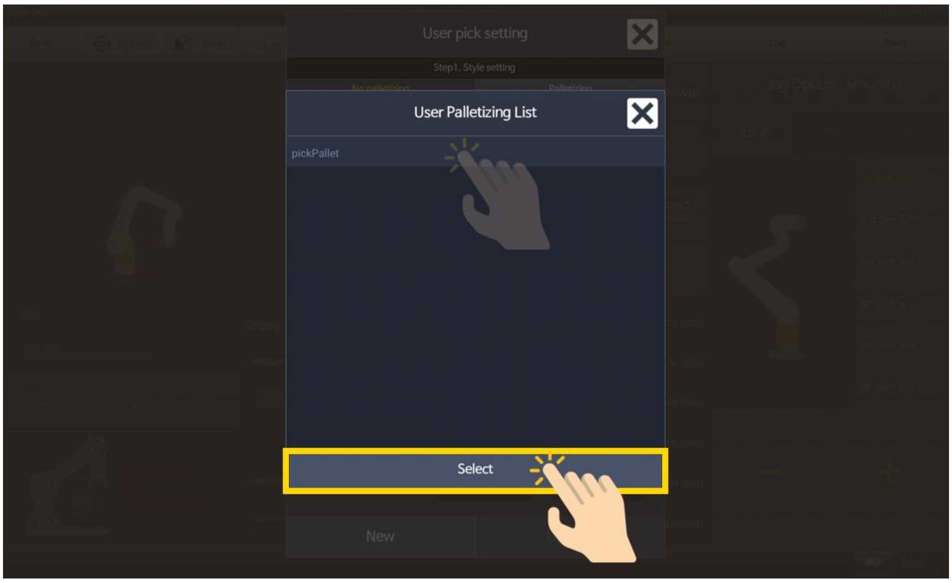
⑦ Touch **Edit** at the top center.



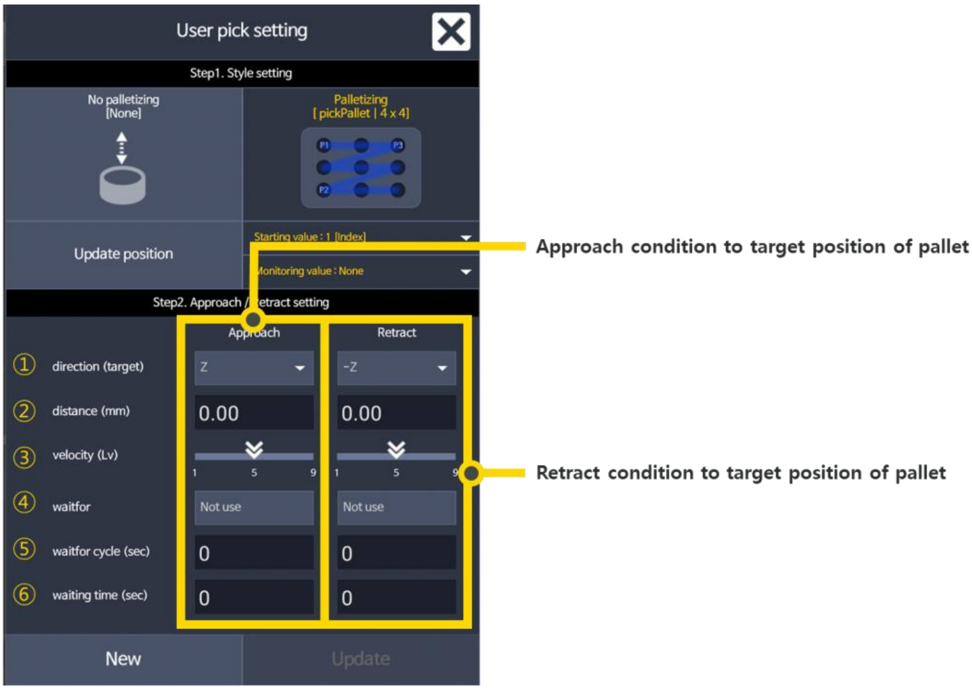
⑧ Touch the **palette-shaped picture** to load the positions of the objects in the preset palette with a certain rule.



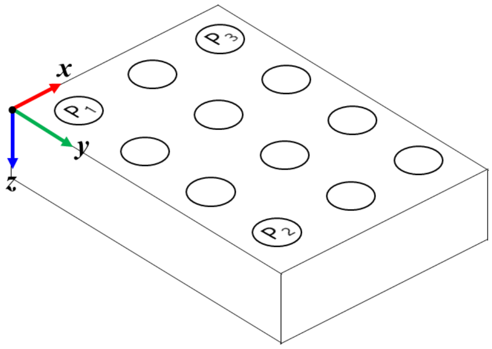
⑨ Select the palette on which you want to pick the target objects in the palette list. If the target palette does not appear in the palette list, the palette is not set yet for this palletizing process. Set the pallet in the Setting. Refer to **Section 6.1 Robot Settings** for a detailed description of how to set a pallet.



⑩ Set the conditions for picking objects on the pallet. Each condition is similarly defined as in pick setting, except for the direction for picking the object.



- **direction (target)**
  It sets the approach and retraction direction with respect to the pallet coordinate system. The pallet coordinate system is determined by the palette anchor point in setting the pallet as shown below.



- **distance (mm)**
  It sets the approach or retraction distance from the current target position of the pallet.

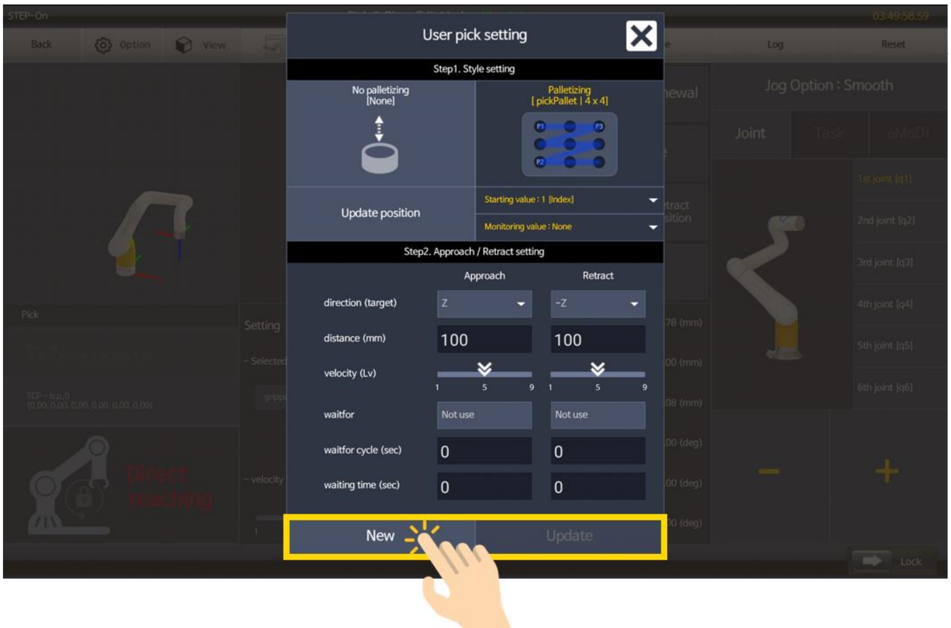
- **velocity (Lv)**
  It sets the speed in approaching to and retracting from the target position on the palette.

- **waitfor**
  Before approaching to and after retracting from the target position on the palette, the robot waits until the signal input set by the user comes in. It sets the user signal here.

- **waitfor cycle (sec)**
  It sets the time duration to periodically check the set user signal. In other words, if you enter 0.1 second, it confirms whether the user signal is input once every 0.1 second.

- **waiting time (sec)**
  Before approaching to and after retracting from the target position on the palette, the robot waits for the amount of time set by the user. It sets the waiting time here.

⑪ Touch **New**. If you have made any changes to existing information, touch **Update**.



⑫ The position list shows the positions of the objects that are placed on the pallet with a certain pattern. Check the movement positions to make sure that each position is set correctly. One can confirm the positions by selecting an object position to be checked in the position list, and by selecting one of the approach position, the target position, and the retract position. Then, the robot will be virtually displayed in purple at the selected position in the left simulation window.

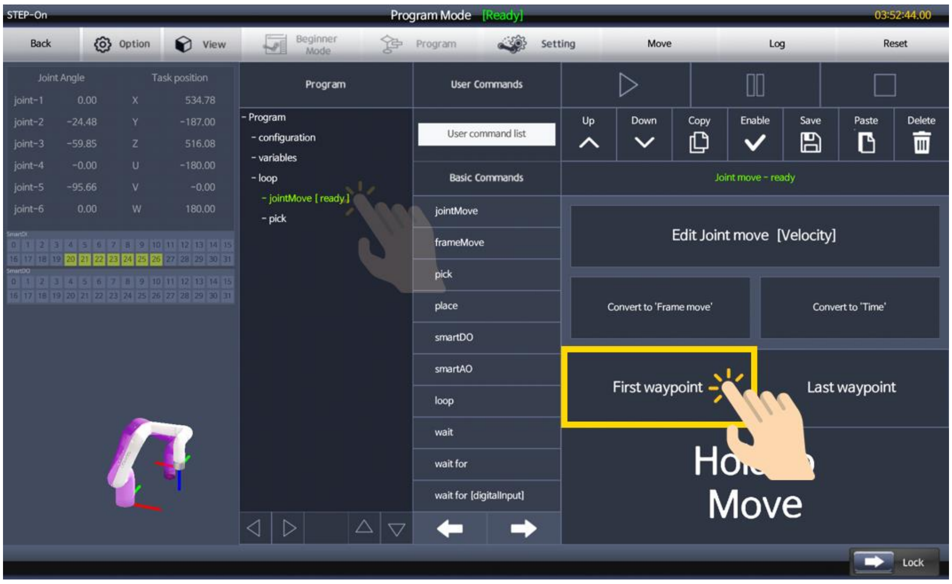
Alternatively, press and hold **Hold to Move**, and the actual robot will move to the selected position.

In this way, you can check the position of each movement.

⑬ When all settings are complete, touch **Save**.

Now you have completed configuring the pick for picking the objects on the pallet.

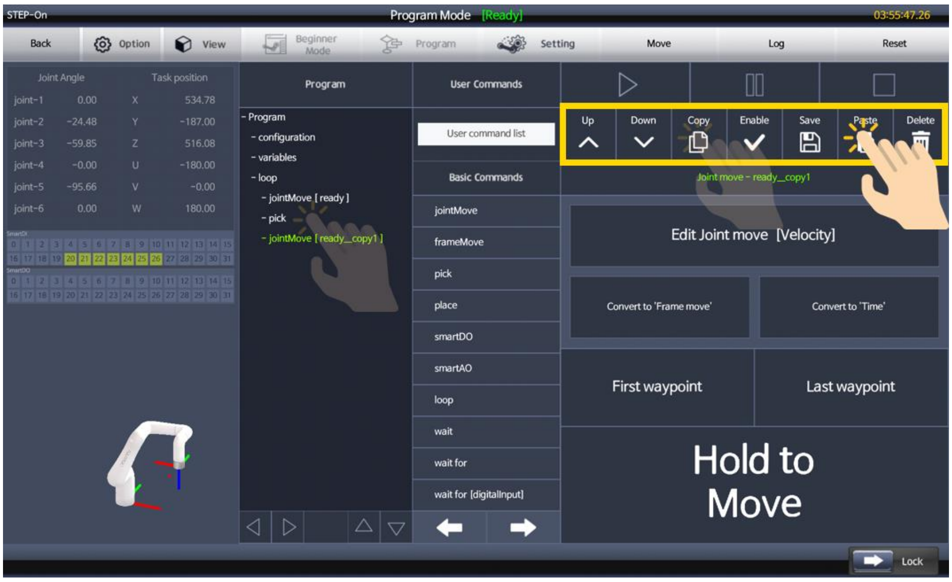
⑭ Move to the first movement position again. Select the first **jointMove** in the program tree and touch the **First waypoint** on the right window. The robot is virtually displayed in purple in the selected position.



You can easily move to the first position by pressing and holding **Hold to Move**, until the robot reaches the selected position.

⑮ On the program screen, add **jointMove** to set the current position to the last movement position. Note that you must first touch pick in the program tree and add jointMove to add the jointMove command to the line following pick.

Alternatively, you can copy and paste the first jointMove in the program tree. You must copy the first jointMove and then touch pick in the program tree first to paste the jointMove command on the line following pick.



The program created so far will be executed after we complete setting place for iteration by a pattern. Continue to check the following place settings.

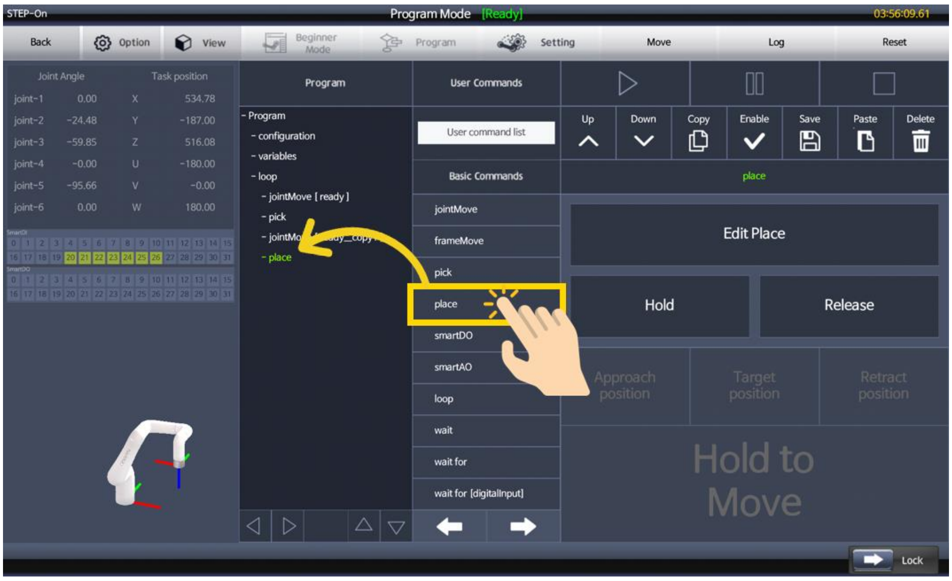
place (palletizing)

We will place the objects picked from the pallet on a new pallet using the **place** command repeatedly. Continue to add in the program we wrote earlier.

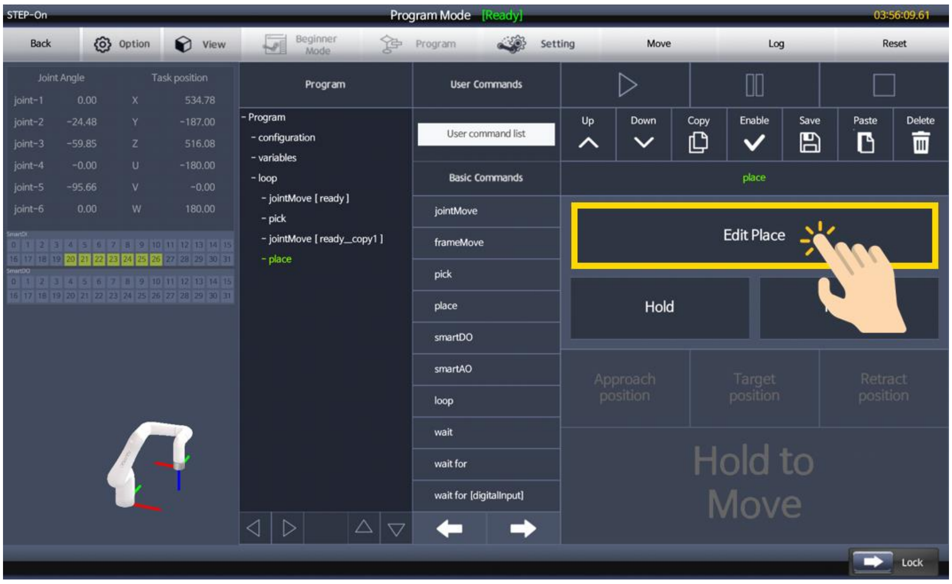
[Example]

The robot now stops at position 1 and approaches vertically downward to a target position, where it places the object places the object, and retracts vertically upward, one by one on the pallet located in position 2, Finally, it returns to position 1.

① On the program screen, touch **place** and add it in the tree.

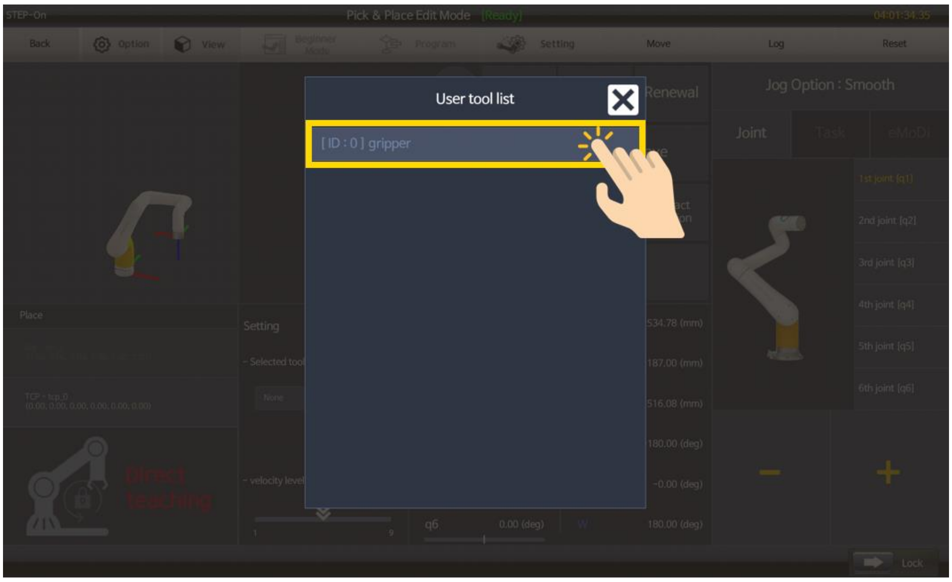


② Touch **Edit Place** on the right window.

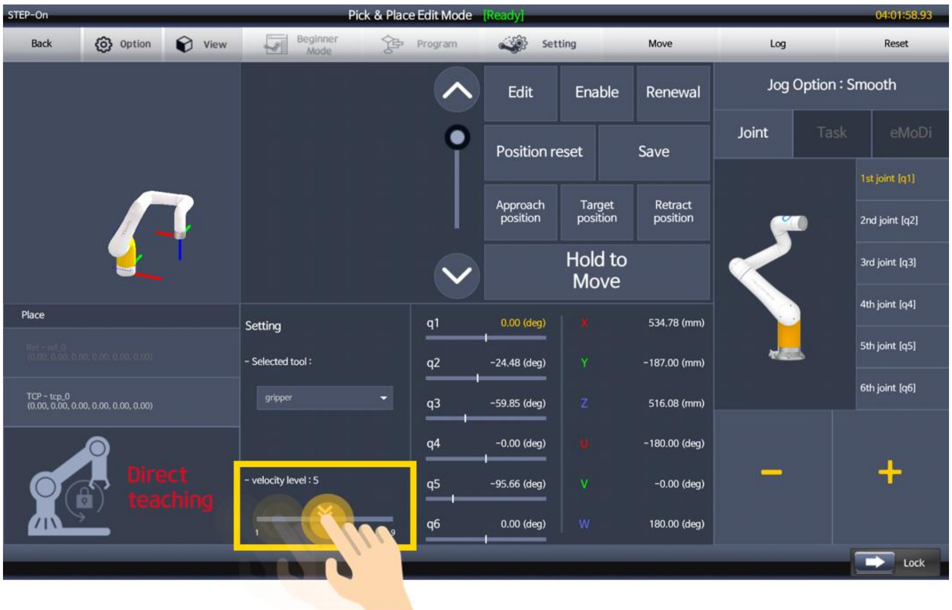


③ Touch the arrow under the **Selected tool** in the Setting window in the center bottom.

④ Select the tool from the User tool list of registered tools.

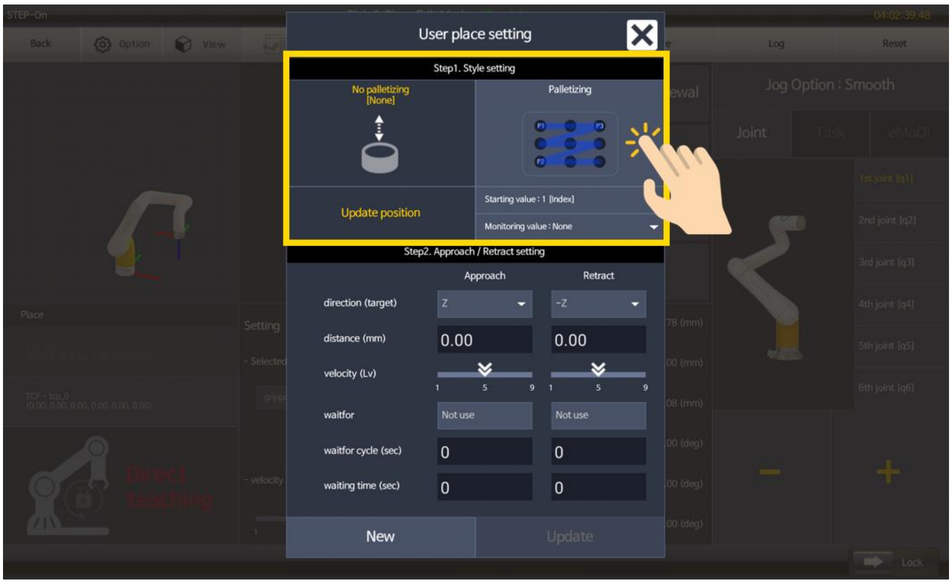


⑤ Set the **velocity level** in the Setting window. This speed is the speed of movement to the position before the object is released and the robot moves in the joint space to avoid singularities.



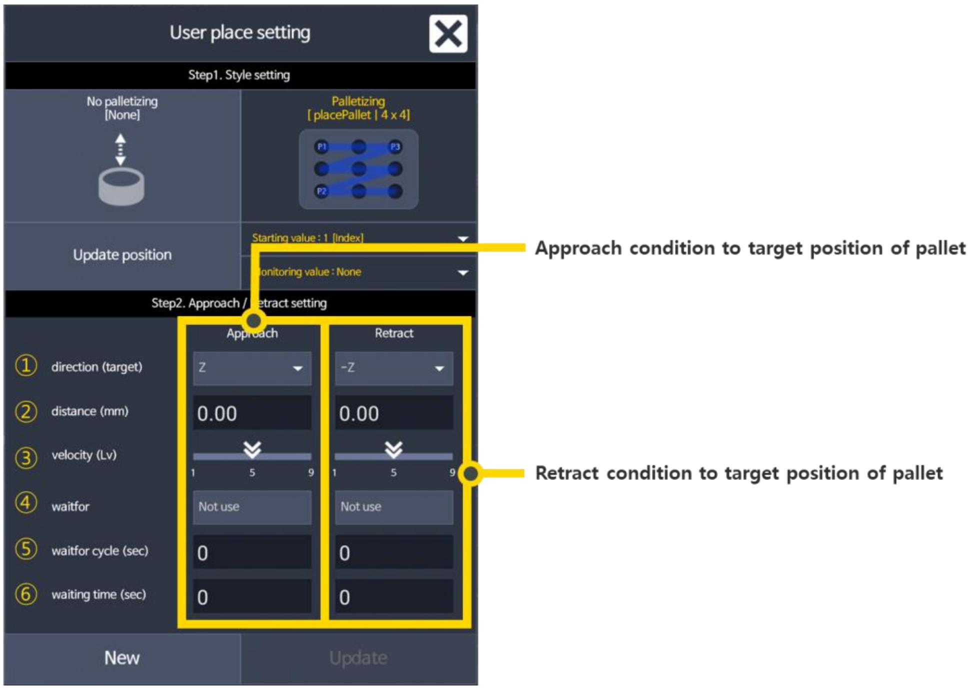
⑥ Touch **Edit** on the right.

⑦ Touch the **palette-like picture** to load the information on the positions for placing the objects on the palette with a certain pattern.

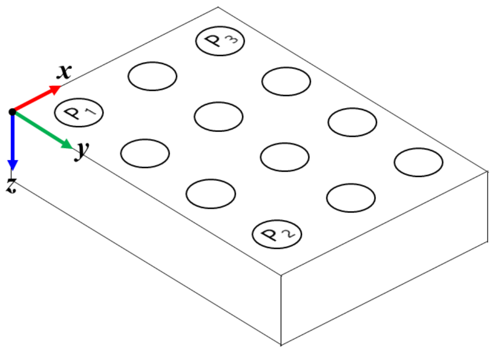


⑧ Select the palette on which you want to place the target objects in the palette list. If the target palette does not appear in the palette list, it implies that the palette is not set yet for this palletizing process. Set the pallet in the Setting. Refer to **Section 6.1 Robot Settings** for a detailed description of how to set a pallet.

⑨ Set the conditions for placing objects on the pallet. Each condition is similarly defined as in setting pick(palletizing).



- **direction (target)**
  It sets the approach and retraction direction with respect to the pallet coordinate system. The pallet coordinate system is determined by the palette anchor point when setting the pallet as shown below.



- **distance (mm)**
  It sets the approach or retraction distance from the current target position of the pallet.

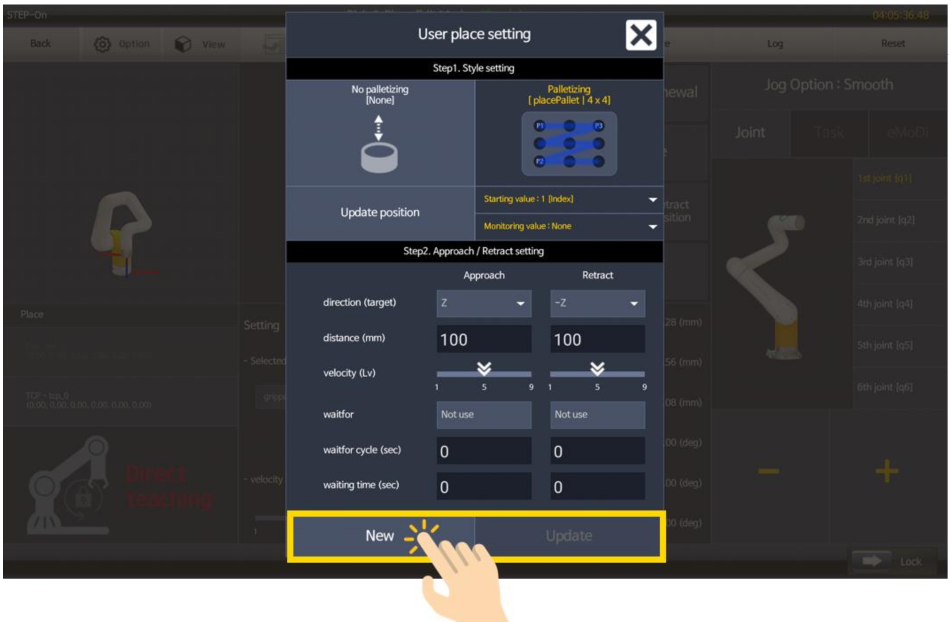
- **velocity (Lv)**
  It sets the speed in approaching to and retracting from the target position on the palette.

- **waitfor**
  Before approaching to and after retracting from the target position on the palette, the robot waits until the signal input set by the user comes in. It sets the user signal here.

- **waitfor cycle (sec)**
  It sets the time duration to periodically check the set user signal. In other words, if you enter 0.1 second, it confirms whether the user signal is input once every 0.1 second.

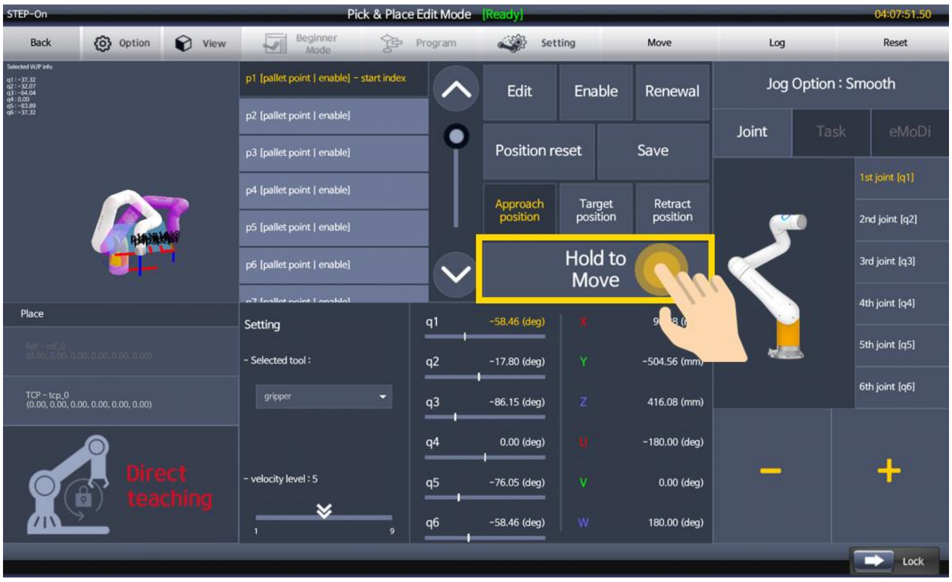
- **waiting time (sec)**
  Before approaching to and after retracting from the target position on the palette, the robot waits for the amount of time set by the user. It sets the waiting time here.

⑩ Touch **New**. If you have made any changes to existing information, touch **Update**.



⑪ The position list shows the positions of the objects where you need to place them on the pallet with a certain pattern. Check the movement positions to make sure that each position is set correctly. If you select one of the approach position, the target position, and the retract position after selecting the position you want to check in the position list, the robot is virtually displayed in purple at the selected position in the left simulation window.

Alternatively, press and hold **Hold to Move**, and the actual robot will move to the selected position.

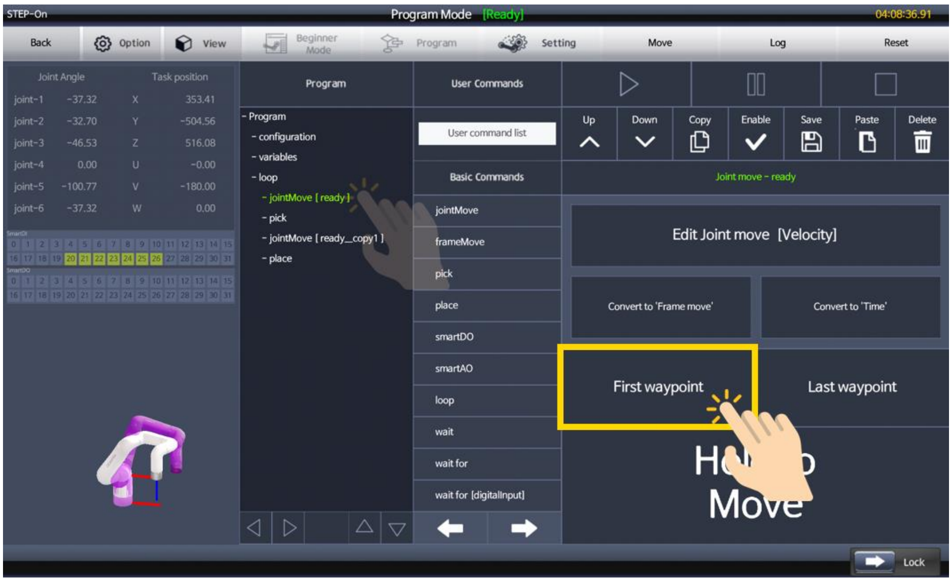


In this way, you can check the position of each movement.

⑫ When all settings are complete, touch **Save**.

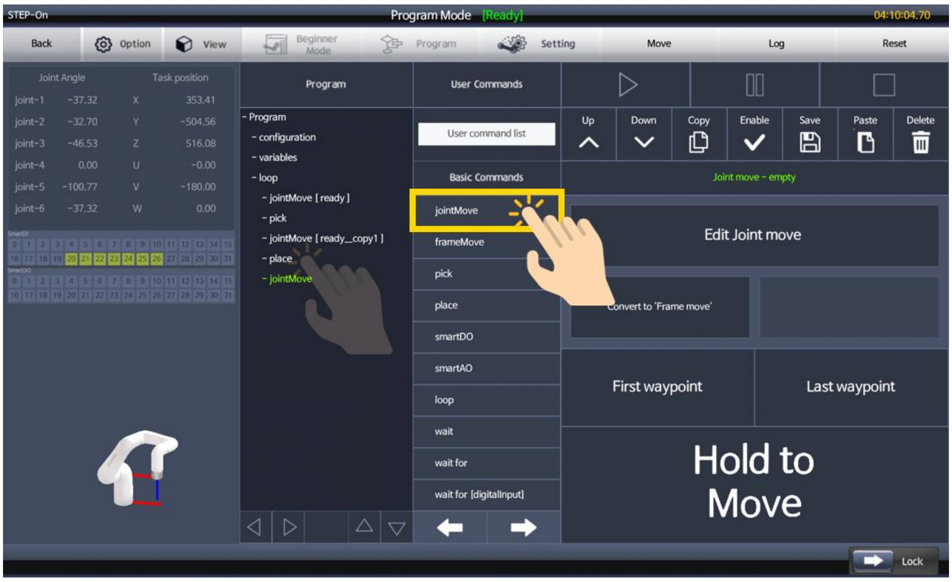
Now you have completed configuring the place for placing the objects on the pallet.

⑬ Move to the first movement position again. Select the first **jointMove** in the program tree and touch the **first waypoint** on the right window. The robot is virtually displayed in purple in the selected position.

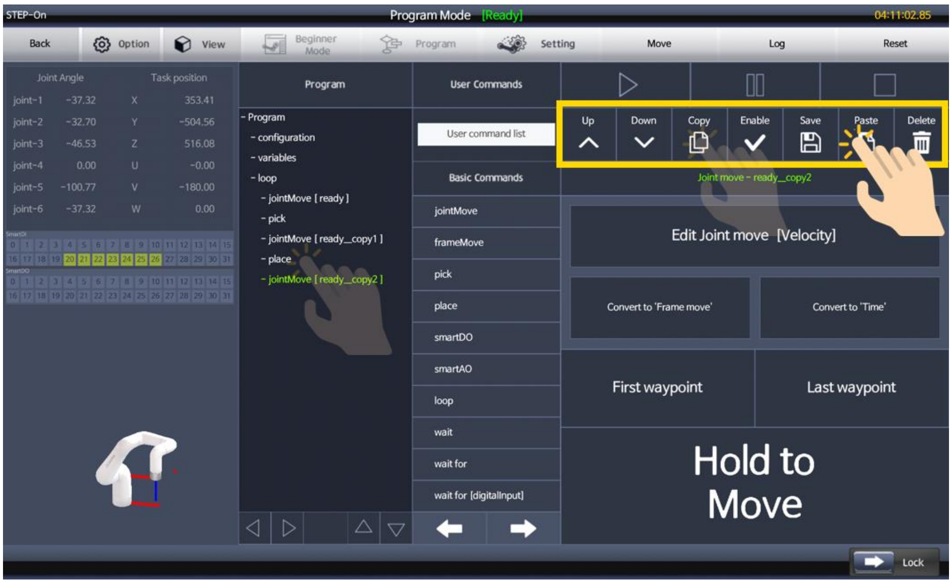


You can easily move to the first position by pressing and holding **Hold to Move**, until the robot reaches the selected position.

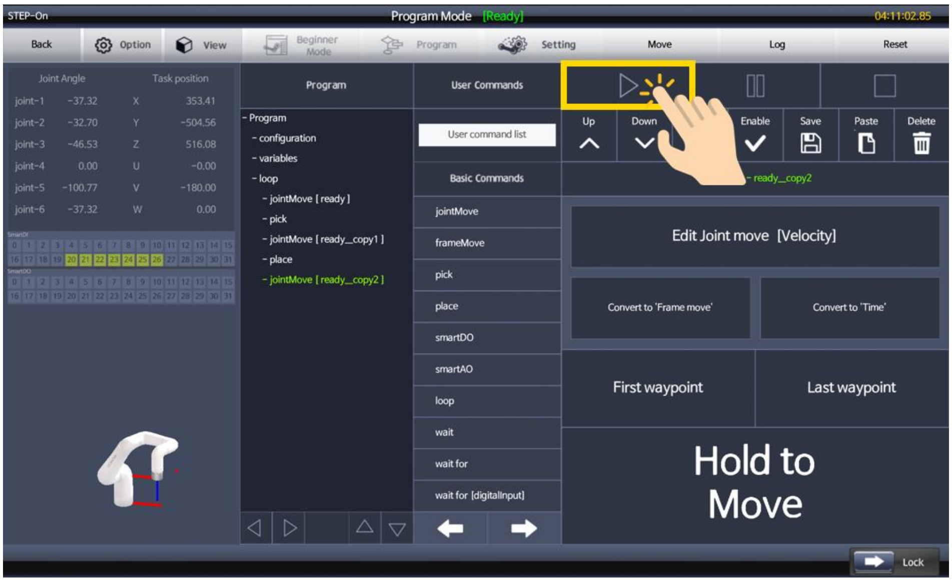
⑭ On the program screen, add **jointMove** to set the current position to the last movement position. You must first touch Place in the program tree and add jointMove to add the jointMove command to the line following place.



Alternatively, you can copy and paste the first jointMove in the program tree. You must copy the first jointMove and touch place in the program tree first to paste the jointMove command on the line following place.



⑮ Your program is now complete. Touch the program start (▷) in the upper right corner of the program screen to try to run the program.



5.9 IndyCARE Commands

They are the commands for using IndyCARE service, and one can use the commands for updating the monitored data during program execution. Depending on the data type the following IndyCARE commands can be set in the configuration of the program tree. For detailed description of IndyCARE setting please refer to **Sec. 5.5 Configurations**.

- **IndyCARE:Count**
  This command is used to count how many times the specific instant or the specific block in the program has been executed during program execution.
- **IndyCARE:Monitoring**
  This command is used to measure and monitor the joint temperatures or the analog signals to the analog input ports.

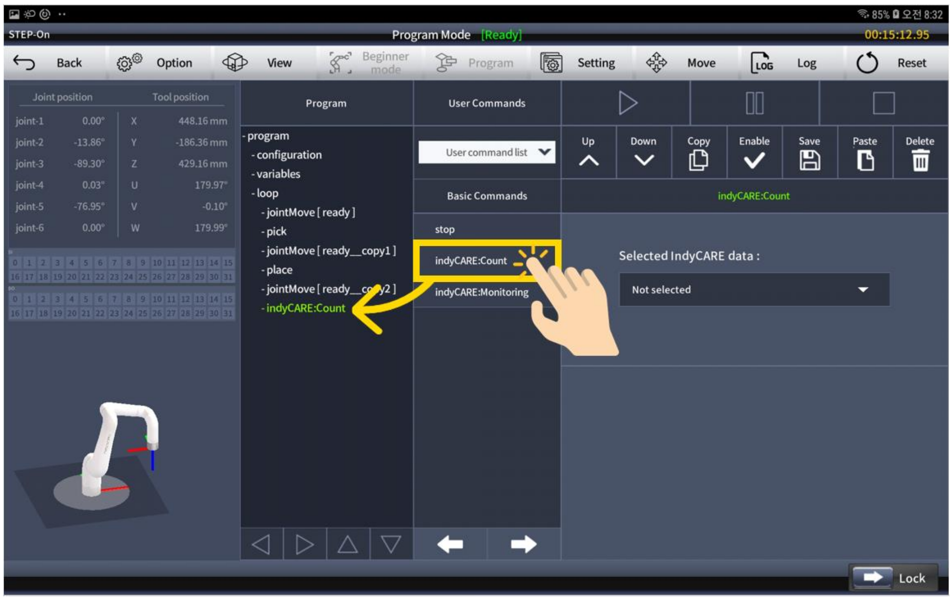
IndyCARE:Count

This example will measure the production performance in terms of IndyCARE:Count, by counting the number by which the object has been picked-and-placed to the empty pallet. The previous program is continued.

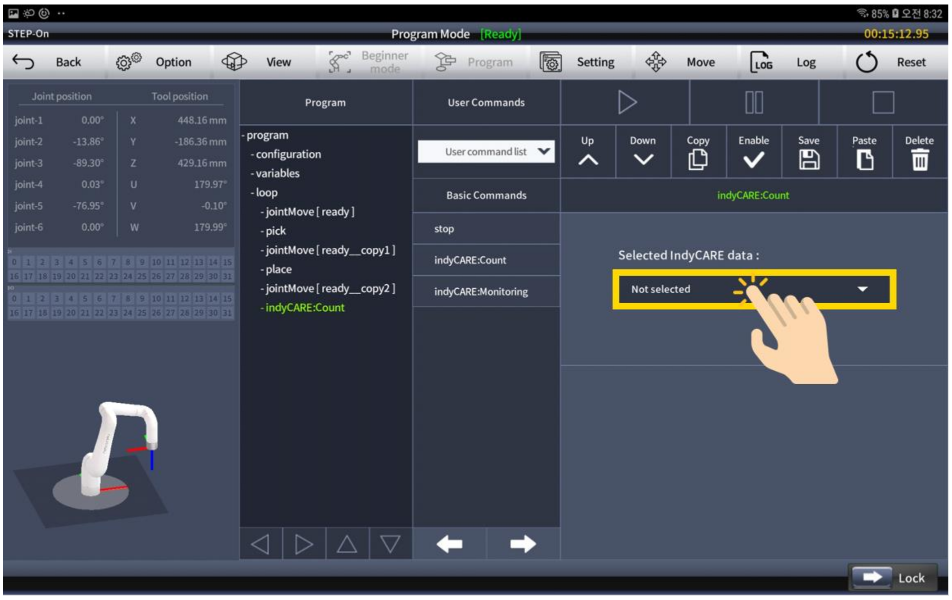
[Example]

As the robot pick-and-places the object in the pallet to the other empty pallet, the count is accumulated and IndyCARE service will monitor the production performance.

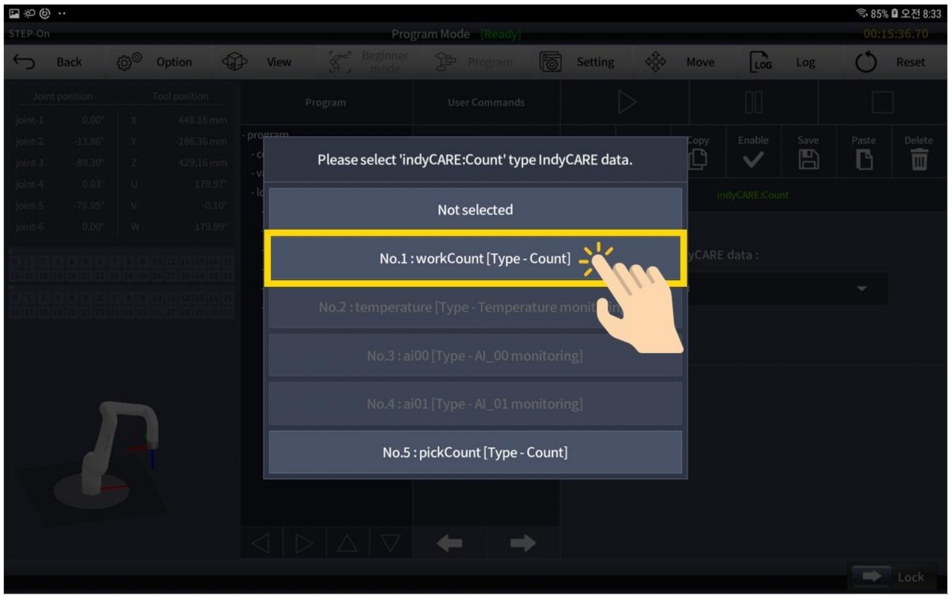
① Add, to the program tree, **indyCARE:Count** command in the user commands in the program window.



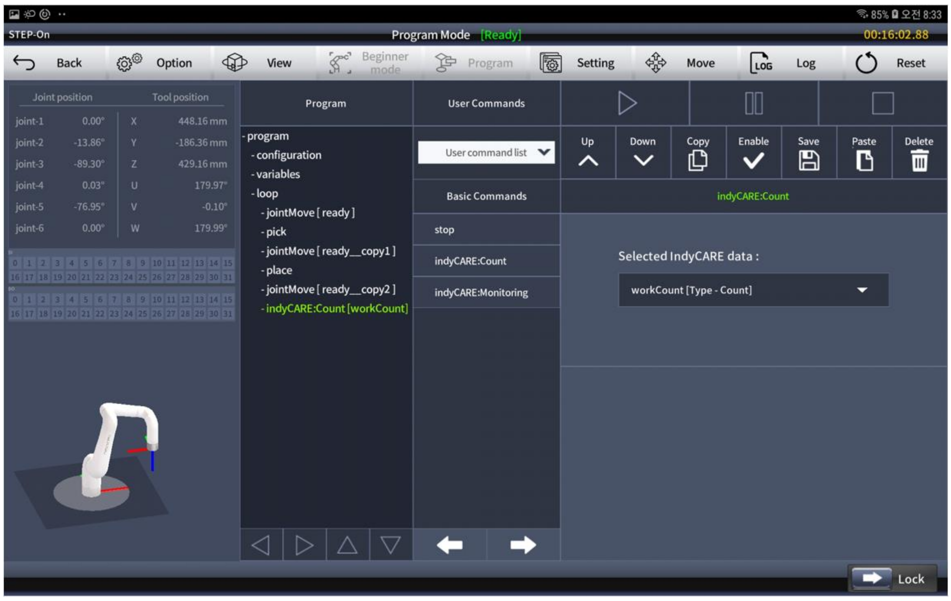
② Touch **Not selected** in the right setting window.



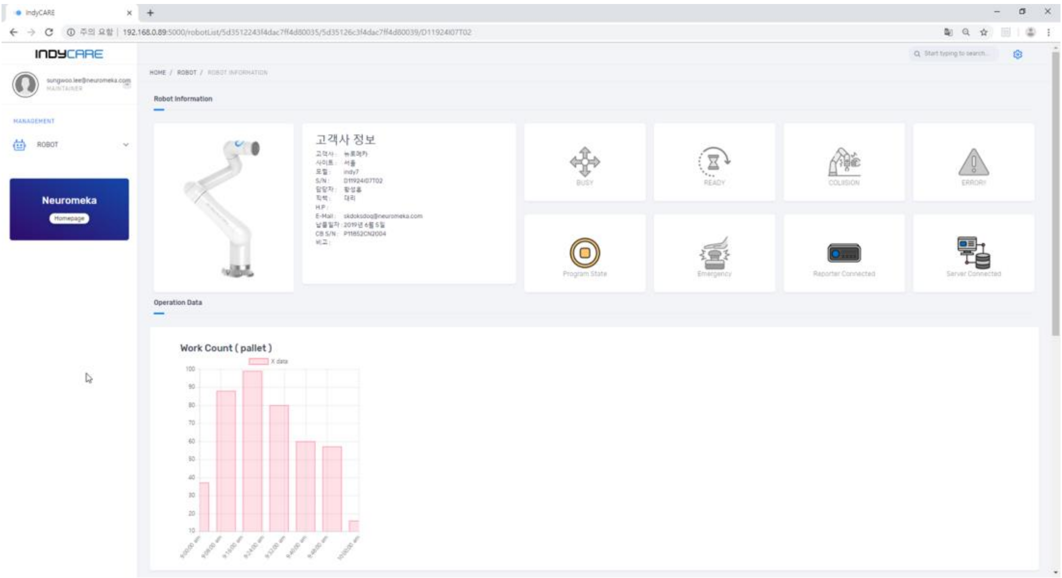
③ Then the list of data you registered in IndyCARE setting is displayed as follows. Note that IndyCARE:Count command is only valid for the data of type [Type-Count]. Choose the **data name** for monitoring.



④ All setting for IndyCARE:Count has been completed.



When you connect to IndyCARE service provider, you can monitor the production performance easily while the program is running.



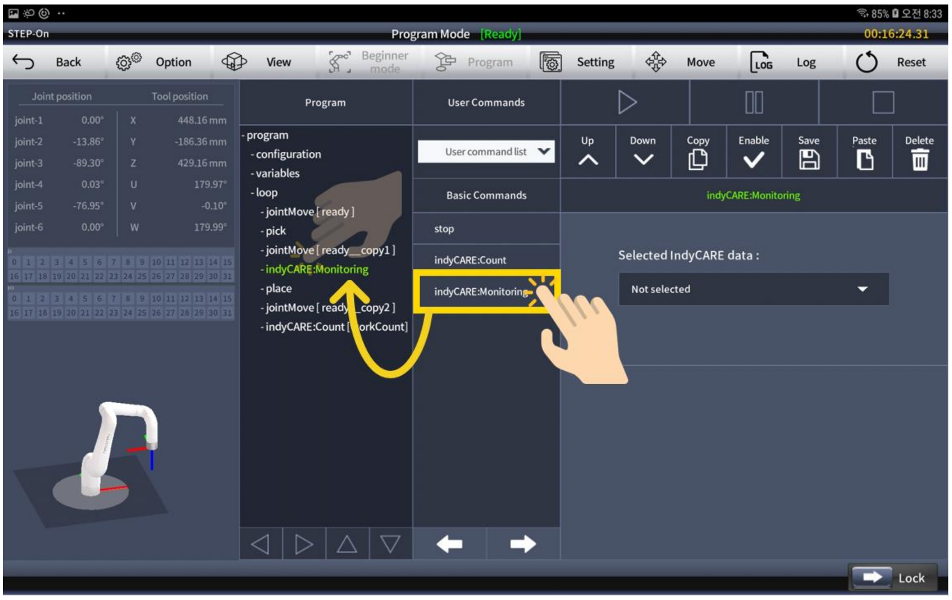
IndyCARE:Monitoring

This example will monitor the temperature of each joint of the robot using the IndyCARE:Monitoring command when the robot will pick the object. The previous program is continued.

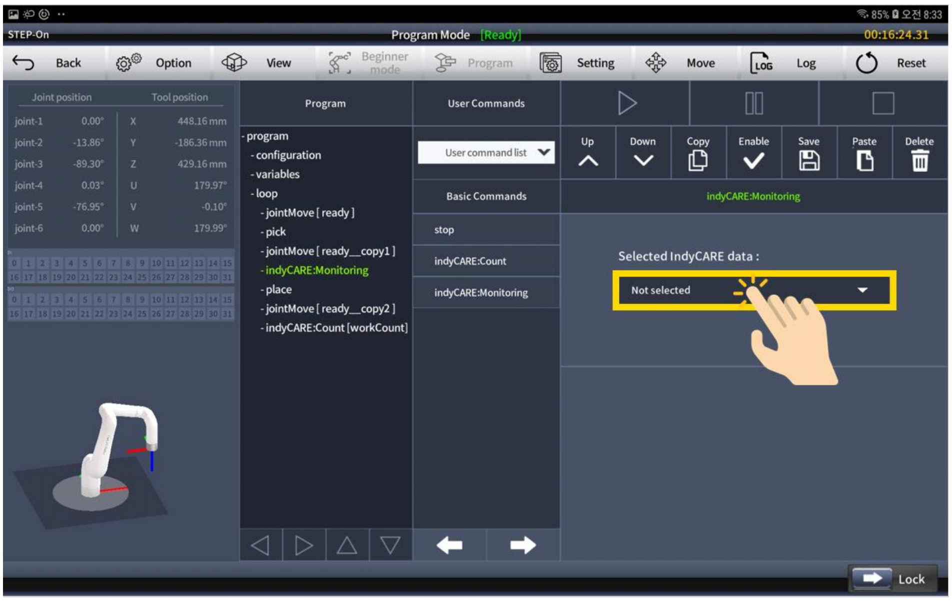
[Example]

When the robot picks the object in the pallet, the heavier the object is the higher the temperatures of the joints. Accordingly, it is desired to monitor the temperature of each joint, e.g. before placing the object, using IndyCARE service in order to prevent any problem due to high temperature.

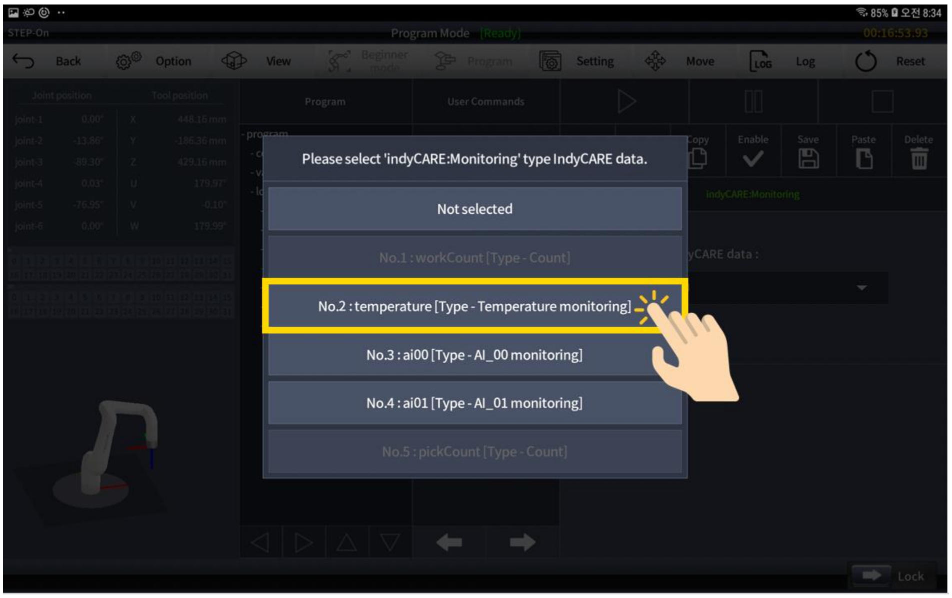
① In the program window, add **indyCARE:Monitoring** command in the user commands to the program tree by first selecting the command located just before the point to measure the temperature. For this example let us add the indyCARE:Monitoring command just before place command.



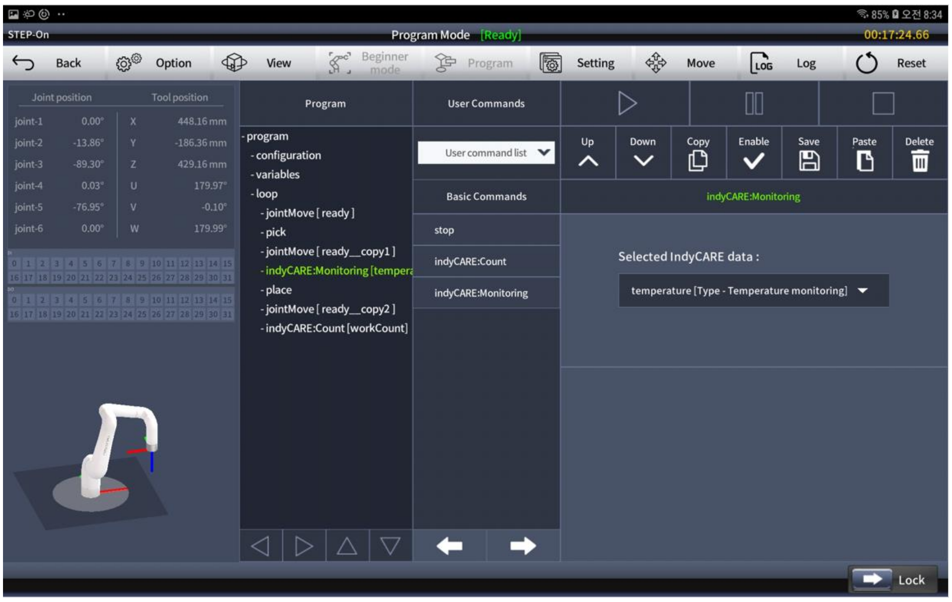
② Touch **Not selected** in the right setting window.



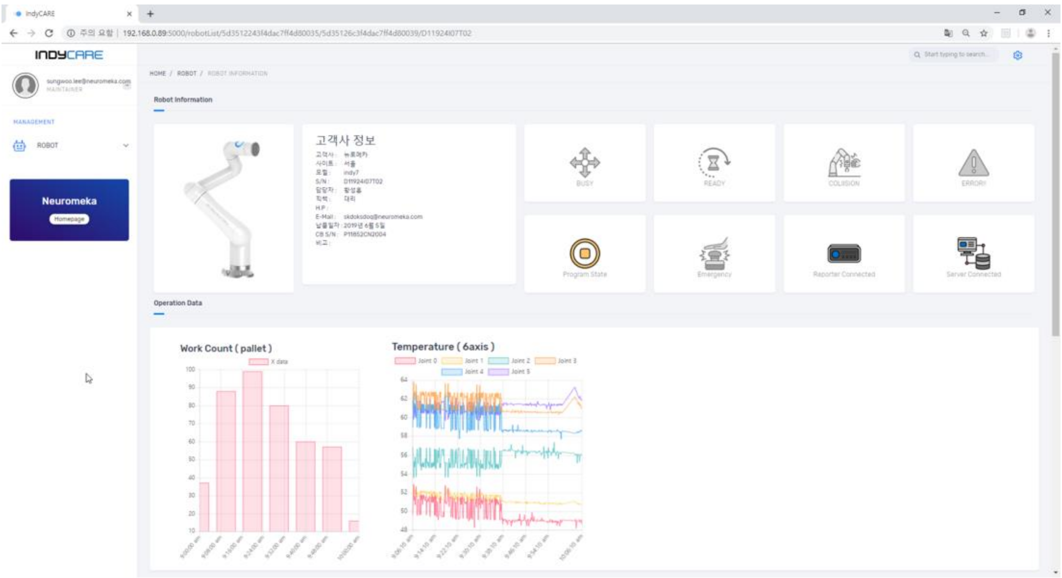
③ Then the list of data you registered in IndyCARE setting is displayed as follows. Note that IndyCARE: Monitoring command is only valid for the data of type [Type-Monitoring]. Choose the **data name** for monitoring the joint temperatures.



④ All setting for IndyCARE:Monitoring command has been completed.



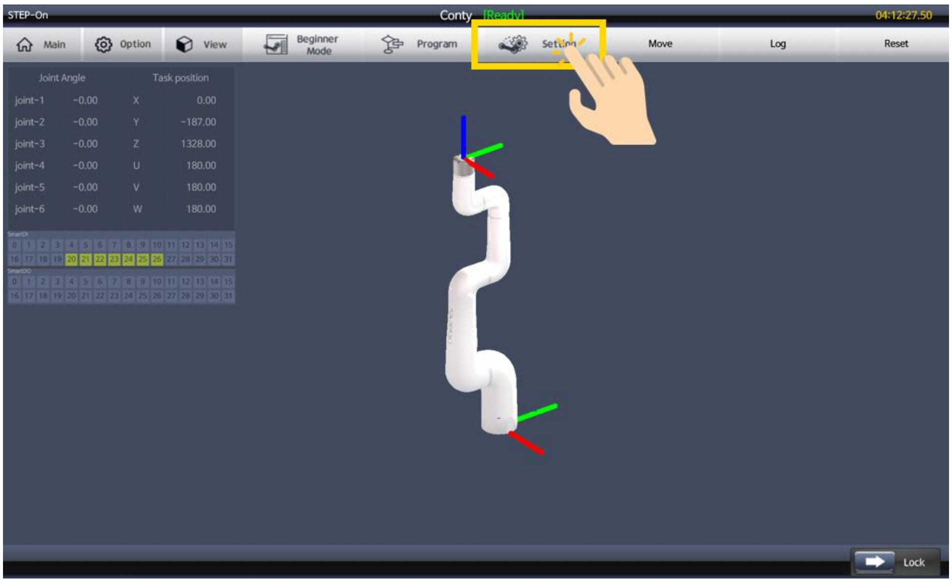
When you connect to IndyCARE service provider, you can monitor the joint temperatures measured at the instant before placing the object as well as the production performance monitored by IndyCARE:Count command.



6 Settings

6.1 Robot Settings

Before using the robot, you can set the configurations related to robot operation and signal input/output. Touch **Setting** in the top menu bar.



Servo / SmartIO

You can monitor and control the signals input to the control box as well as joint motors and brakes, e.g. manually powering on/off of motors and locking/unlocking brakes. Touch **Servo/SmartIO** in the Setting menu on the left window.

- **Manual power off of Servoes**

  One can control servo power for each joint. If the robot is in normal state, all the servoess are powered on and the brakes are not activated, or free. Indicators in fluorescent color means normally operational state, while gray indicates non-operational state. Touch the corresponding servo indicator of the joint in order to turn off the servo power.

When the servo of the selected joint is powered off as shown in the following figure, the joint is locked by activating the corresponding brake automatically, so that the joint does not fall due to gravity. At this time, the state of the robot changes from normal to NotReady state. Touch the servo of the joint again to turn on the servo and release the brake.

- **Manual power off of Brakes**

  Each joint brake can be controlled. Note that the brake should be activated when the corresponding servo is powered off. Touch the brake of the joint for which you want to unlock or lock.

When the brake indicator turns to gray as shown below, the user can force the joint to move by applying forces.

Caution

Caution

When the brake is released manually, the joint falls down by gravity. Be sure to support the robot arm so as not to fall before releasing the brakes, because the falling may be accelerated with heavy force and/or heavy tools.

- **Monitoring and Controlling of Analog Signals**

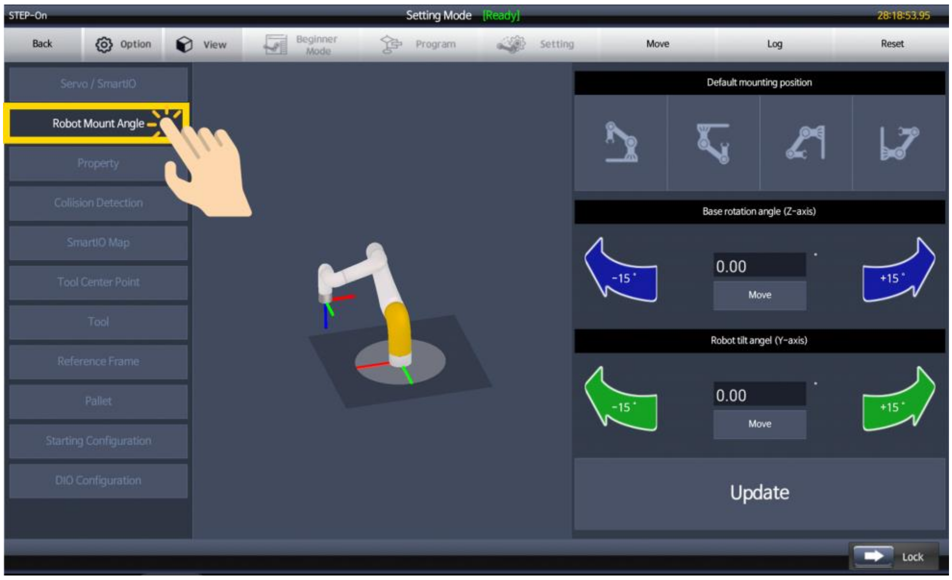
  One can monitor the analog input signals of the terminals of the control box connected to external devices, or send the analog output signals to external devices. The upper row displays the two-channel analog signal inputs sent from the external device to the control box. In the lower row one can send the analog output signals to each channel connected to the external device by entering the value and touching **Send**.

- **Monitoring and Controlling of Digital Signals**

  One can monitor the digital input signals to the terminals of the control box connected to external devices, or send the digital output signals to external devices. The upper block consisting of 32 channels allows you to monitor the digital signal input from external devices connected to the control box, and the lower block consisting of 32 channels allows you to set the digital signal output to external devices.

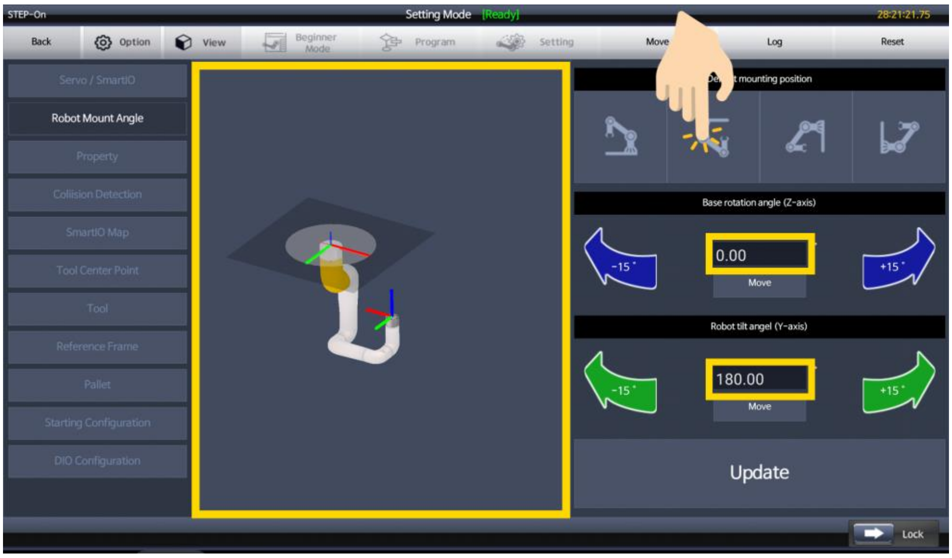
Angles of Inclination of Robot Mounting Base

When installing the robot on a wall or a ceiling, it is necessary to set the rotation angles and the tilt angle properly before use. Touch **Robot Mount Angle** in the Setting menu on the left.



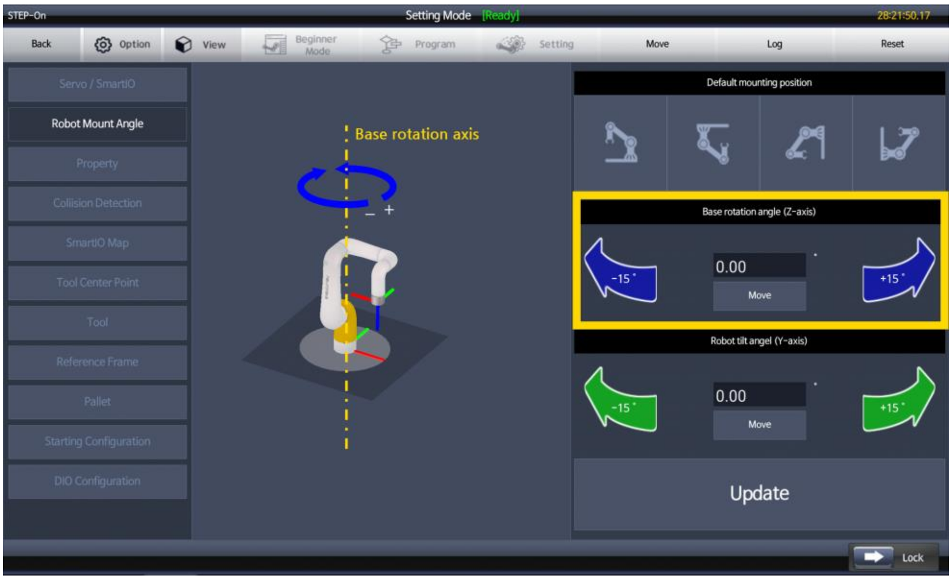
- **Preset mounting angles**

  Typical mounting angles, such as the horizontal floor, the vertical walls or the ceiling, are provided as preset mounting angles. When you touch each button for a preset mounting position, the information on the base rotation angle and the robot tilt angle is displayed in the bottom window. In the simulation window in the center of the screen, you can check the change of the robot's posture.



- **Base rotation angle (about Z axis)**

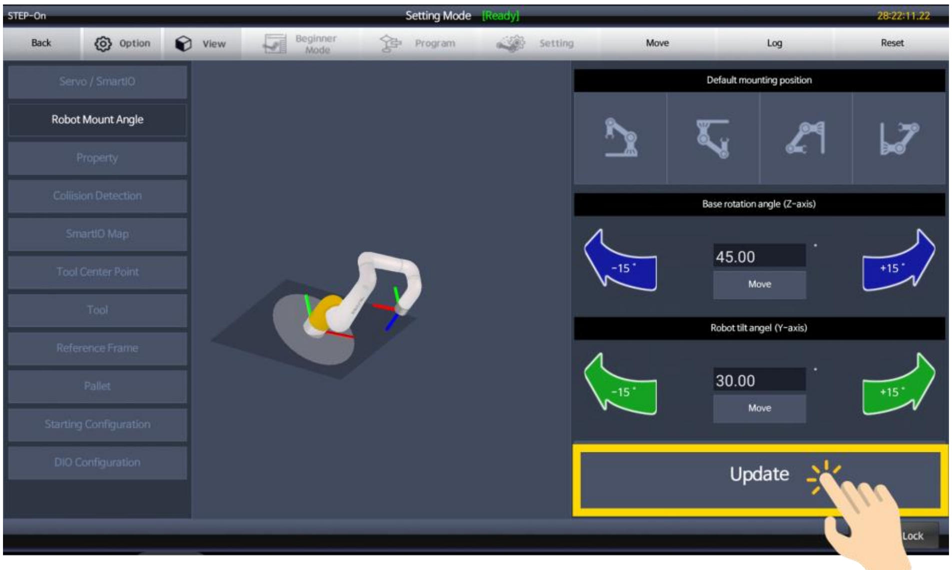
  You can set arbitrary base rotations manually. The base rotation angle is the rotation angle about the Z axis of the default reference frame as shown in the following figure. Enter a value directly in the center input field or touch the left or right button for rotation by 15 ° increment in each direction. After entering the desired angle information, touch **Move**. The changed posture can be checked through the simulation window.



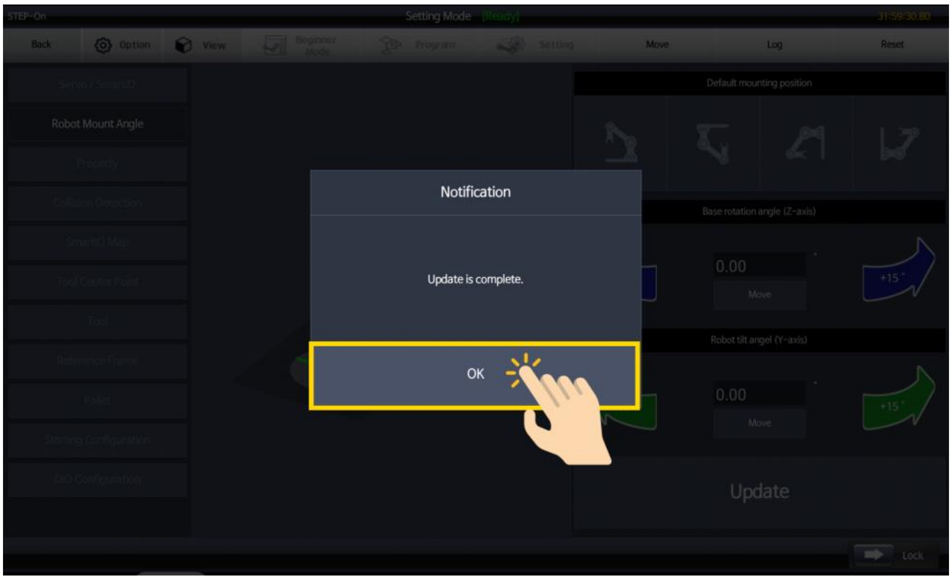
- **Robot tilt angle (about Y axis)**

  You can tilt the robot arbitrarily by entering the tilt angle manually. The robot tilt angle is the rotation angle about the Y axis of the default reference frame as shown in the following figure. Enter a value directly in the center input field or touch the left or right button for rotation by 15 ° increment in each direction. After entering the desired angle information, touch **Move**. The changed posture can be checked through the simulation window.

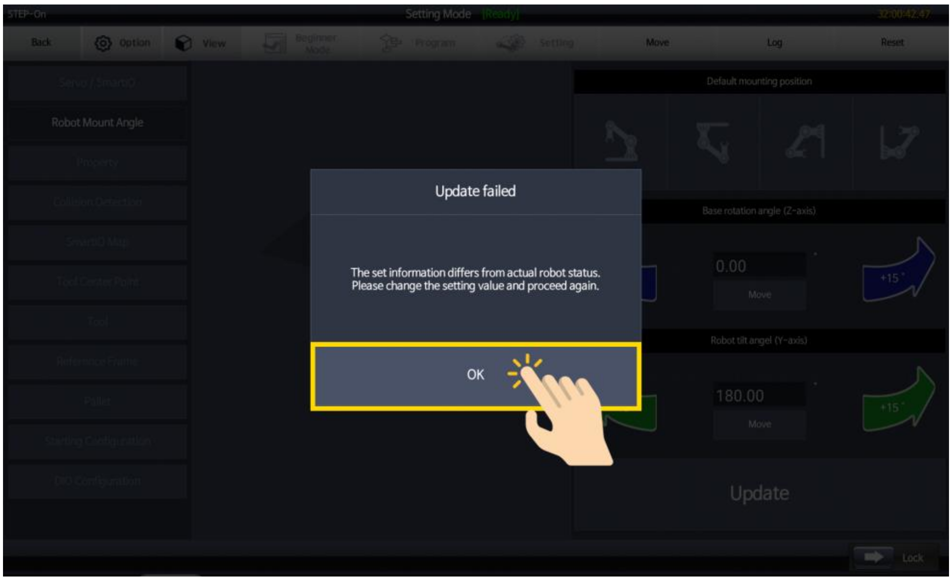
After either selecting a preset mounting position or entering the base rotation angle and the robot tilt angle manually, touch **Update** at the bottom.



If the mounting inclination information entered by the user is normal, the message "**Update is complete.**" will be displayed. Touch **OK** to complete the setup.



If the information on the mounting inclination entered by the user differs from the actual one, the following message will be displayed. Touch **OK** to restore the information on the previous mounting inclination before the update. Check again the actual mounting angle and retry.

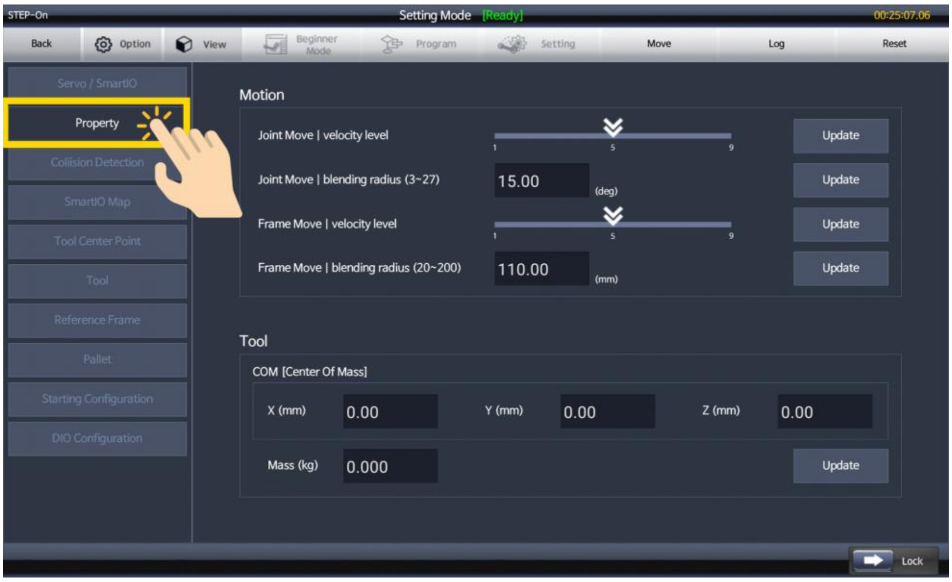


Warning

Unreflected mounting angle results in malfunctioning of the robot after installing the robot on a sloped surface such as a wall or a ceiling. Particularly in direct teaching mode you must be careful because the robot can fall arbitrarily in gravity direction. Furthermore, when the robot is manipulated using a jog or a move command, it causes large vibration or false collision detection frequently during movement. So, make sure to enter the mounting information correctly before use.

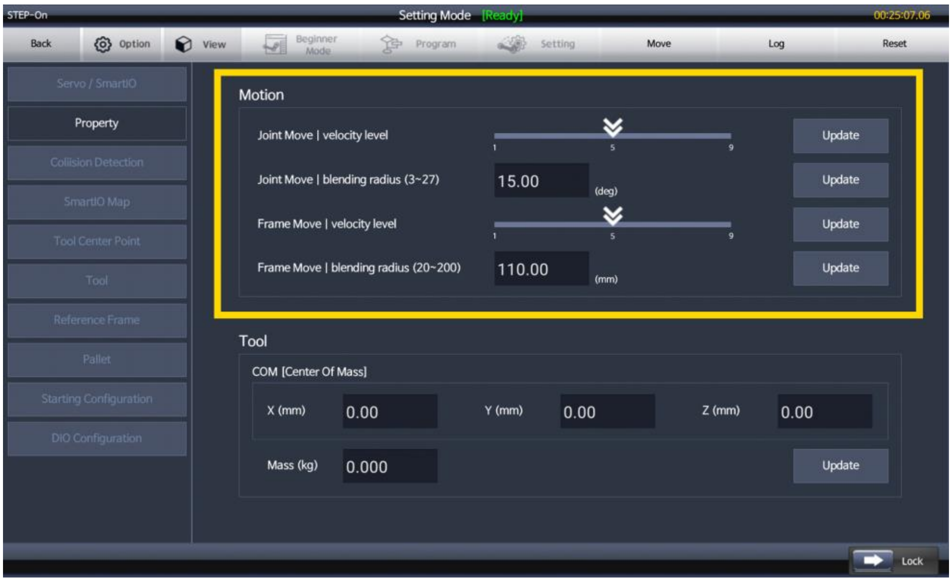
Property

In Properties window one can get/set the default values of the motion commands, or set the mass and the center-of-mass of the tool mounted on the endtool. Touch **Property** in the Setting menu on the left.



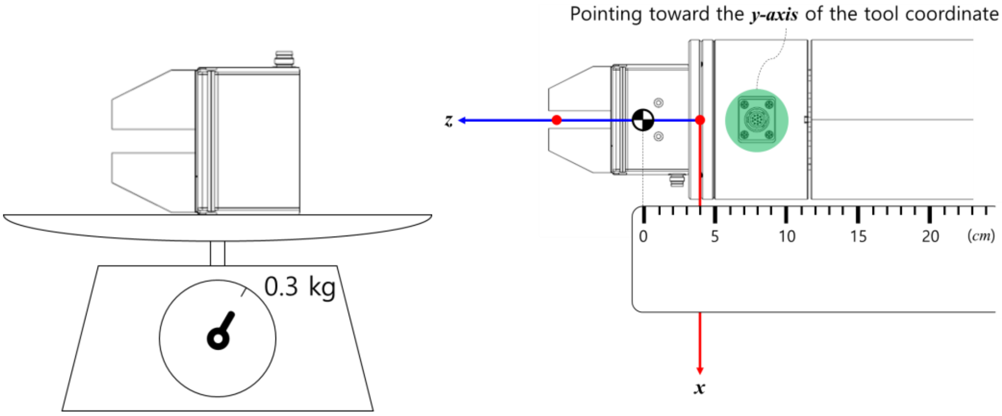
- **Motion command properties**

  It sets the default values for the speed and the blending radius of the jointMove or frameMove command. It is convenient because you don't have to input them every time you add commands. Enter the desired value for each property and touch **Update** to the right in order to change the default value.

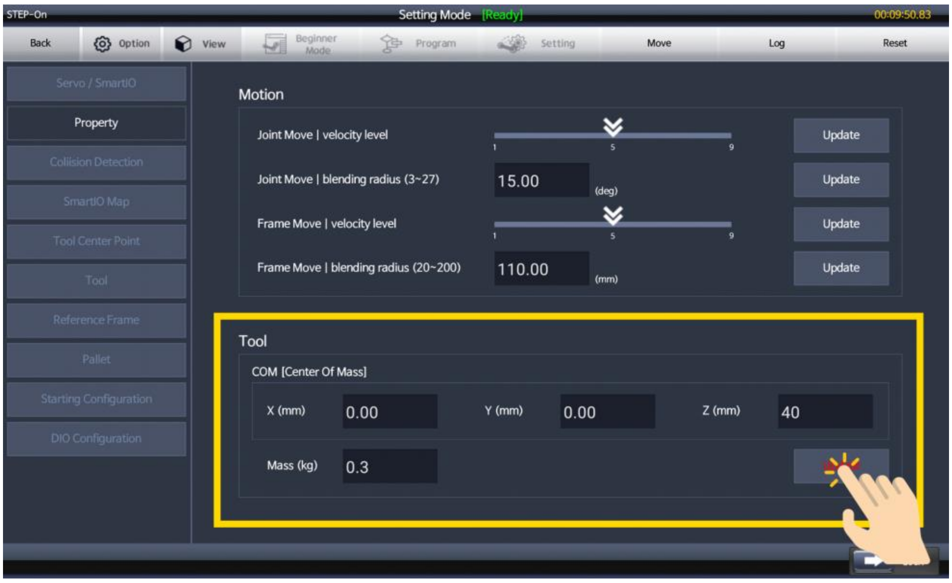


- **Tool properties**

  It sets the mass and the center-of-mass of the tool. The center-of-mass is represented by the position from the default tool frame origined at the endtool point to the tool center-of-mass, measured with respect to the tool frame.



Touch **Update** after entering the center-of-mass and the mass.

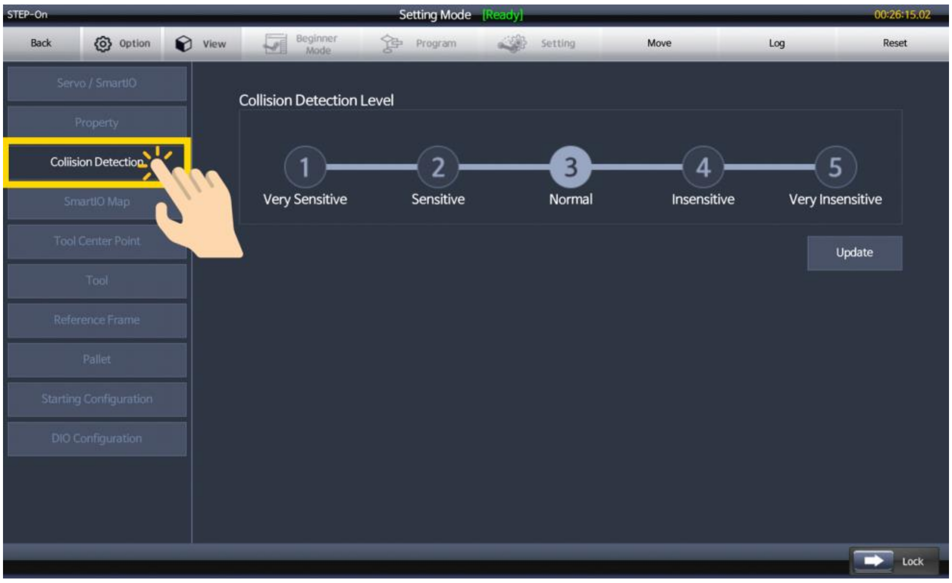


Warning

Imprecise tool properties e.g. the mass and the center-of-mass can generate false collision detection during motion. Also, the robot cannot stay stationary when switching to direct teaching mode due to wrong compensation of the robot arms dynamic effect.

Collision Detection

It sets the collision detection sensitivity level. Touch **Collision Detection** in the Setting menu on the left.



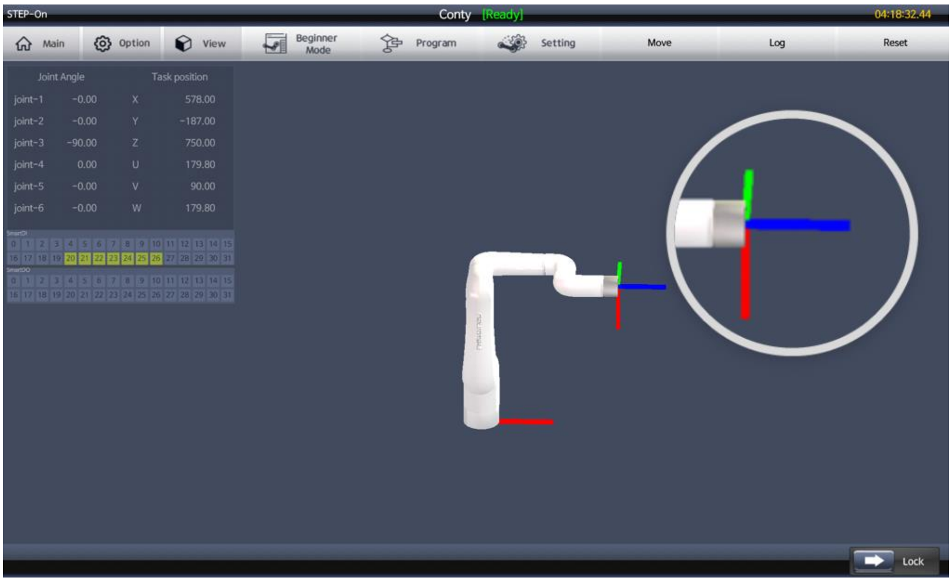
Collision detection level is selectable from level 1 to level 5, and the higher the number, the more insensitive, that means more severe collision is necessary to raise collision alarm. After selecting the collision detection level, touch **UPDATE** to set the default value.

SmartIO Map

It displays the various I/O port positions on the back panel of the control box. Touch **SmartIO Map** in the Setting menu on the left.

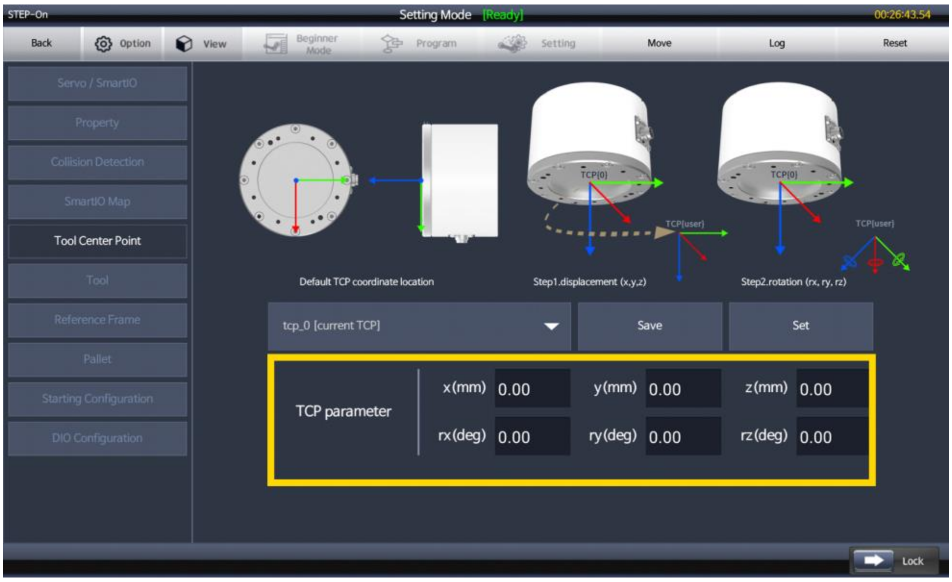
Tool Center Point

It sets the information on the tool frame as well as the tool center point. There can be many tool frames registered, each with its own unique name. Note that the stored tool frame information cannot be modified but only can be deleted. These preset tool frames are used as the current tool frame that is the basis of frameMove or task jog movements. The default tool frame is defined at the center of the endtool flange as follows. Now let's register the information on a new tool frame and set as the current one.

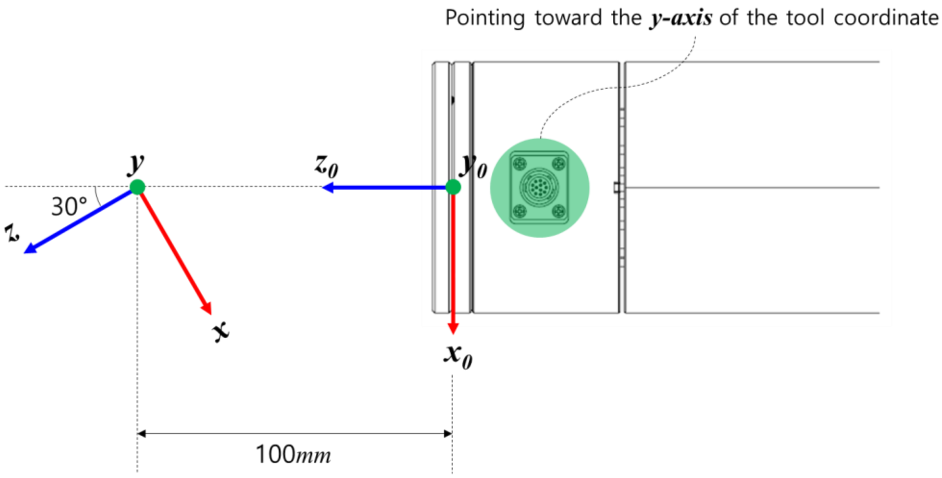


① Touch **Tool Center Point** in the Setting menu on the left.

② Enter the **TCP Parameters**.

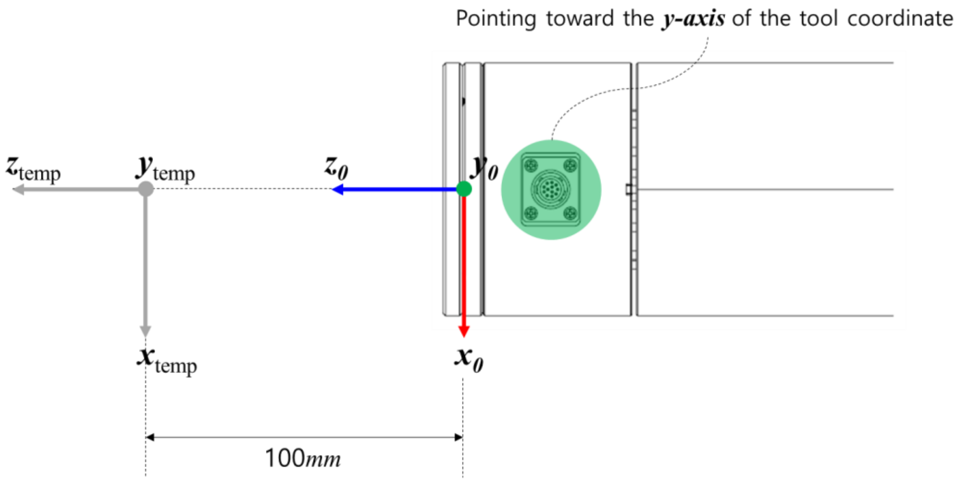


We will show, for example, how to register a new tool frame for a new tool that is 100 mm away from the center of the endtool flange surface along the Z-axis, and is rotated by 30 degrees about the Y-axis, as follows:



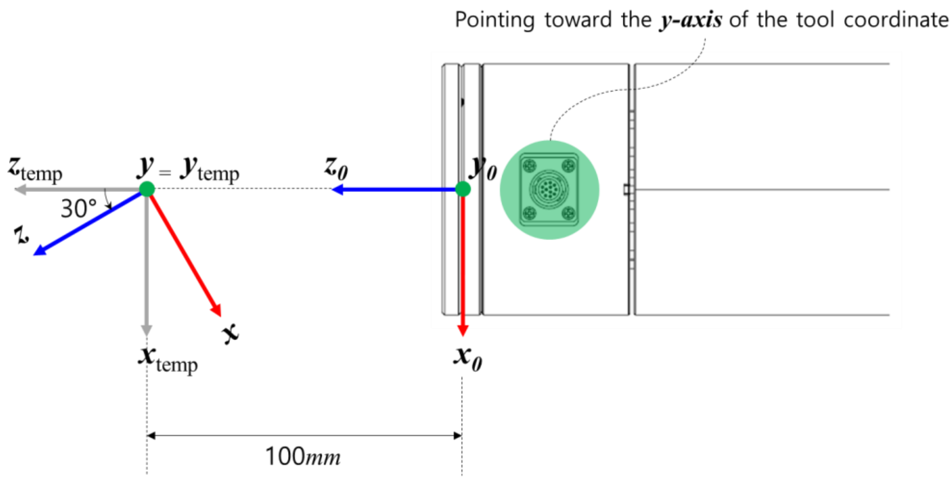
- **x, y, z (mm)**

  It is the distance from the endtool flange center point, i.e. the default center tool point, to the newly defined tool center point. It is represented with respect to the default tool frame consisting of x0, y0, and z0 axes, that is the distance is measured relative to x0, y0, and z0 axes.



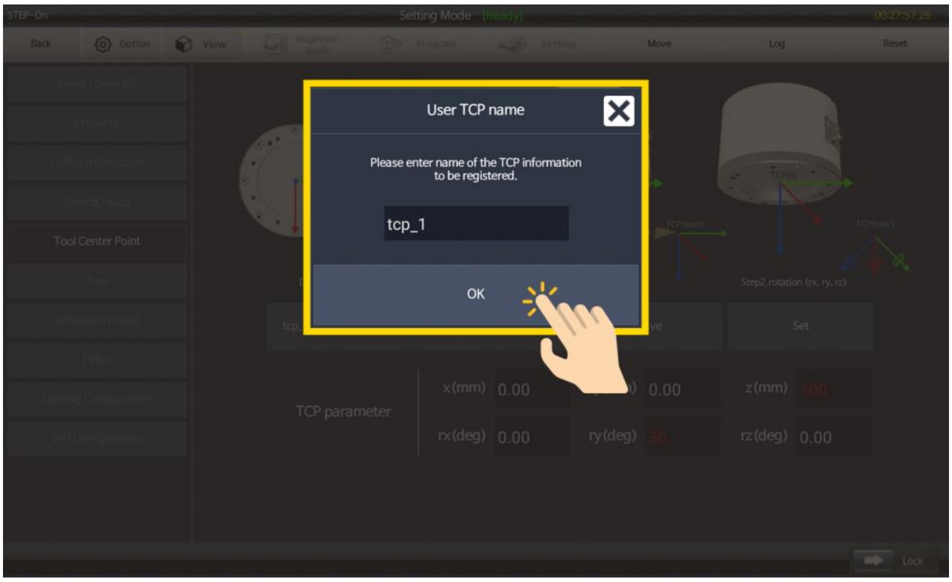
- **rx, ry, rz (deg)**

  These are the rotation angles of the newly defined tool frame at the new tool center point relative to the default tool frame. The rotation is made by three consecutively rotations of the default tool frame, now relocated at the newly defined tool center point, that is the coordinate system consisting of X_{temp}, Y_{temp}, and Z_{temp} axes, based on the fixed XYZ convention. The fixed XYZ convention rotates the relocated coordinate system, first about the X-axis of the frame. The resulting rotated coordinate frame is rotated next about the Y-axis of the original relocated coordinate frame. Lastly, the resulting rotated frame (from the previous two rotations) is now rotated about the Z-axis of the same original frame. Here, the total rotation is denoted by three angles of rotation about X_{temp}, Y_{temp}, and Z_{temp} axes, respectively.



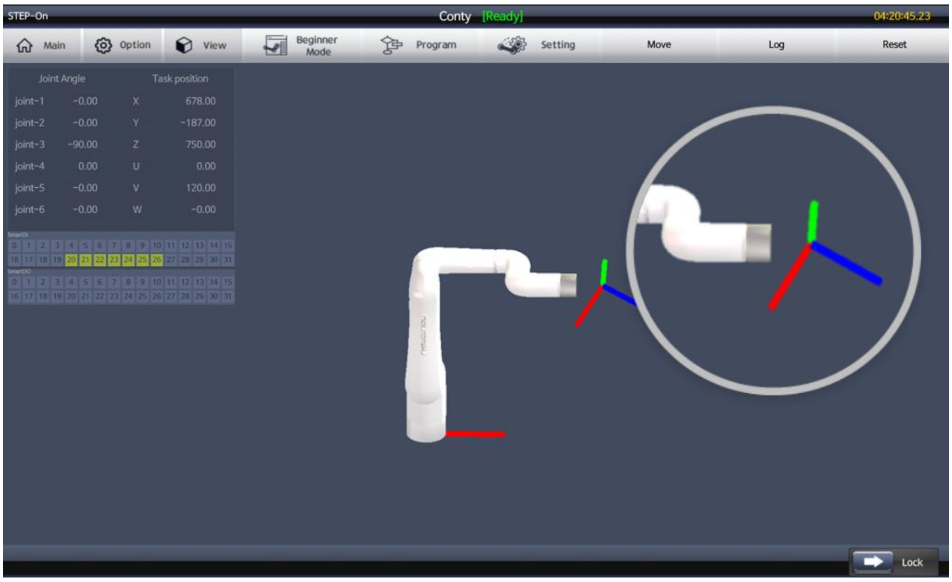
③ Touch **Save** to register the newly entered tool information. If the information you have entered is displayed in red, it indicates that it has not been saved yet.

④ Enter the name of the tool frame newly registered, and then touch **OK**. Duplicate names are not allowed.



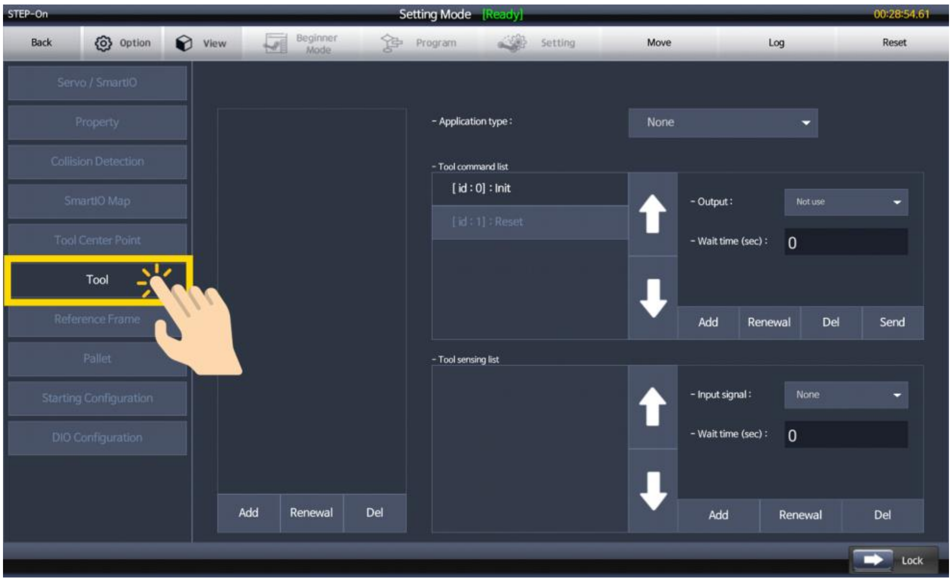
⑤ If the newly entered tool frame is saved normally, the red changes to white and the registered name is displayed. If you want to set the newly registered tool frame to the current tool frame of the robot, touch **Set**.

⑥ The tool frame is now set as follows. The robot position in the task space, that is the task position or the tool position, is now represented relative to the current tool frame. Note that the origin of the current tool frame is the tool center point.



Tool

One can define the tool operations associated with each electrical signal for the tools connected with the control box or the endtool port. Tool commands according to tool operations include basic commands, application commands specific to the process selected by the user, and user-defined commands. Touch **Tool** on the left Setting menu.



- **Basic tool commands**

  There are Init and Reset provided as basic tool commands.

Tool command	Description
Init	A preset signal is generated at the start of program execution. This is useful if you need to initialize the signal transmitted to the tool.
Reset	A preset signal is generated when program terminates execution or pauses. This is useful for those processes where the signal to be transmitted to the tool should be automatically cut off during abnormal termination of the program, such as painting, welding, and bonding.

- **Application tool commands**

  This is a tool command that is used for process-specific application specifically selected by the user. Currently, the only application tool command provided is the tool commands for pick and place process.

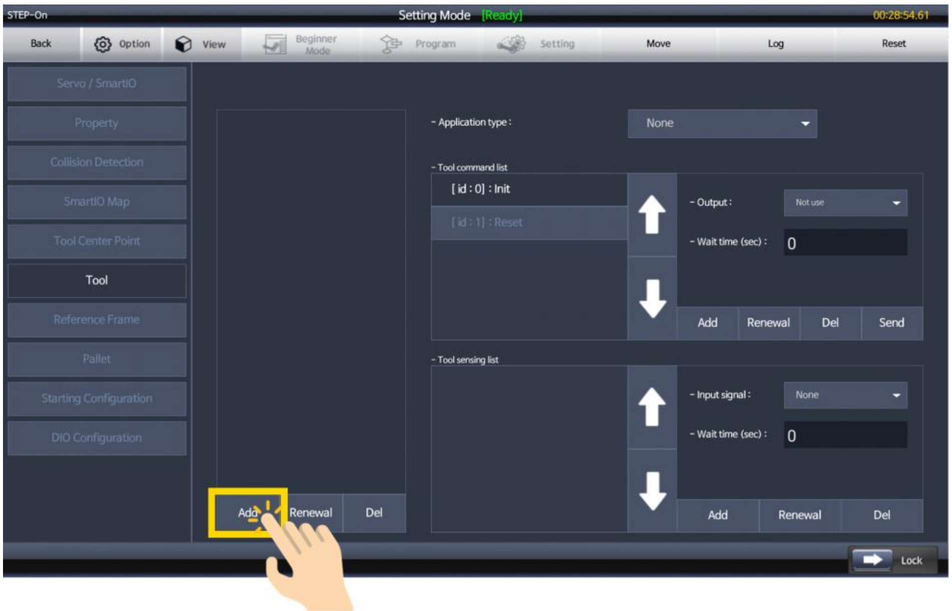
Tool command	Description
Hold	It generates the signal to close the gripper.
Release	It generates the signal to open the gripper.

- **User tool commands**

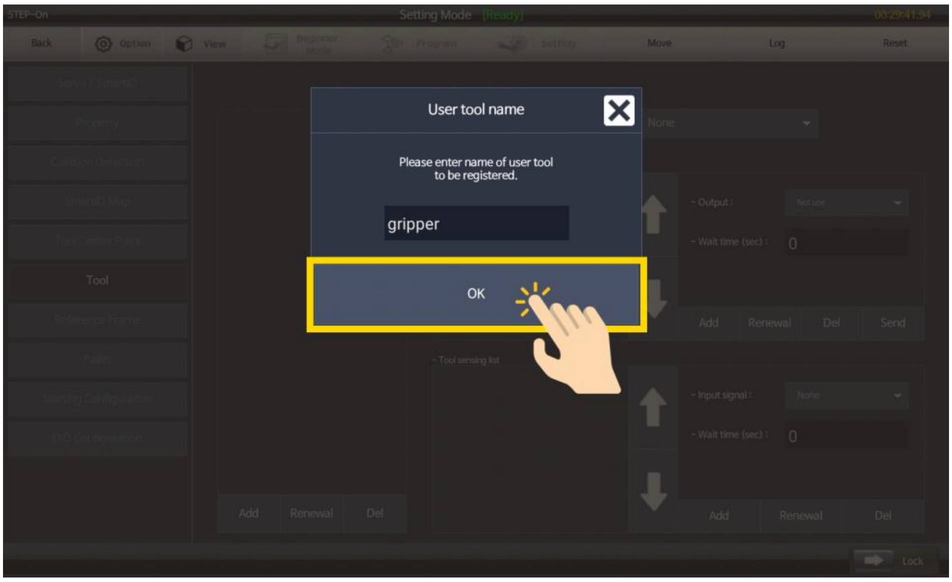
  You can create your own tool commands and set the signal.

Follow the following steps:

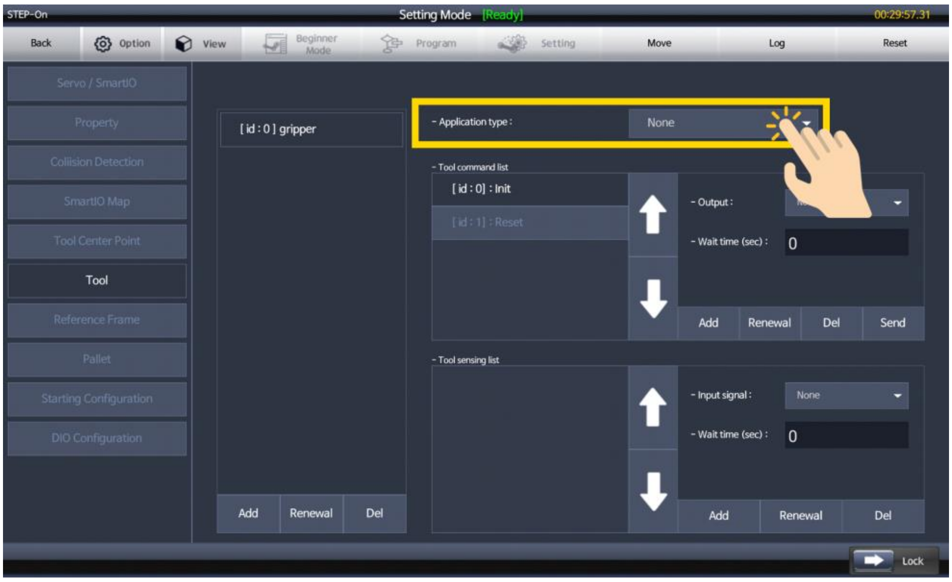
① Touch **Add** at the bottom left window.



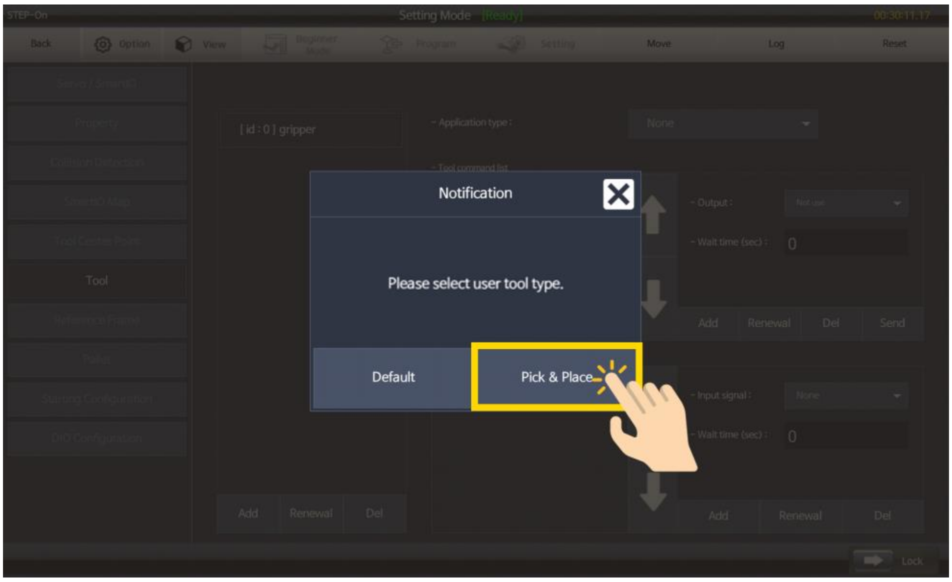
② Enter a new user tool name, say 'vacuumGripper', and touch **OK**.



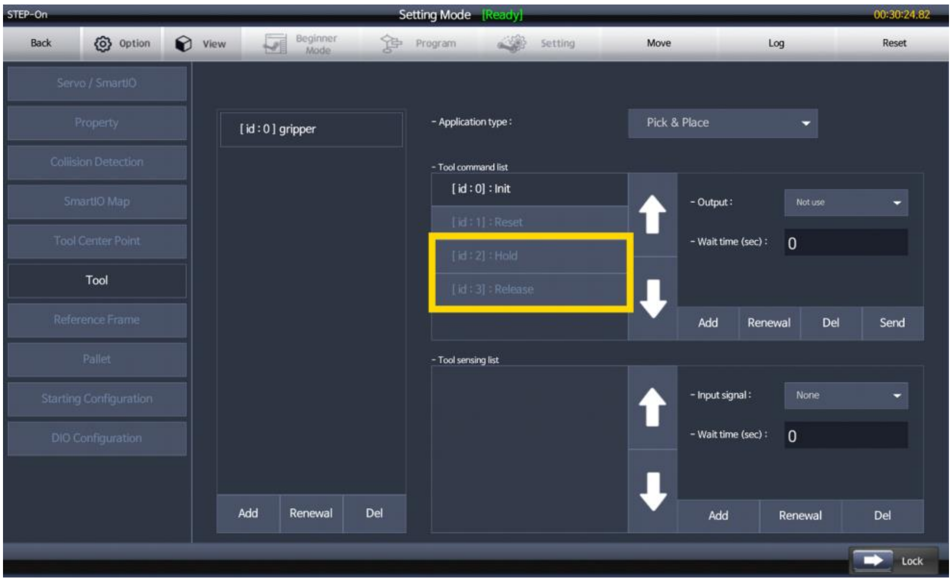
③ The added user tool is displayed. Let's define the application commands for this tool. Touch the combo box arrow in the **Application type** field.



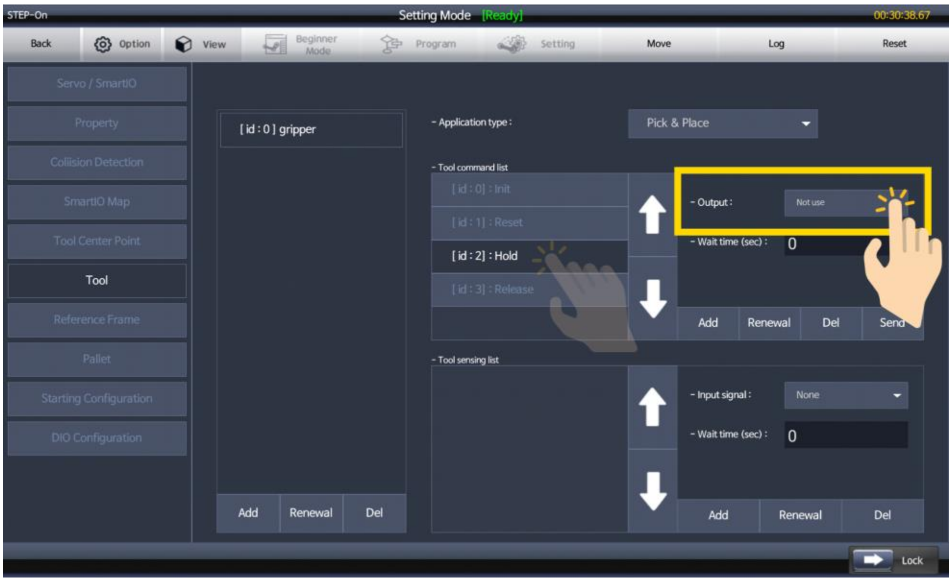
④ When you see the message "**Please select user tool type.**", touch **Pick & Place**.



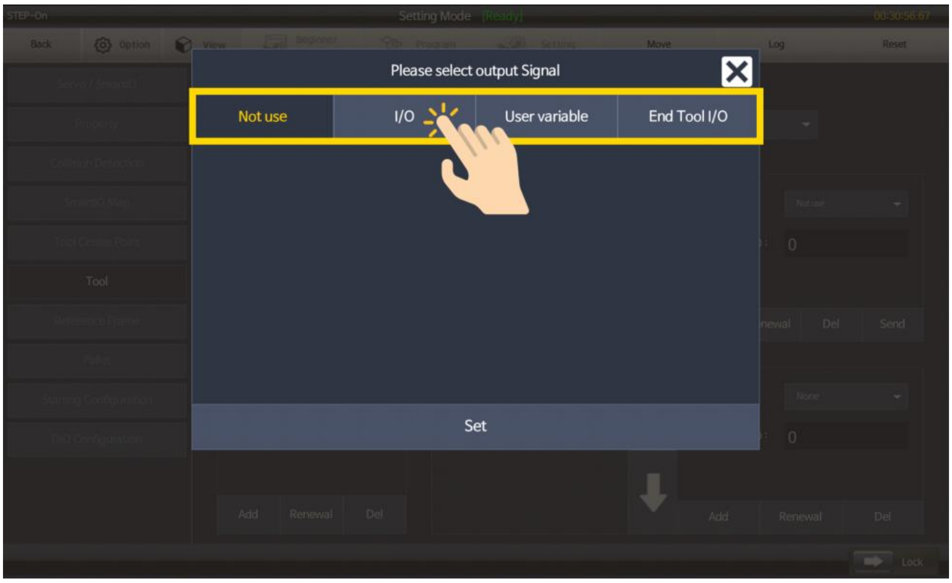
⑤ The application tool commands associated with the pick and place process, that is Hold and Release, are newly added, as shown in the figure.



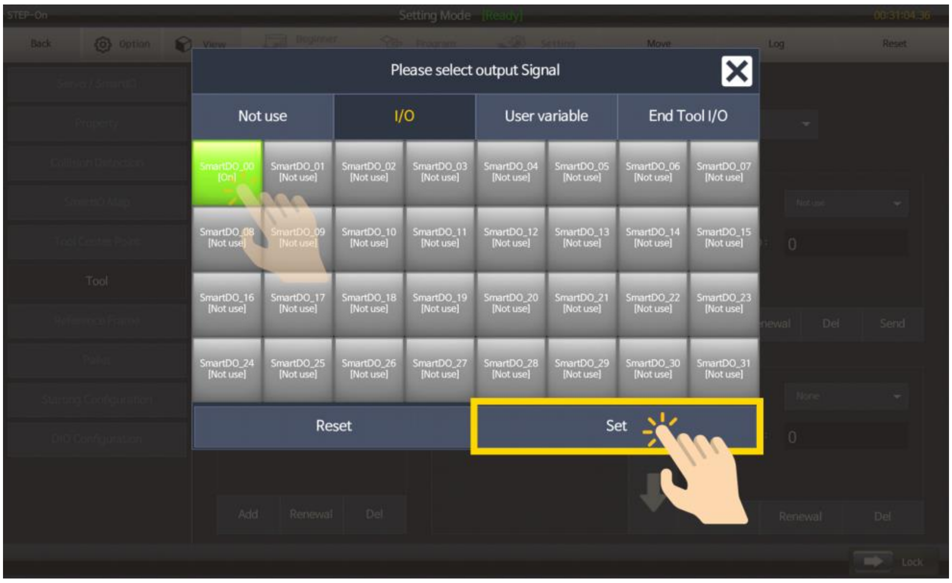
⑥ You need to set the proper signal for each command. Select the tool command **Hold** and touch the arrow in the Output field.



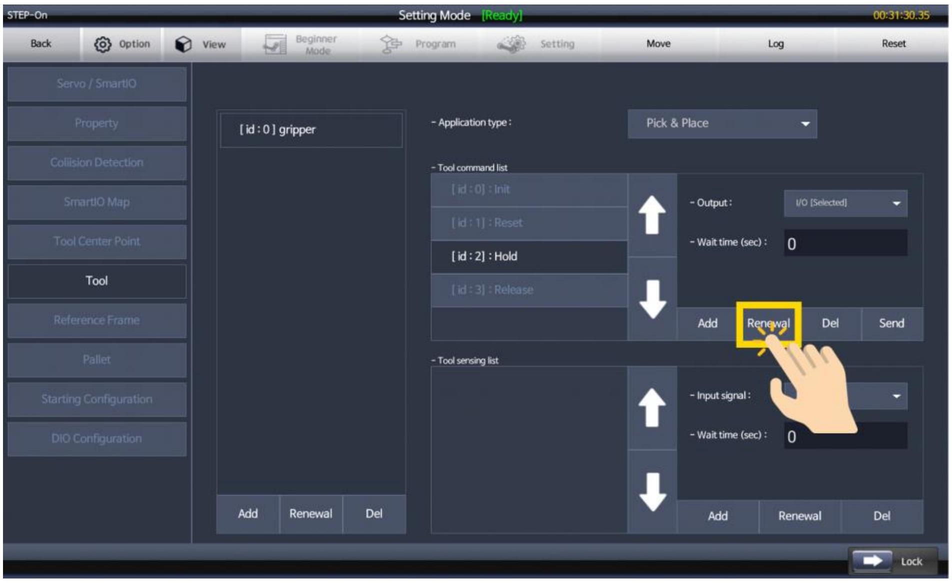
⑦ It sets the signal type and the port for output when executing the tool command. We will use the digital output signal from the control box, for example. Touch **I/O** menu on the top.



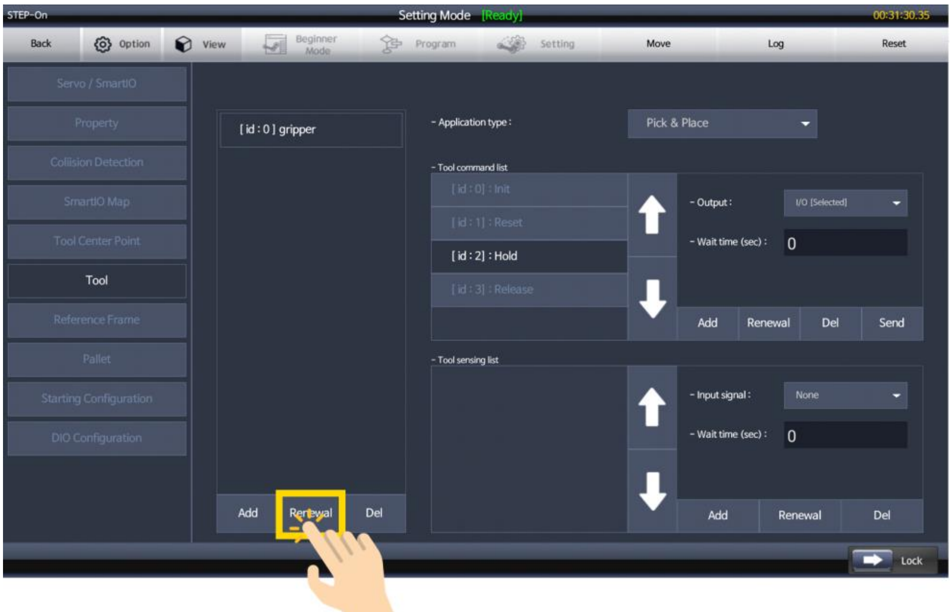
⑧ Select the digital output port of the control box wired to the tool, and then touch **Set**.



⑨ When the setting is completed normally, the output field display changes to [Selected]. The wait time is the waiting time after the tool command is executed until the selected signal is output. It is not set here, implying no delay for signal delivery. Touch **Renewal**.



⑩ Set the other tool commands similarly as well. When all commands necessary for tool operation are completed, touch **Renewal** in the bottom left corner. Now registration of the user tool is completed.

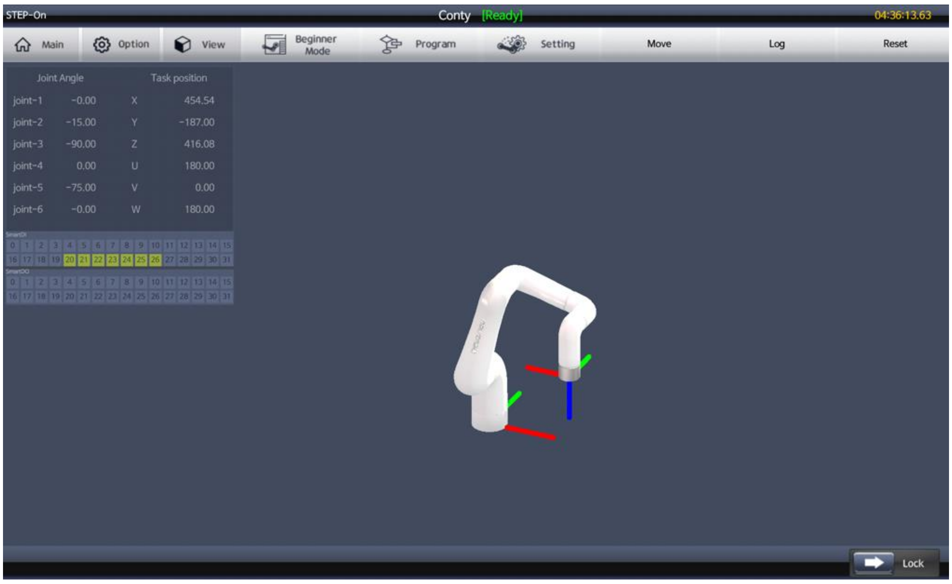


Any tool that has been properly set will operate by the preset conditions when the application command or the toolCommand command is executed in the program.

Reference Frame

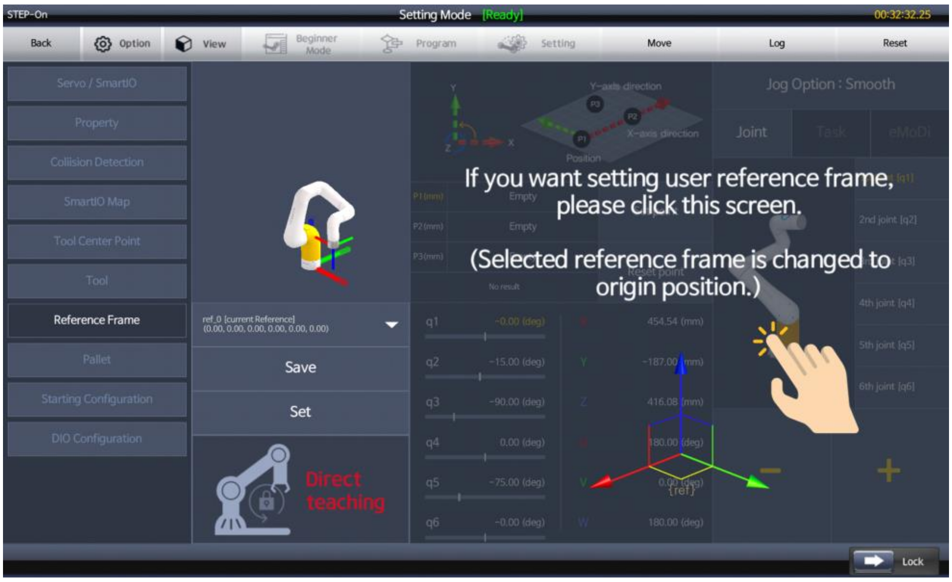
There is a reference frame, with respect to which the current tool frame is represented, to measure the robot motion in the task space. You can register multiple reference frames, each with its own unique name. The registered reference frame is used to define the waypoint of frameMove movements in the program or to execute task jogging in manual operation. The default reference frame is fixed at the floor with its origin coinciding with the center of the robot base, whose Z-axis is upward perpendicular direction to the floor, and X-axis is opposite to the robot communication cable connector, both emanating from the origin. We will register a new reference frame and use it to move the robot.

Initially, the default reference frame is the current reference frame. We will modify the current reference frame.

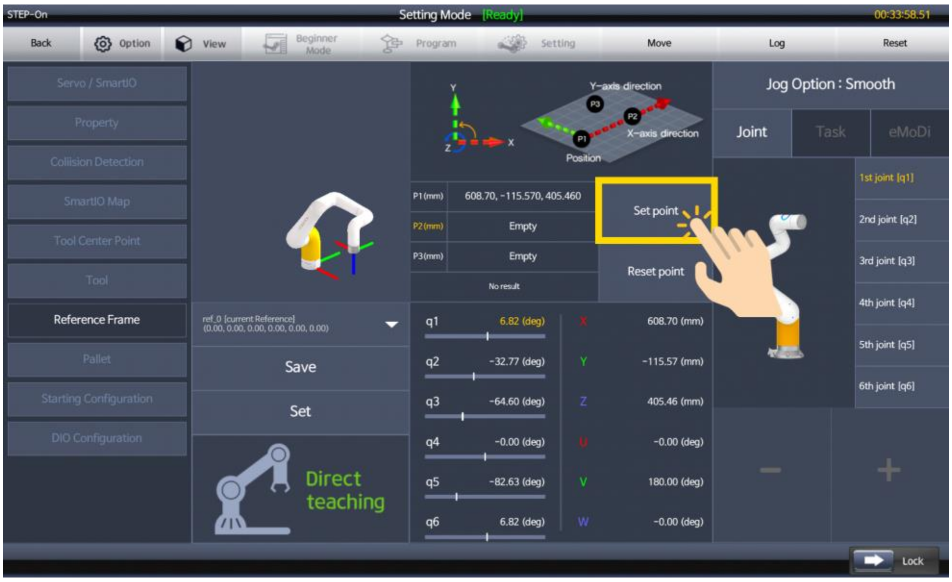


① Touch **Reference Frame** in the Setting menu on the left.

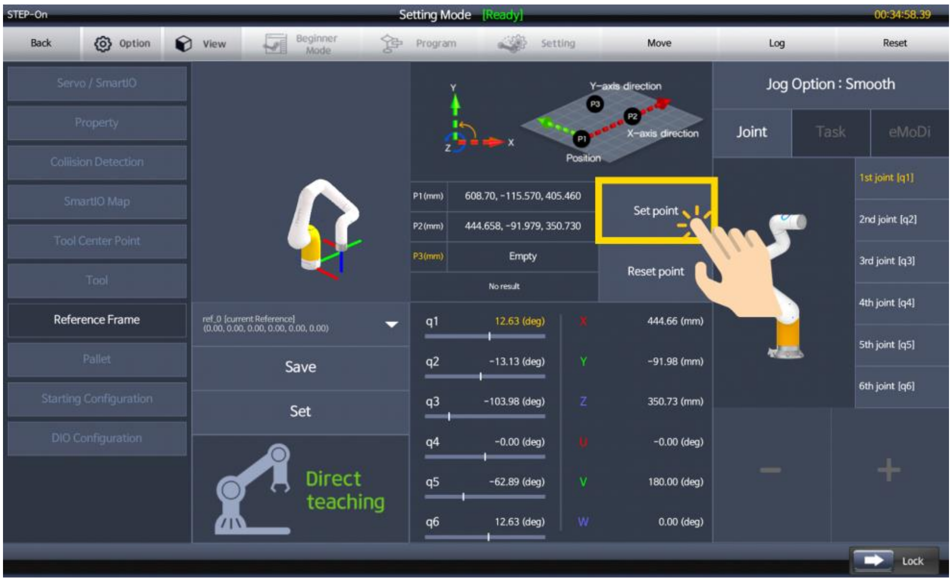
② Instruction guide before setting is displayed. Touch the screen to disappear.



③ The coordinate system is defined in terms of three points in space. Use direct teaching or jog move to teach the three points by consulting to the information graphic in the center window. First, teach the first point and touch **Set point** in the same window. This point is labeled by P1 and becomes the origin of the reference coordinate system.



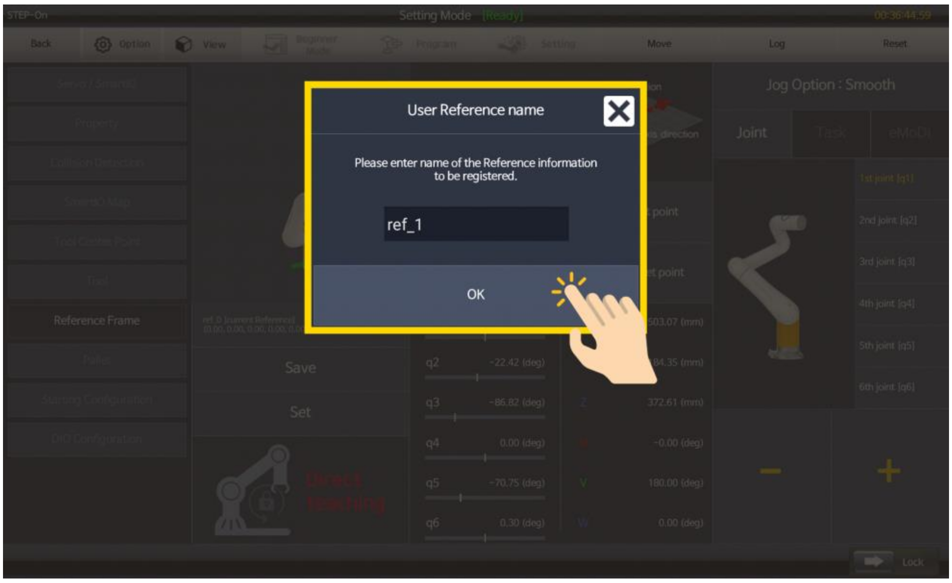
④ After teaching the second point, touch **Set point**. This point is denoted by P2. Here, the direction connecting the first point P1 to the second point P2 becomes the X-axis.



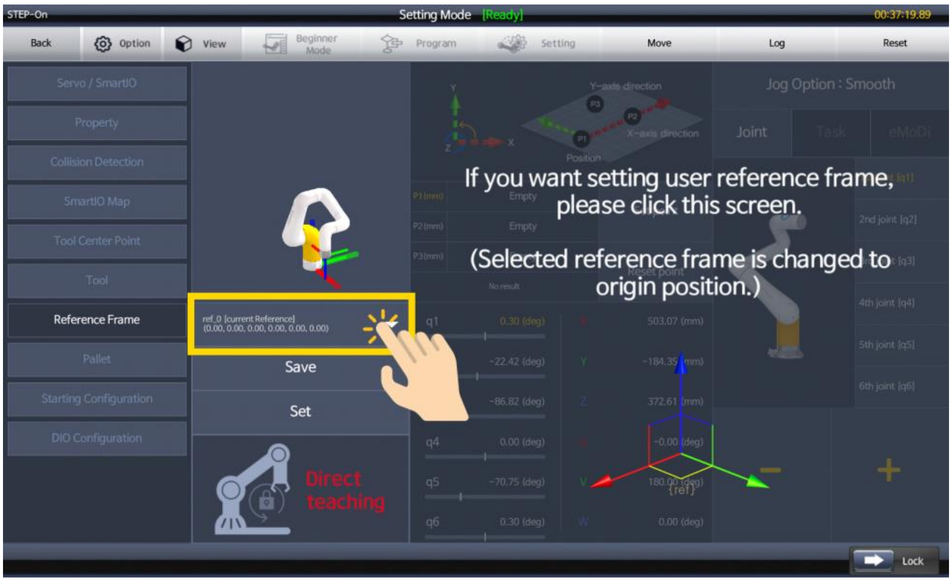
⑤ After teaching the last third point, touch **Set point**. This point is denoted by P3 and is used to define the XY plane. First, the Z-axis is determined automatically by Euler's right-hand rule in terms of the previously defined X-axis and the direction connecting P3 from P1. Then, the Y-axis is fixed from this Z-axis and X-axis by the right-hand rule.

⑥ Touch **Save** in the center of the screen.

⑦ Enter the name, say ‘ref_1’, of the reference coordinate system to be newly registered, and touch **OK**.

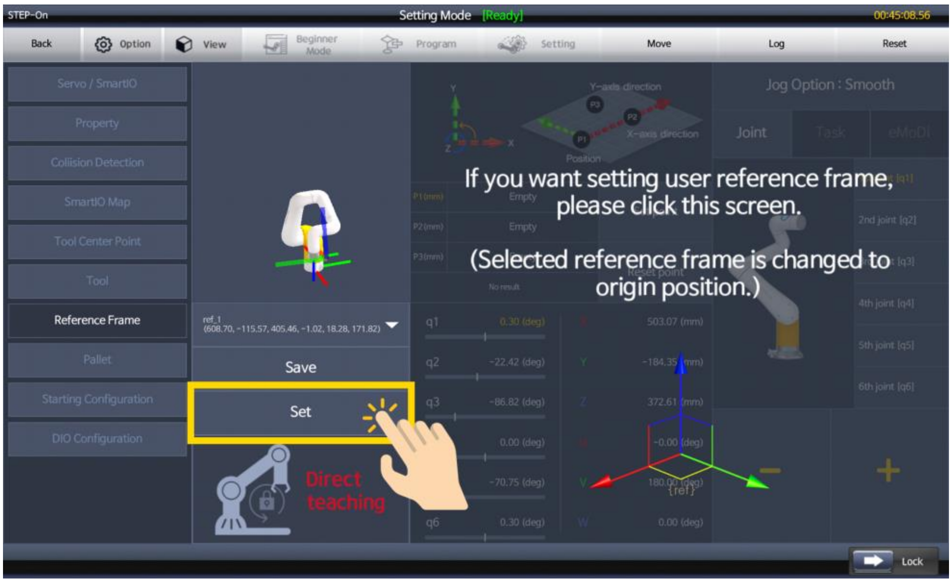


⑧ Touch the arrow in the area where the name and the values of the reference coordinate system are displayed.

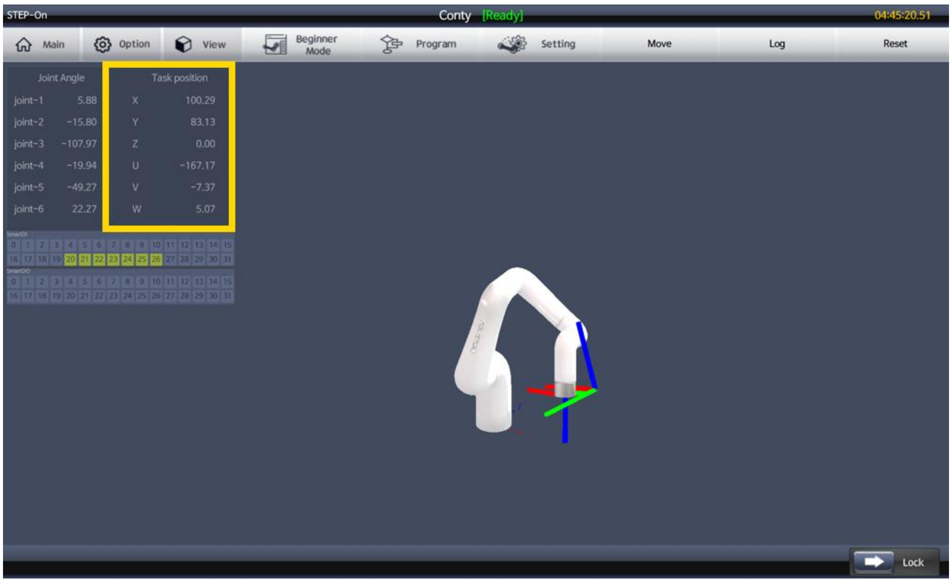


⑨ The newly saved reference coordinate system is displayed in the list. Select **ref_1** and touch **Select**.

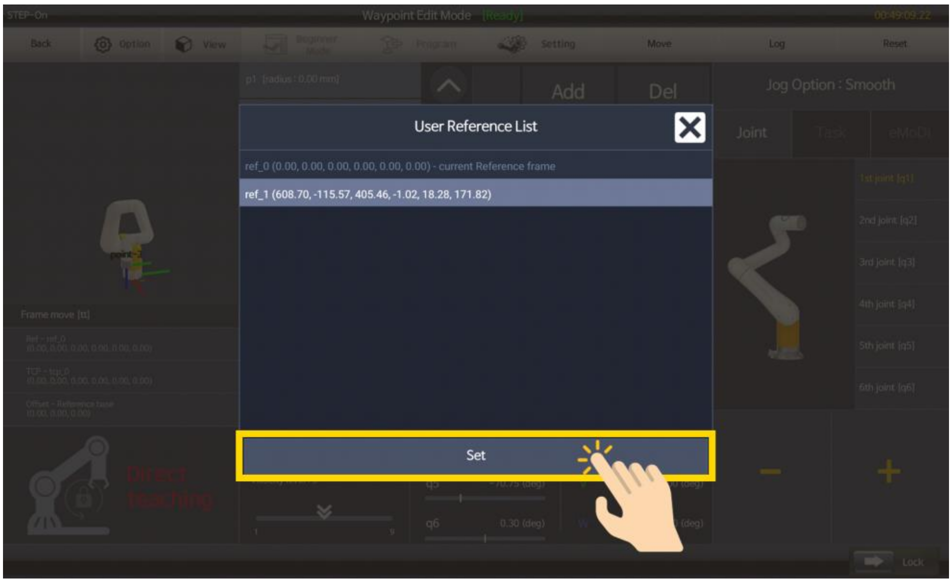
⑩ Touch **Set** to apply the newly registered reference coordinate system to the current reference frame for the current robot in use.



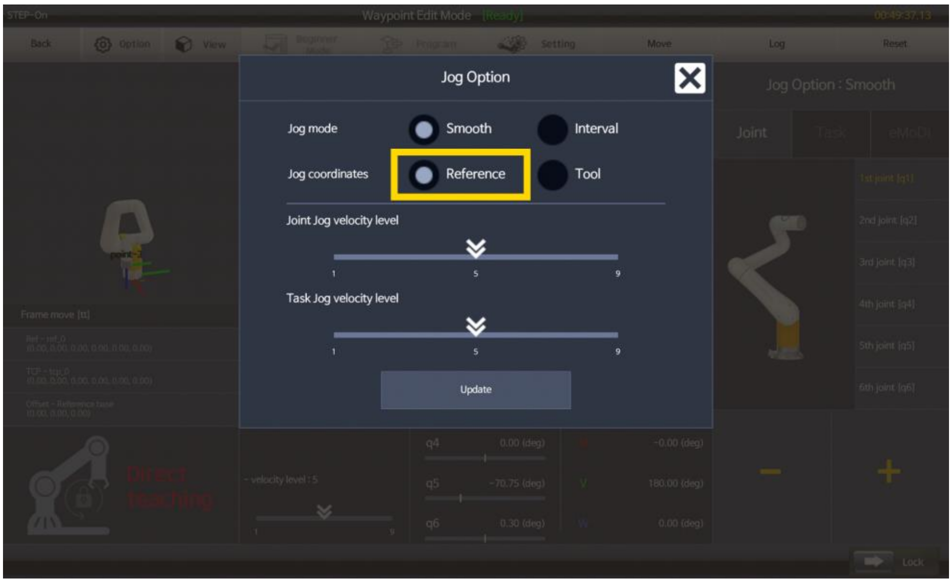
⑪ As shown in the figure, the current reference frame has been moved from the bottom of the robot base, i.e. the default one, to the new one. The tool position is also updated relative to the newly set current reference frame.



⑫ In the frameMove command, touch the reference coordinate system displayed on the left, as shown below, to display the list of registered reference frames. If you change the reference frame here, the current frameMove will be based on the changed reference frame.



⑬ If the jog coordinate system is set as reference in the jog option, the jog function will operate based on the changed reference frame.

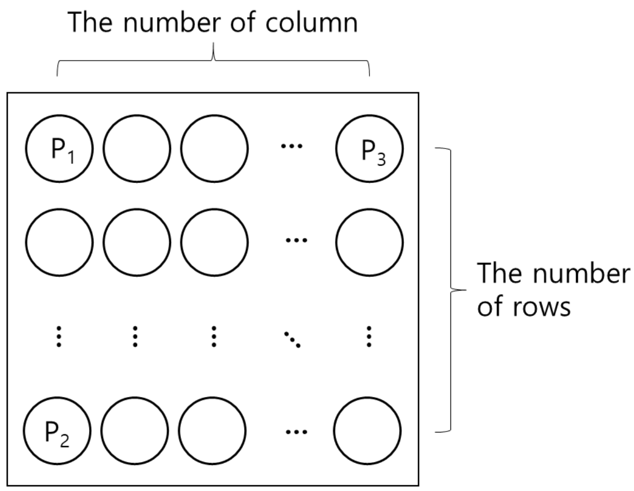


Pallet

It defines the pallet for palletizing process. Pallets are a sort of box, divided to a number of rows and columns which are arranged at regular intervals, where objects can be kept and retrieved in a certain pattern. These pallets vary in size and interval from one user process to another, so it is very time-consuming and complex to teach multiple pick and place commands for each iteration. Therefore, the pallet setting is a pain-saving utility function that automatically calculates the target positions by using only the three teaching points, the interval in row and column, and the palette pattern. You can register as many pallets as you need in the process, each with its own name, and use the necessary palette in the pick or place command. In the Setting menu on the left, touch **Pallet**.

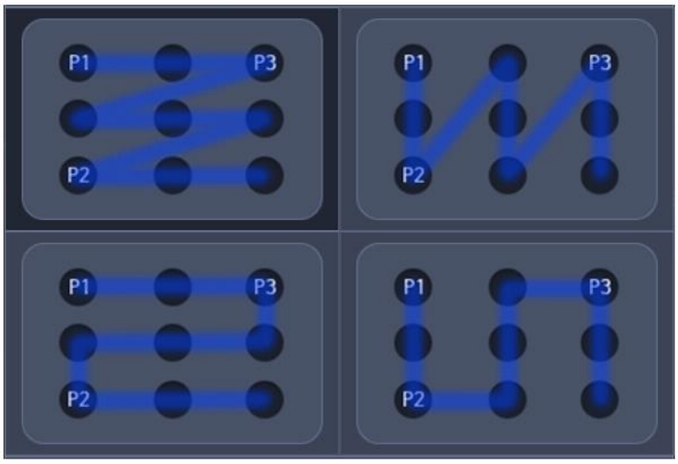
- **Palette base points and size**

  Every palette is geometrically defined by the three edge positions, called palette base points, as well as two numbers of rows and columns as shown below.



- **Palette pattern**

  We provide a total of four palette patterns. Upon changing the order of the palette base points, you can create palettes of all rectangular shapes in terms of just these four patterns.

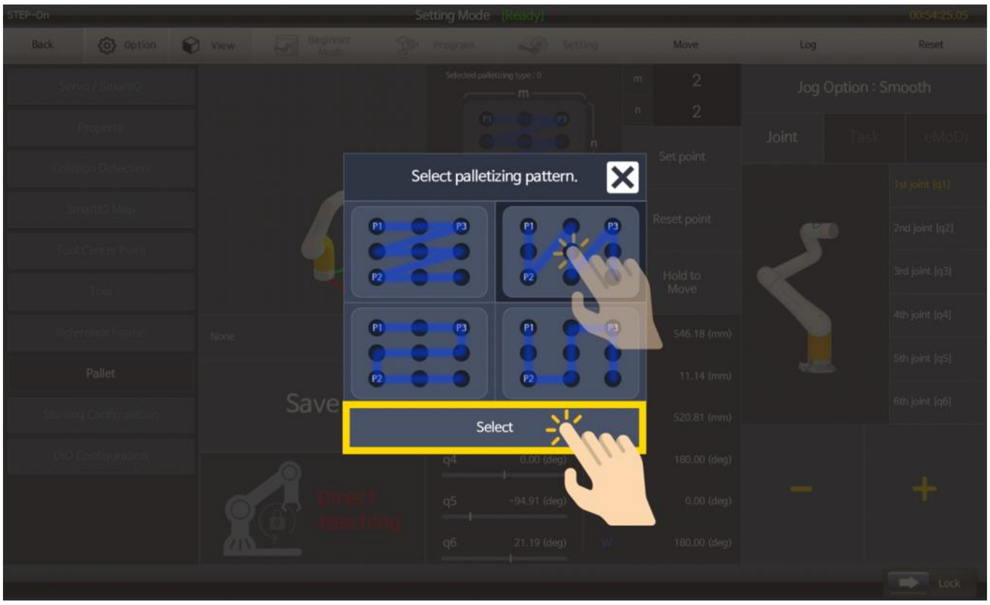


Now let's create a palette using the pallet settings as follows:

① Use direct teaching or jog move to teach the first base point of the pallet and then touch **Set point**. The current position is stored and displayed as P1. Refer to **Section 4.2 Basic Operations** for details on manual movement of the robot.

② In the same way, teach the second and third base points of the pallet, respectively, and then touch **Set point**, respectively.

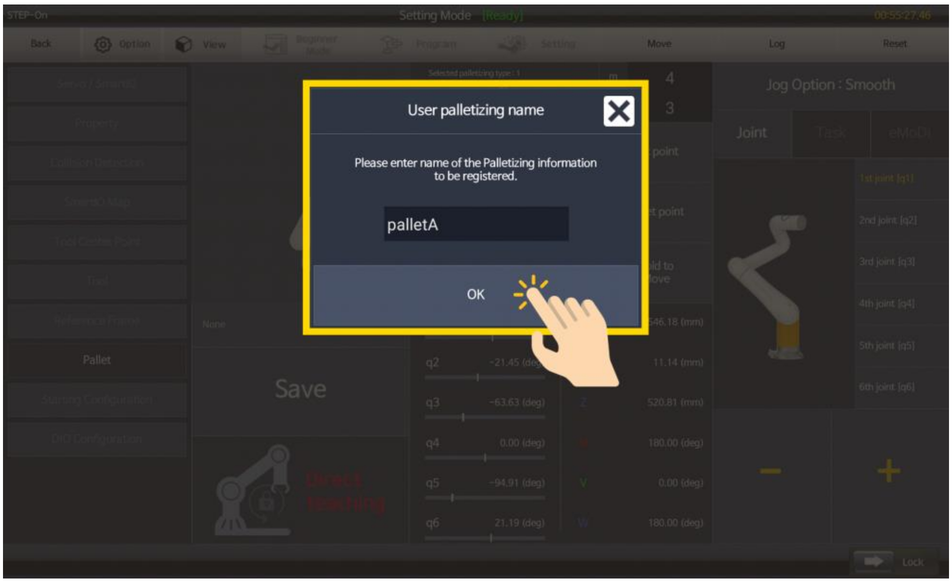
③ Once you have finished fixing all the base points of the pallet, you need to determine the pallet pattern. Touch the palette graphic on top to see four palette patterns available. Select the desired pattern and touch **Select**.



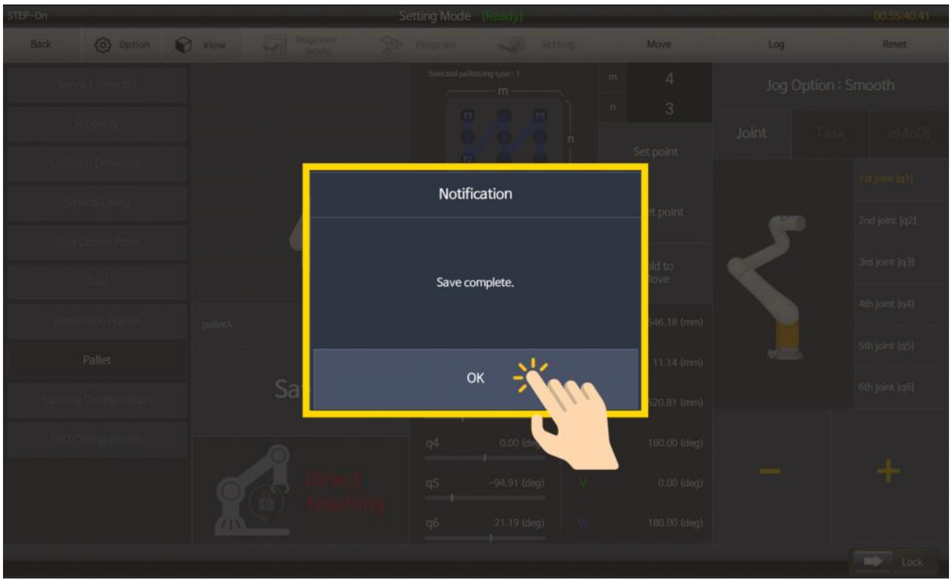
④ Finally, entering the number of rows and columns in the palette will complete all setting. Touching the value fields marked m and n on the right side of the pallet graphic, you can input each number, where m is the number of columns, the number of positions between the first and the third base points, and n is the number of rows, the number of positions between the first and the second base points. Enter **m** and **n**.

⑤ All inputs are complete. Touch **Save**.

⑥ Enter the name of the currently created palette and touch **OK**.

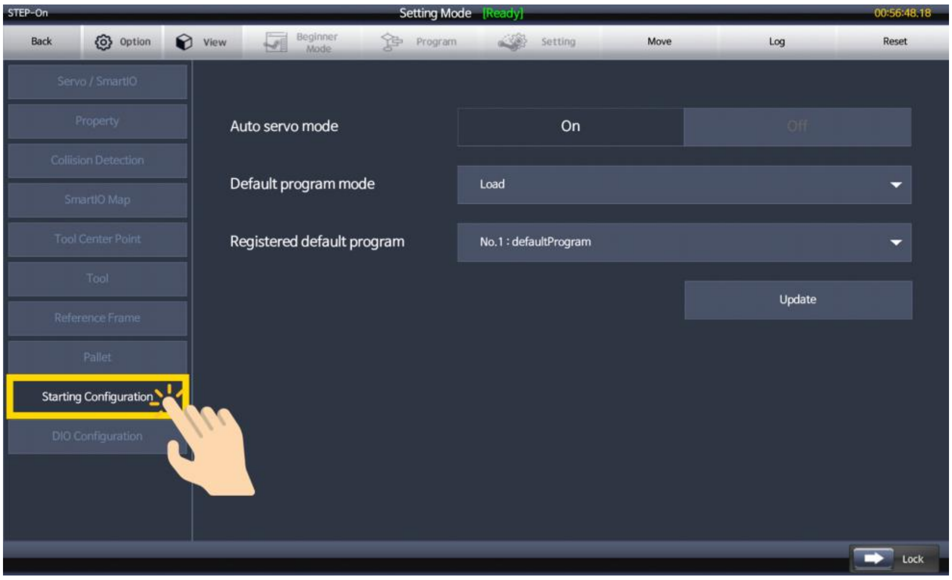


⑦ When the message "**Save complete.**" appears, touch **OK**. Any pallet saved with a unique name can be called from the program commands, such as pick or place.



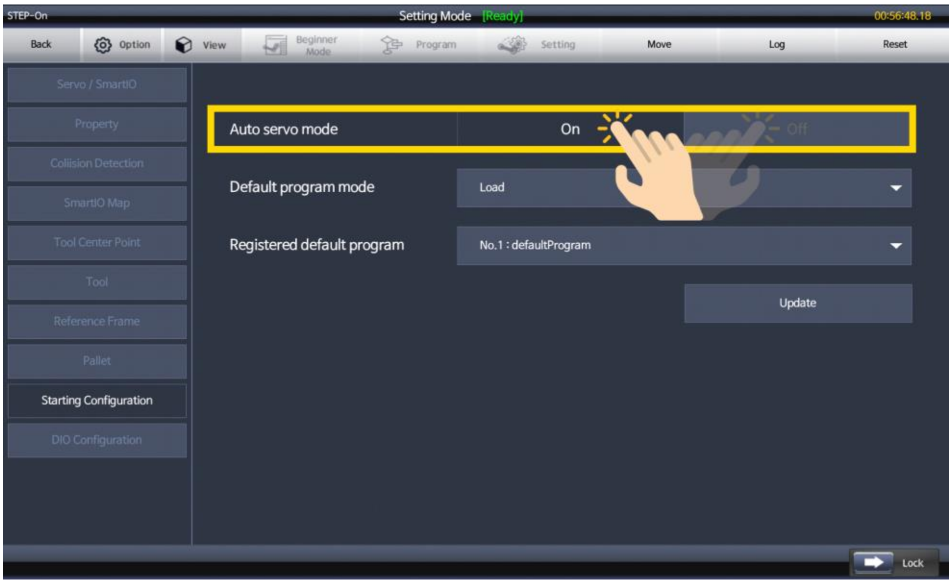
Startup Configuration

The startup configuration configures the preparation steps until the system is ready to get the first user input from the system power-on. At startup the system can start with the motors powered on or off, or the default program can be loaded or even started automatically. In the Setting menu on the left, touch **Starting Configuration**.



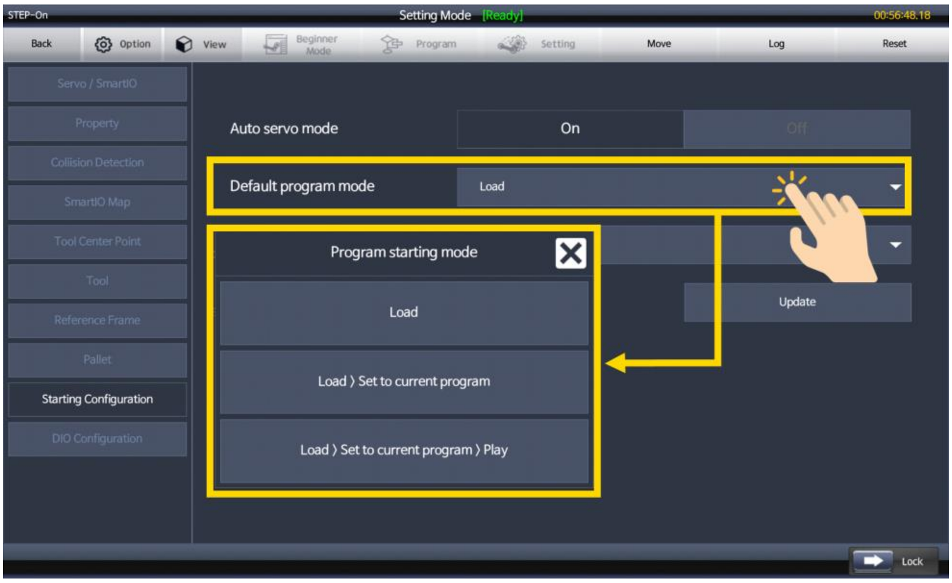
- **Auto servo mode**

  It sets servo powered on or off at startup. If the system is started with the servoes powered off you have to turn them on manually in Servo/SmartIO setting.



- **Default program mode**

  It sets the startup mode of the default program.



① **Load**

The program registered as the default program is loaded and displayed on Conty's program tree.

② **Load > Set to current program**

It loads the program registered as the default program and set it as the current program. It is used when the program is executed by external PLC or PC.

③ **Load > Set to current program > Play**

It loads the program registered as the default program and set it as the current program. Also, upon normal completion of all booting process the program will run automatically.

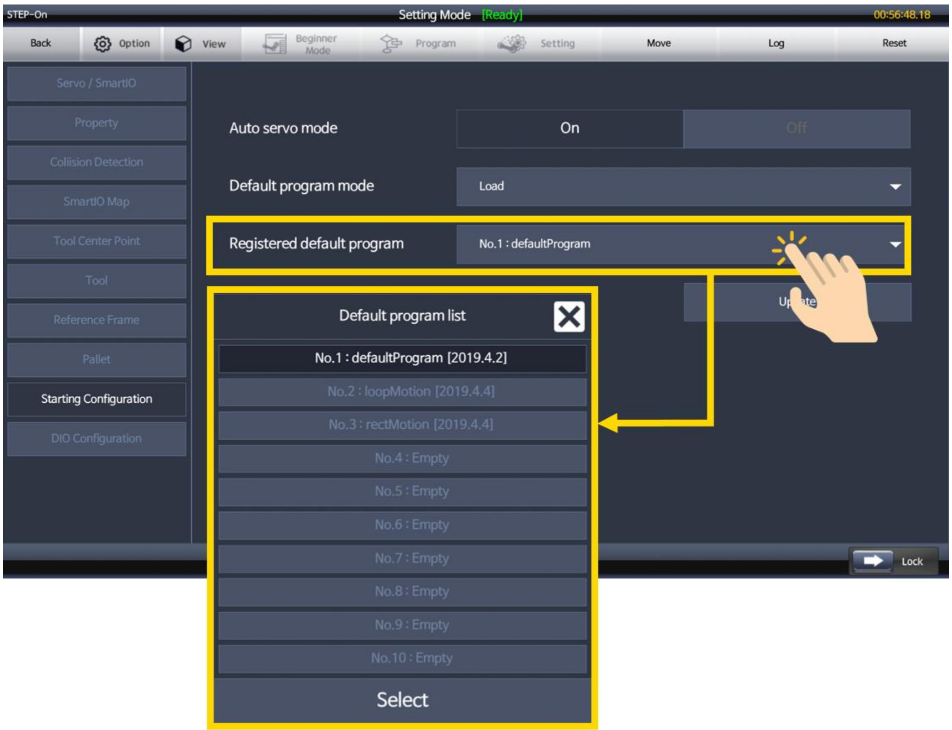
Warning

Warning

In the case where the default program mode is set to Automatic run, the robot can operate automatically after all the booting process is completed normally. This requires extreme precaution to prevent any hazards. In general, do not use this mode except when an I/O button or an external device is connected for triggering.

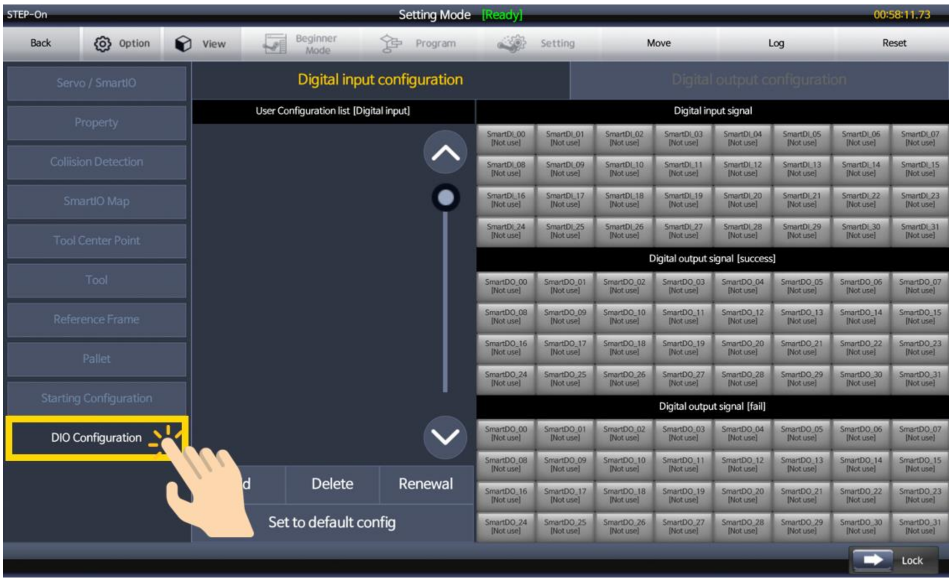
- **Registered default program**

  Select one of the programs listed in the control box and register it as the default program as follows. The control box can store up to ten programs created by Conty. Refer to **Section 5.4 Program** for details of how to save programs.



DIO Configuration

One can set the function for each digital I/O signal of the control box so that you can control the robot or receive the status of the robot using the digital I/O signal. This allows you to associate functions with a single signal or a combination of signals. In the Setting menu on the left, touch **DIO Configuration**.



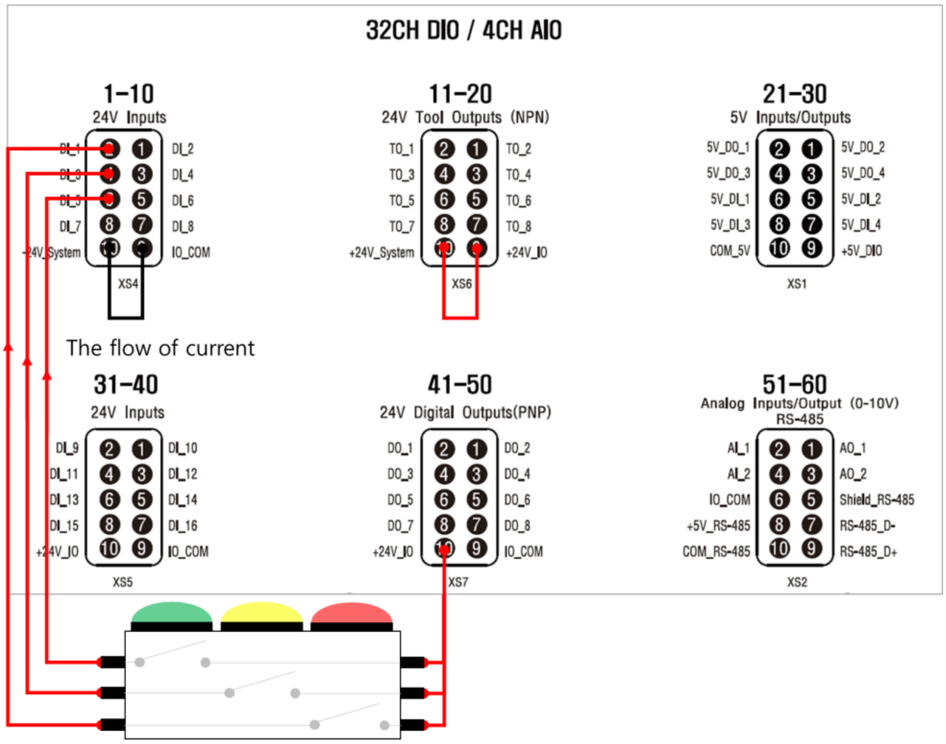
- **Digital input configuration**

  When a digital signal is input from an external device to the control box, the following functions can be assigned for each digital input.

Map ID	Command
0-9	Register as a Default Program in the slop
10	Start Registered Default Program
11	Start Program
12	Stop Program
13	Pause Program
14	Resume Program
60	Reset Robot
61	Force to Reset Robot
62	Stop Motion
63	Emergency Stop
64	Move to Home
65	Move to Zero
70	Switch to Direct Teaching Mode
71	Finish Direct Teaching Mode
200-299	Execute Specific Name Move Command (up to 100)

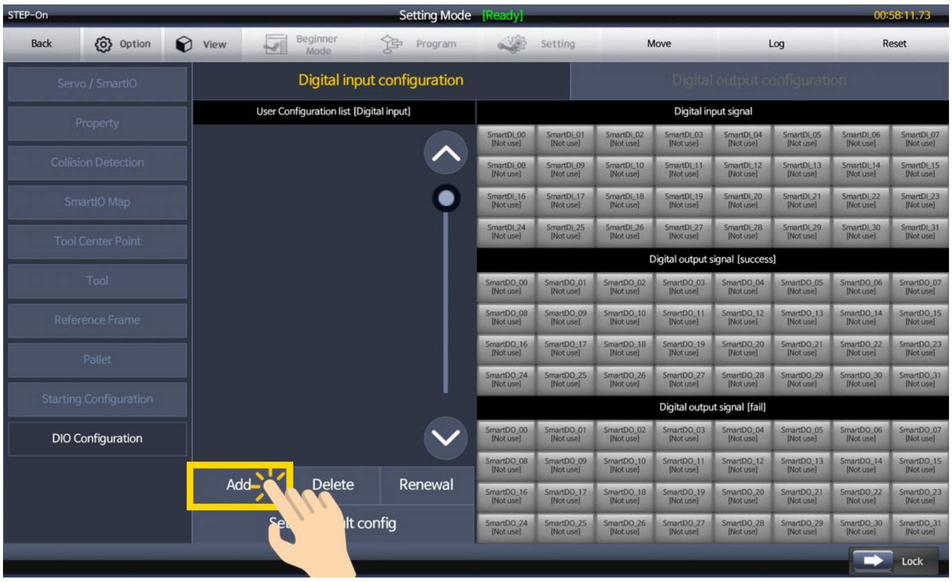
The result of functions set for each digital input signal can be transmitted to an external device by sending the execution result to each digital output signal. The following screen shows Setting digital input.

Connect the signal line from the external device to the digital signal input terminal of the control box as follows. We will configure the DIO so that the three buttons from the left will perform automatically program execution, pause, and restart, respectively.



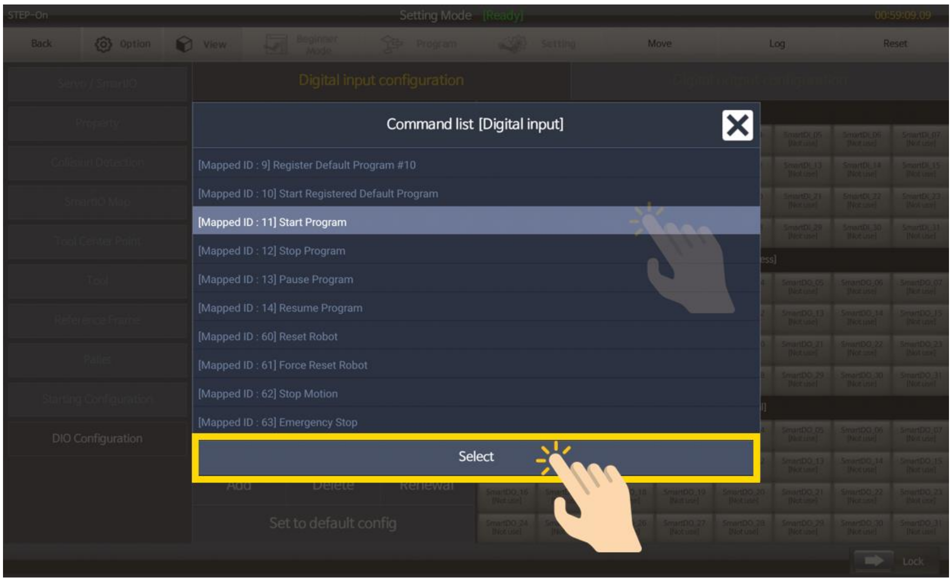
① Touch **Digital input configuration** at the top.

② Touch **Add** at the bottom to add functions to be associated with the digital input signal.

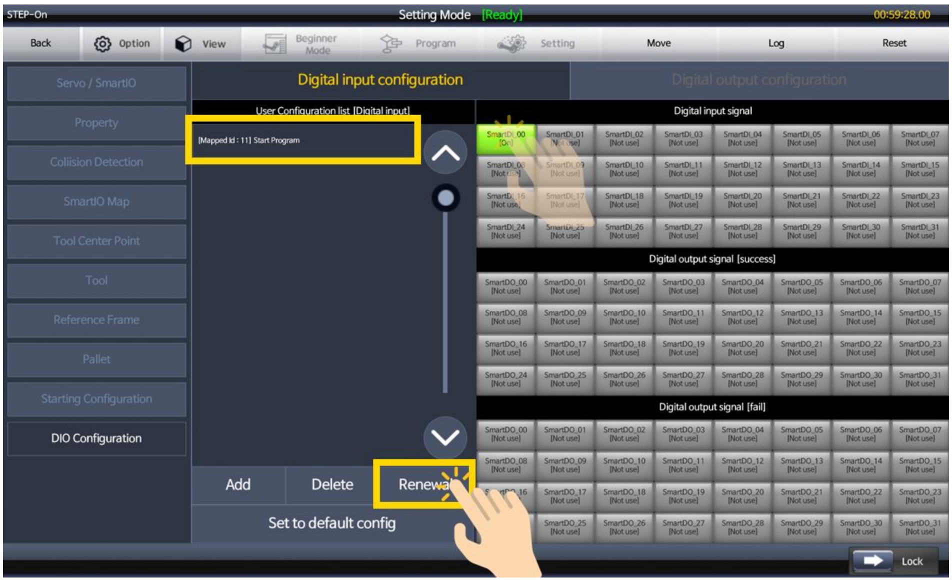


③ The commands that can be executed by the digital input signals are listed as follows.

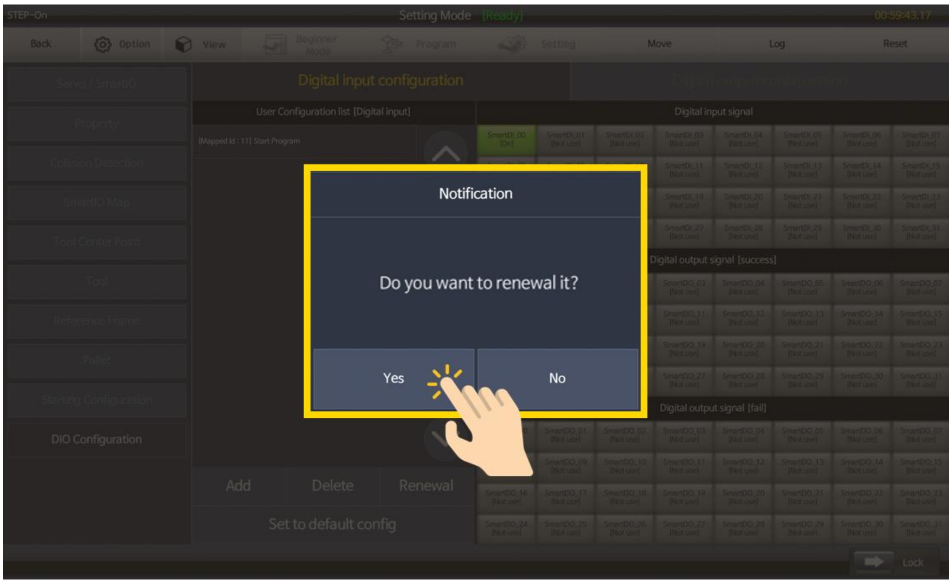
④ Select **[Mapped ID: 11] Start Program** and touch **Select**.



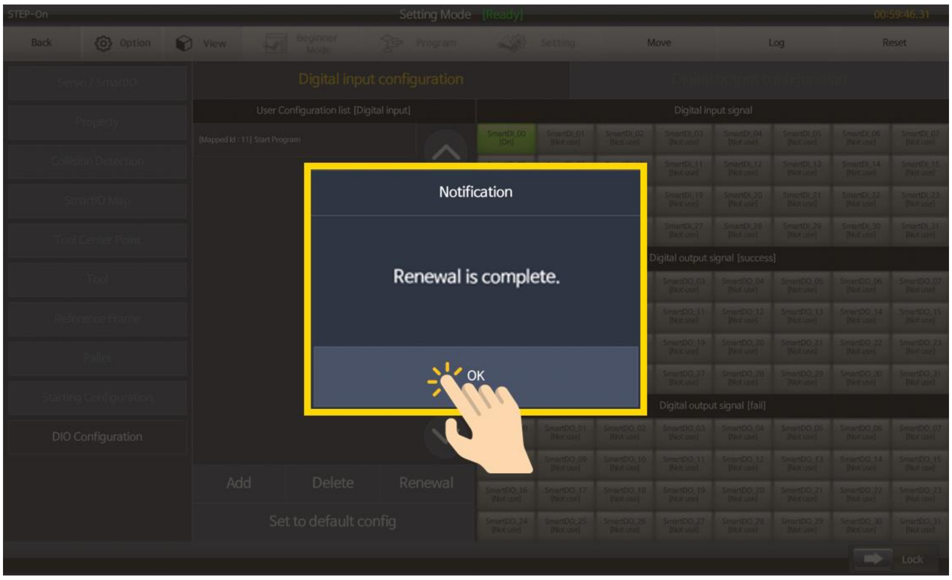
⑤ **[Mapped ID: 11] Start Program** is displayed in the User Configuration list. Touch the button of the target digital input port on the right window until the color turns to green. Each time you touch, the color iterates red, green, and gray again. Green means the function executes itself when the 'on' signal is input to the port, and red means the function executes itself when the signal is 'off'. In this example, if a digital signal is input to the selected port, Start Program will be executed. Touch **Renewal** to save the entered settings.



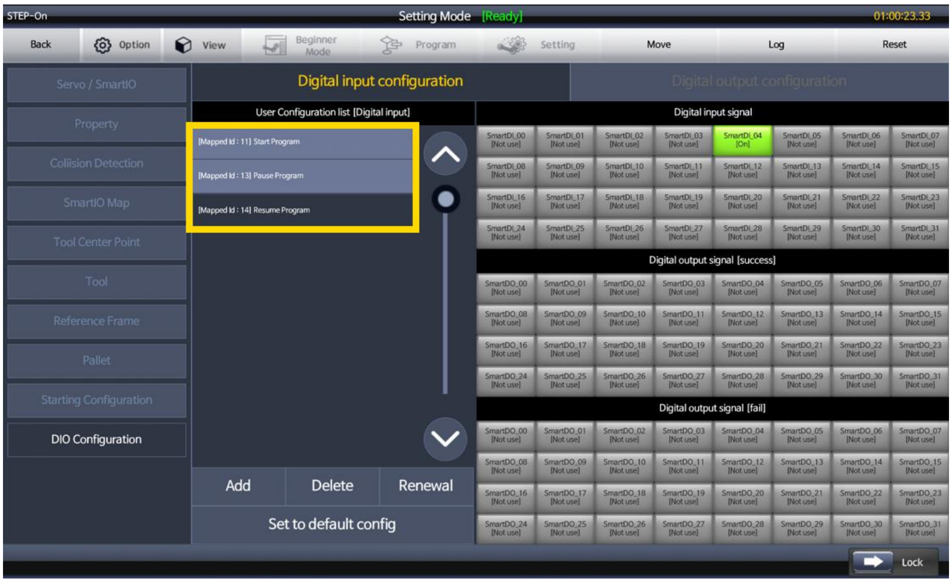
⑥ When the message "**Do you want to renew it**?" appears, touch **Yes**.



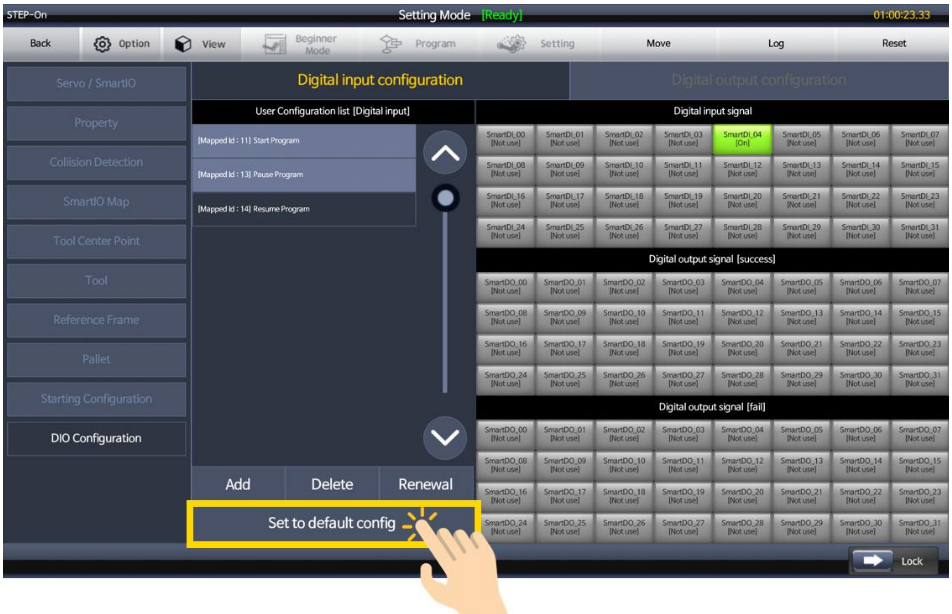
⑦ The message " **Renewal is complete**" is displayed. Touch **OK**.



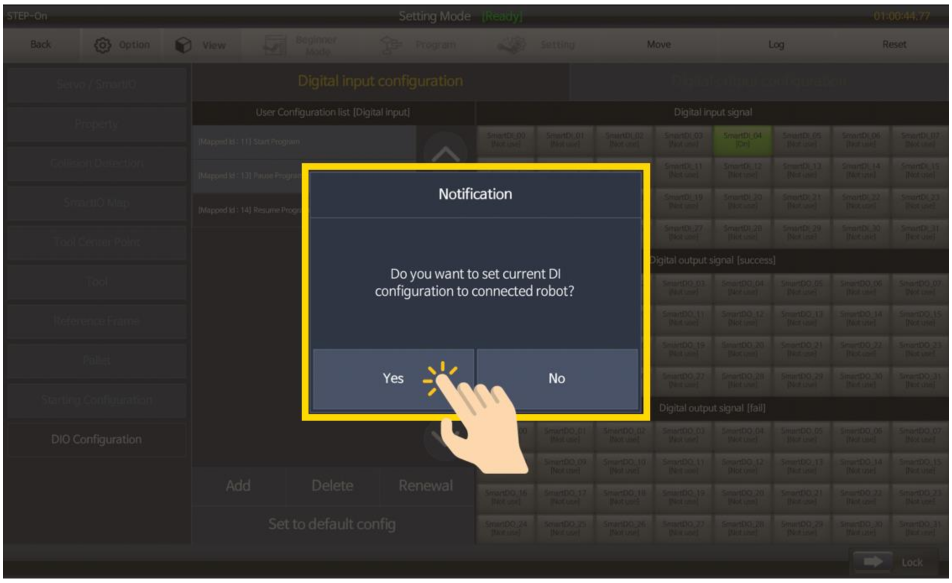
⑧ In the same way, associate Pause Program and Resume Program with the proper port of the digital input port to which the buttons are connected. Also, set the color of each Digital input to green.



⑨ When all settings are complete, touch **Set to default config** at the bottom.



⑩ When the message "**Do you want to set current DI configuration to connected robot?**" appears, touch **Yes**. Now, digital input setup is completed.



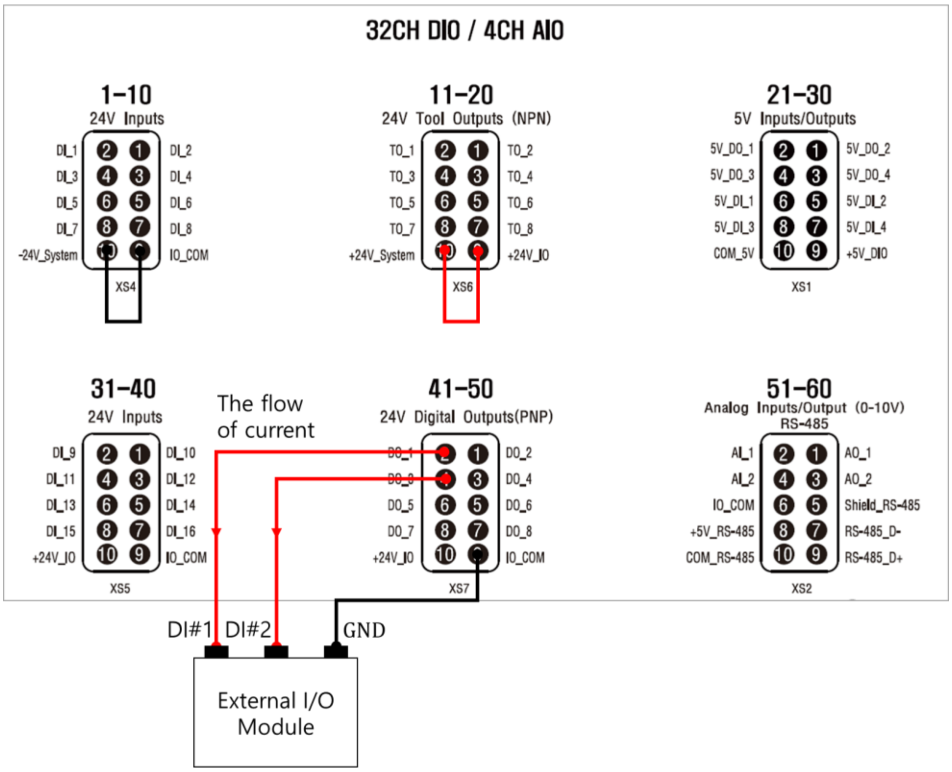
- **Digital ouput configuration**

  Using the digital output signal of the control box, the robot status is transferred to the external device. The following robot states can be associated with any digital output signal.

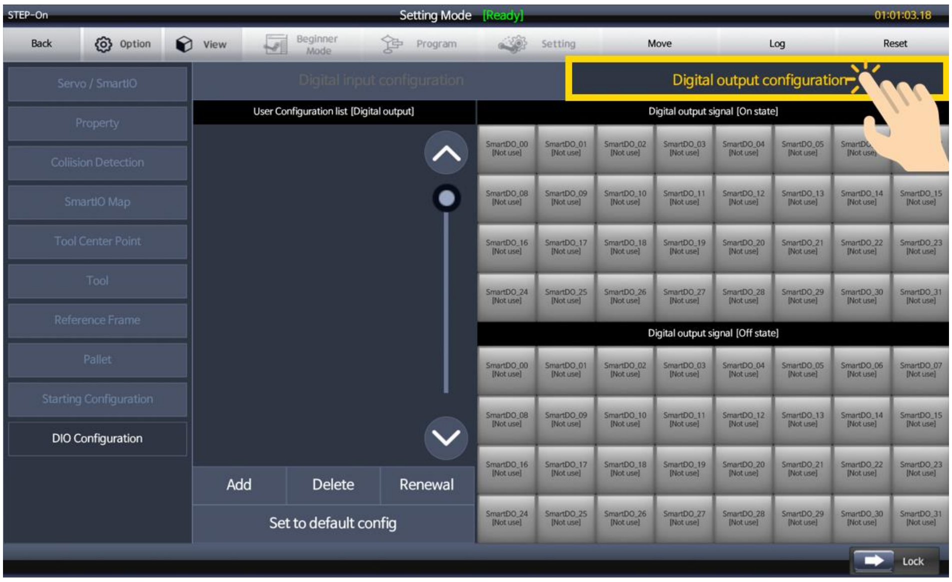
Map ID	Command
11	isRobotReady
12	isEmergencyState
13	isCollided
14	isErrorState
15	isBusy
16	isMoveFinished
17	isHome
18	isZero
19	isInResetting
80	isDirectTeachingMode
81	isTeachingMode
82	isContyConnected
83	isProgramRunning
84	isProgramPaused
200-206	Servo On/Off (up to 7 axes)
211-216	Brake On/Off (up to 7 axes)

The following is the setting screen for digital output configuration.

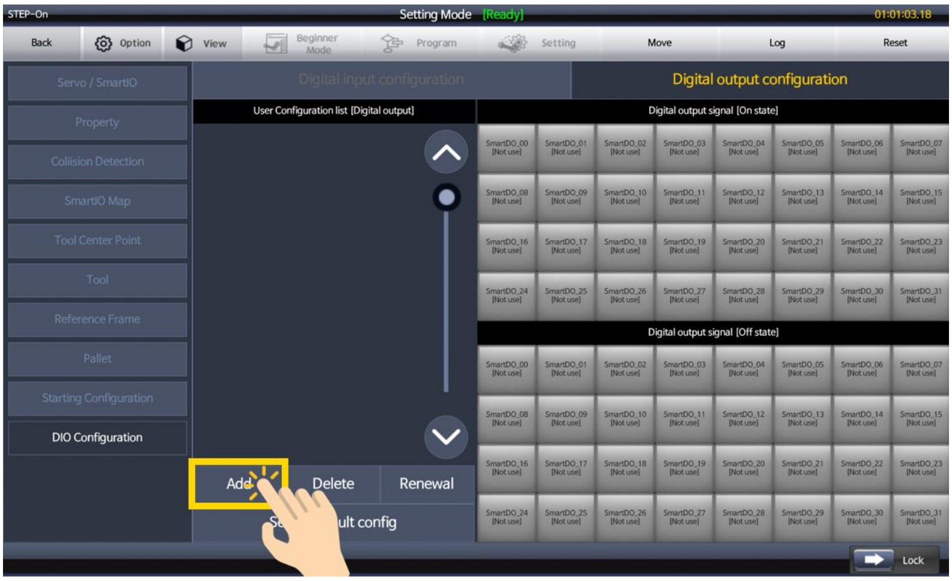
Connect the signal line from the external device to the digital signal output terminal of the control box as follows. We will configure the digital output signals so that the control box can notify the status indicating whether the robot is stopped normally or in emergency stop to an external device.



① Touch the **Digital output configuration** at the top.

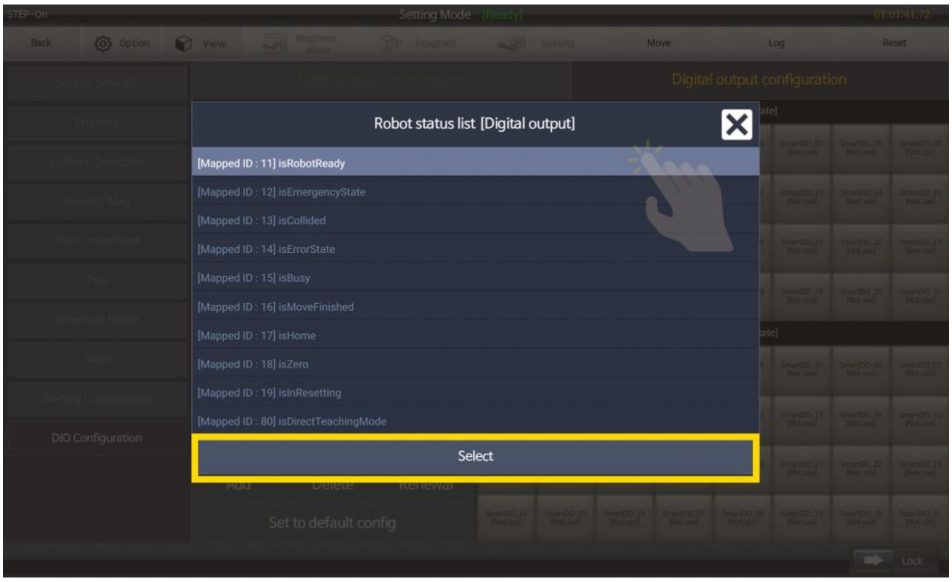


② Touch **Add** at the bottom to add the robot status to be associated with the digital output signal.

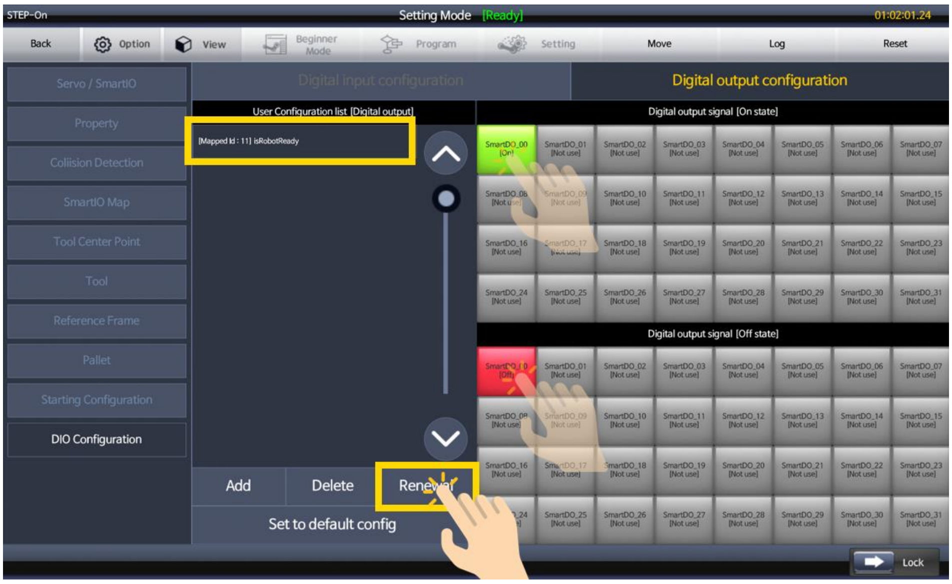


③ Robot statuses that can be associated with the digital output signals are listed as follows.

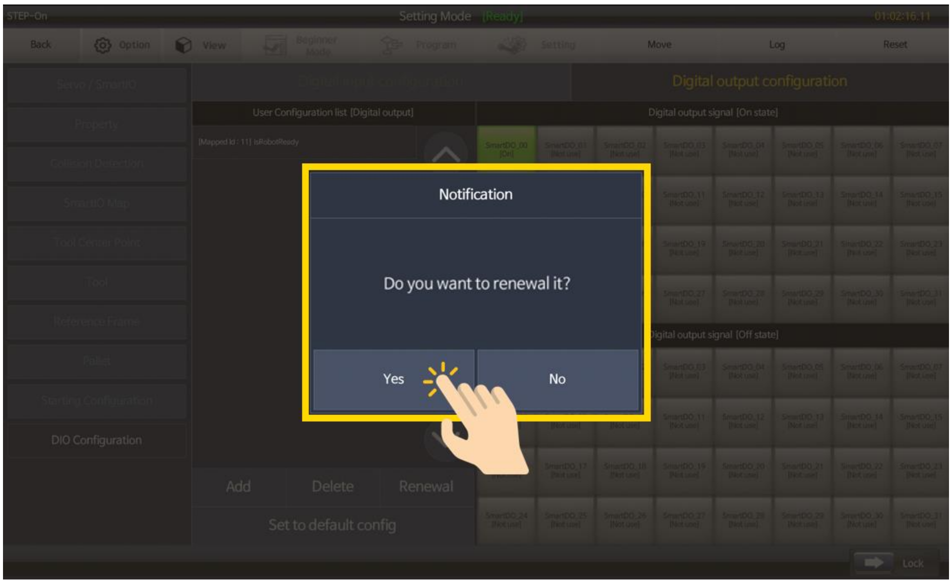
④ Select **[Mapped ID: 11] isRobotReady** and touch **Select**.



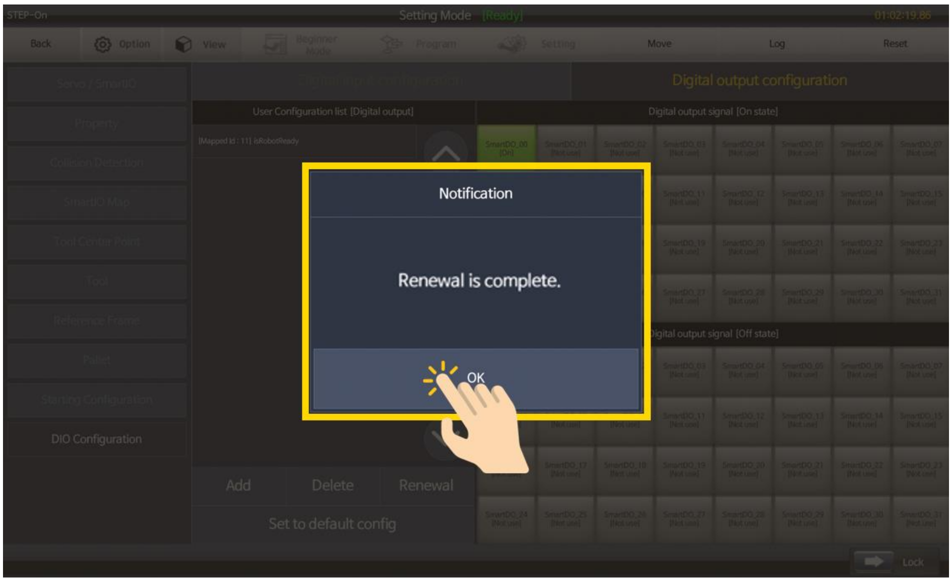
⑤ **[Mapped ID: 11] isRobotReady** is displayed in the User Configuration list. Set the digital signal output port in the OnState, which generates 'on' signal when the specified robot status is true. If necessary, the digital output signal port can be set in the OffState, generating 'on' signal, when the specified robot status is false. When the robot is waiting in normal state, the digital signal is delivered to the external device with the selected ports. Touch **Renewal** to save the entered settings.



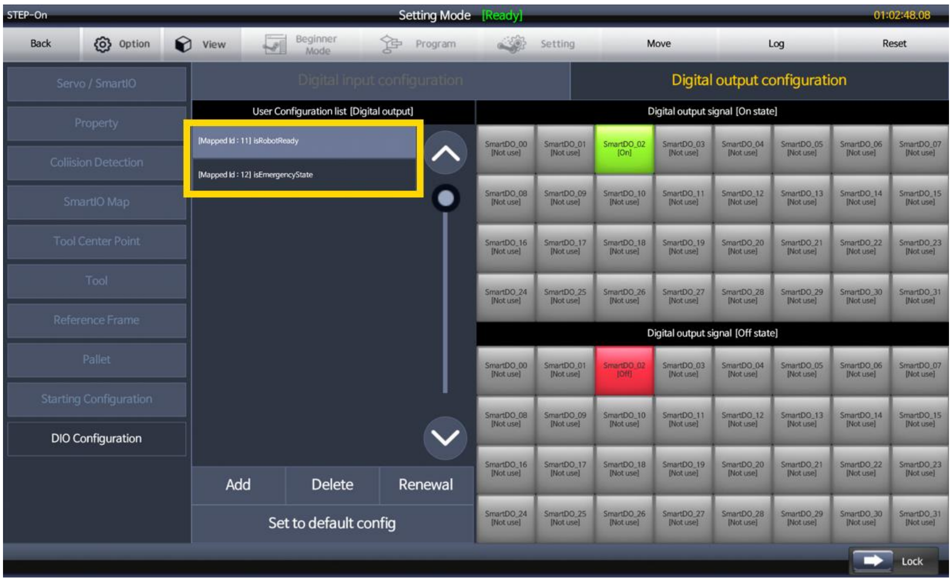
⑥ When the message "**Do you want to renew it**?" appears, touch **Yes**.



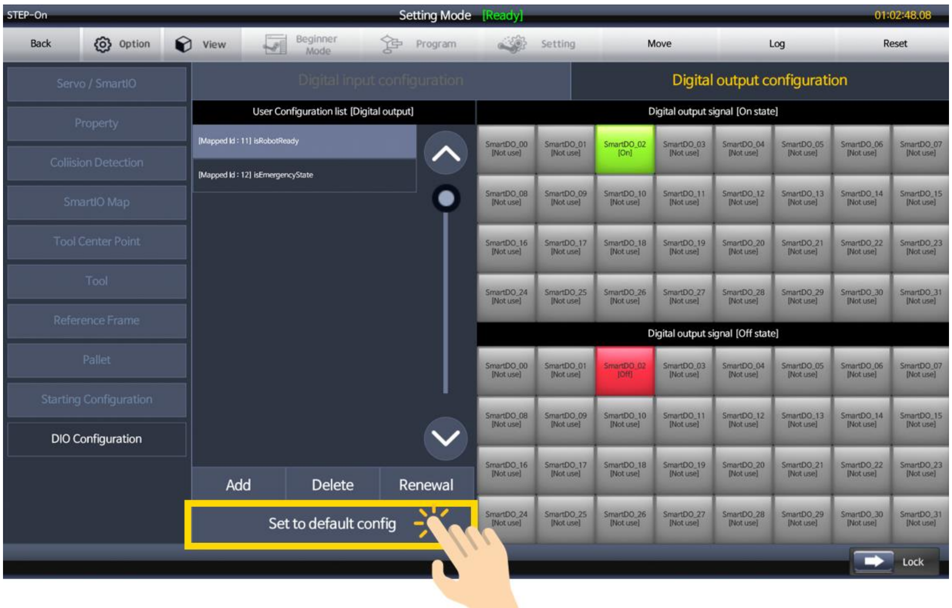
⑦ The message "**Renewal is complete.**" is displayed. Touch **OK**.



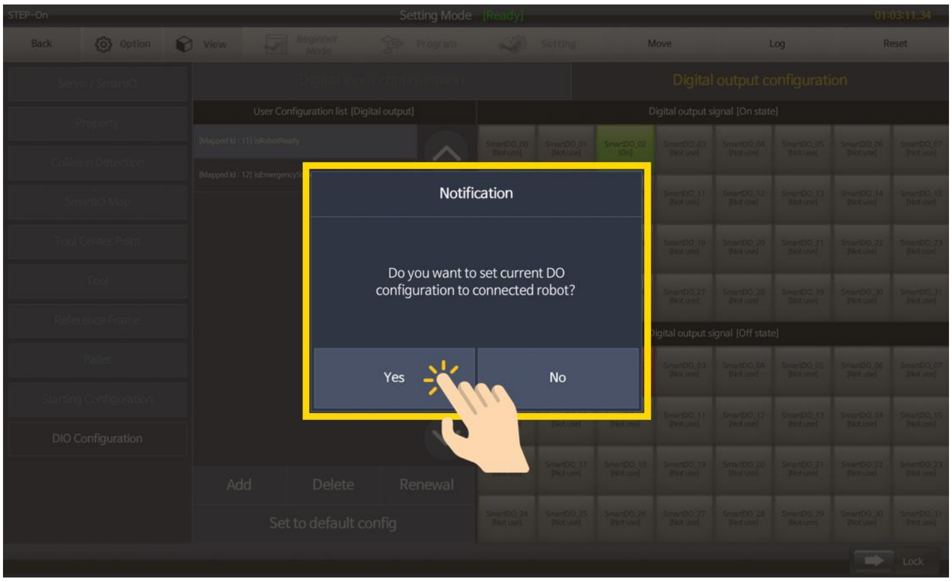
⑧ Just in the same way, you can associate the emergency stop status of the robot with the any ports of the digital output terminal connected to the external device.



⑨ When all settings are complete, touch **Set to default config** at the bottom.

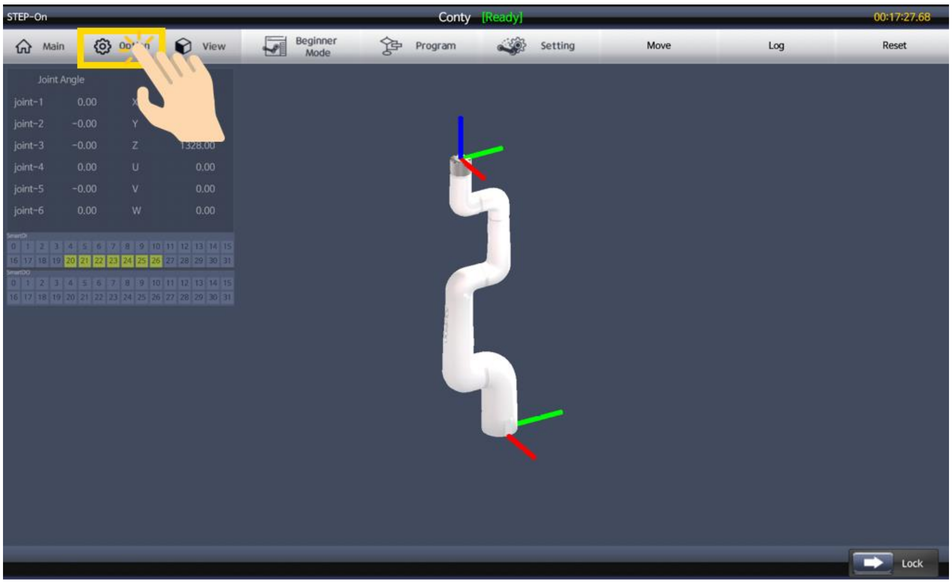


⑩ When the message "**Do you want to set current DO configuration to connected robot?**" appears, touch **Yes**. Now digital output setup is completed.

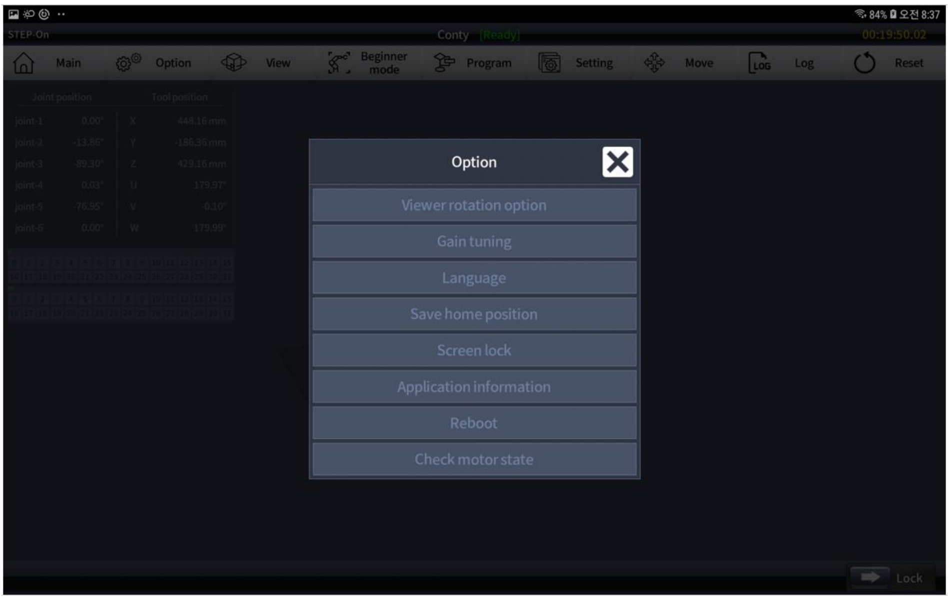


6.2 Options

There are Conty-related settings and settings for the manufacturer's service engineers provided. Touch **Option** in the top menu bar.



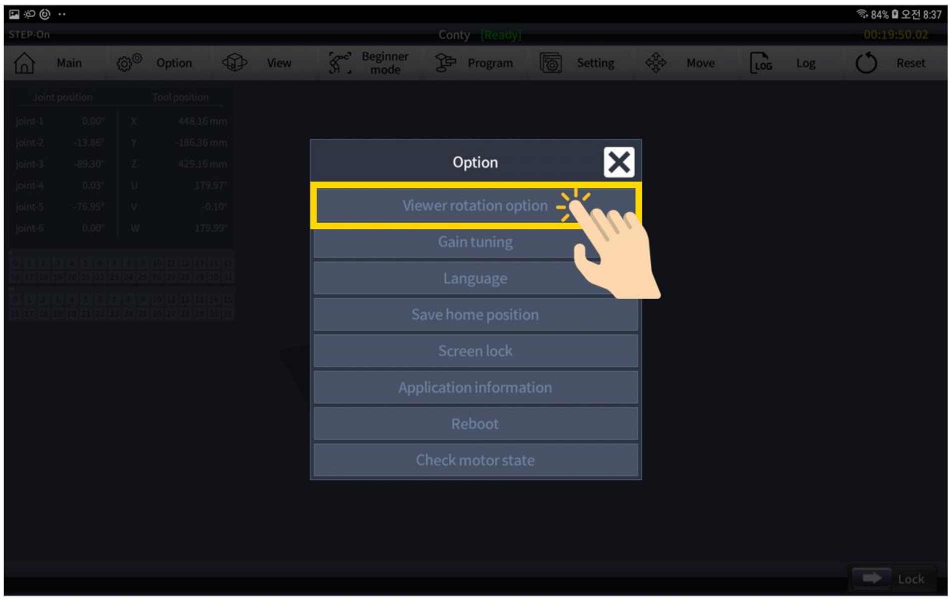
There are the following options available.



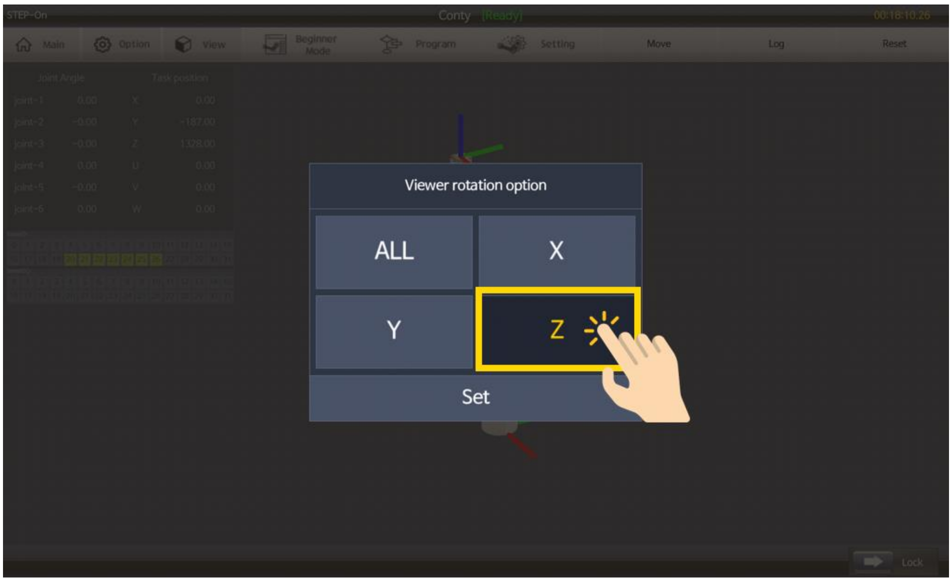
Viewer Rotation Option

It permits the viewpoint rotation of the three-dimensional renderer displayed on the Conty. You can view the virtual robot model in Conty from a custom viewpoint by rotating it about the axes.

① In the list of options, touch **Viewer rotation option**.



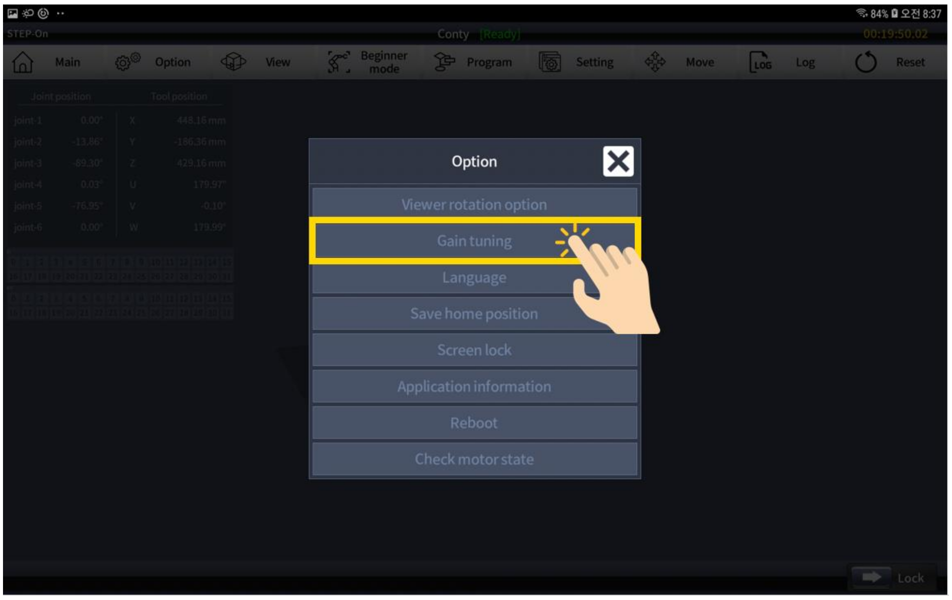
② The default axis of viewpoint rotation is the Z axis, and you can change it by touching the desired axis as follows.



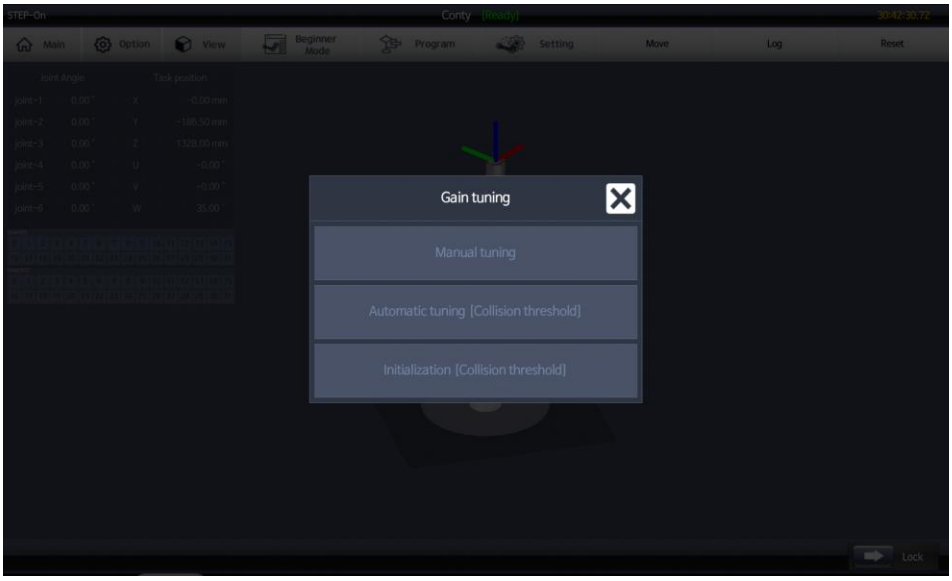
Gain tuning

It sets the control gains and the collision detection threshold for the internal motion controller.

① Touch the **Gain tuning** in the Option list.

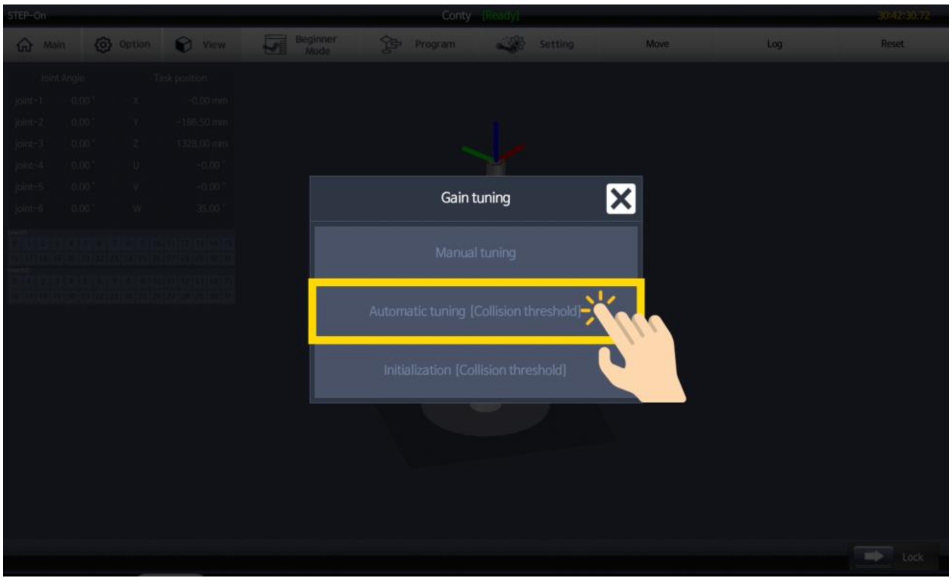


② Three options are provided in **Gain tuning** window as follows.

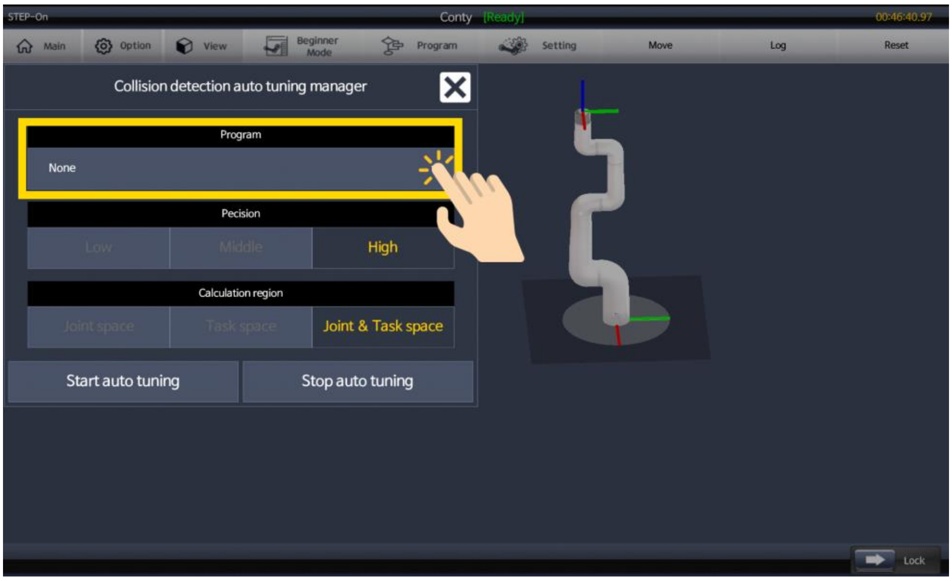


- **Manual tuning**
  This setting is for service engineers and is not available to general users.
- **Automatic tuning [Collision threshold]**
  Conty will automatically find and set the appropriate collision detection threshold for your program.
- **Initialization [Collision threshold]**
  The collision detection threshold is reset to the factory default value.

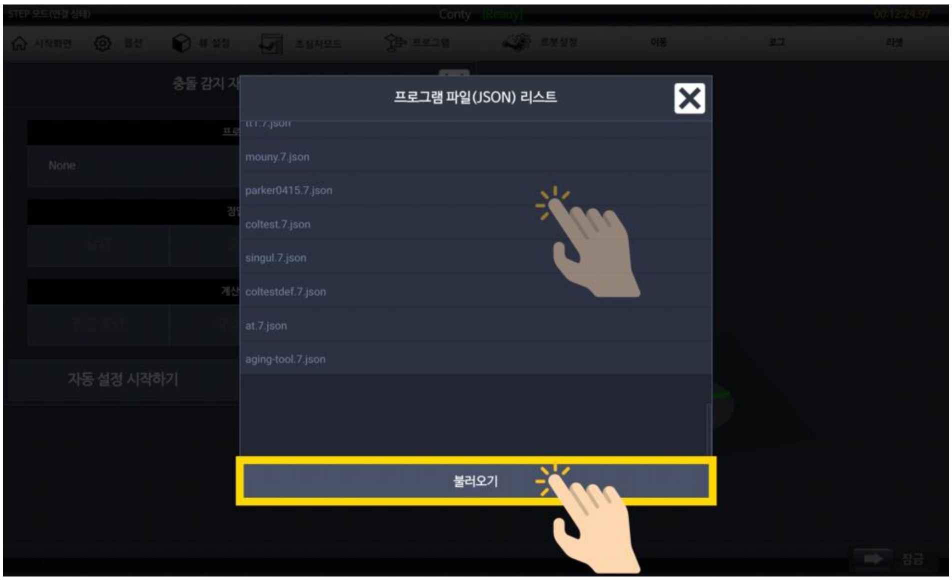
③ In the **Gain tuning** list, touch **Automatic tuning [Collision threshold]**. Automatic tuning [Collision threshold] is used when the default collision detection threshold does not handle collisions successfully for current movement. For example, this automatic tuning is used when collision detection happens falsely in movement with no actual collision, e.g. if a heavy tool is attached to the robot, the exact mass and the center of mass of the tool is not known, or if the speed and the direction change of the motion are so severe.



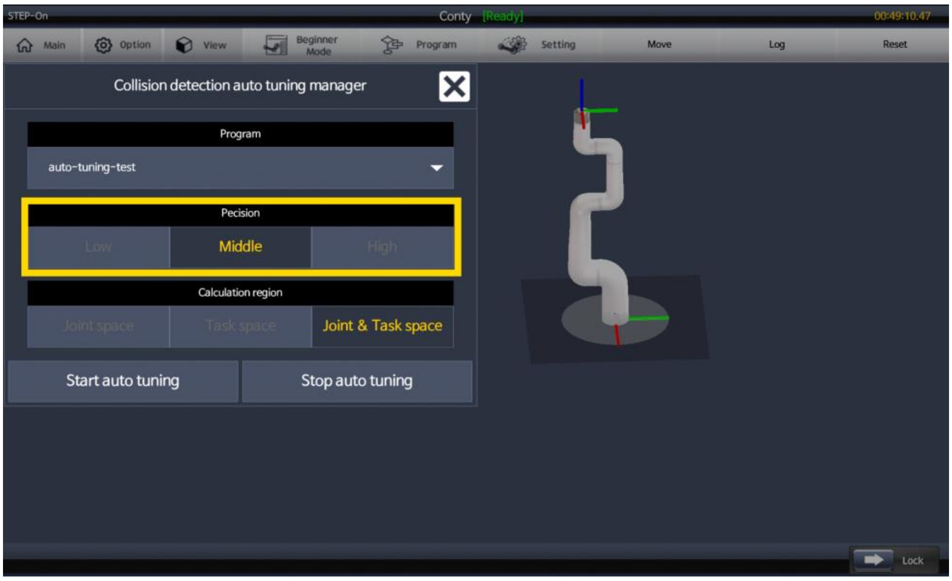
④ In the Collision detection auto tuning manager window, touch the **arrow in the right** of the program field.



⑤ Select the program for which you want to set a new collision detection threshold and touch **Load data**.

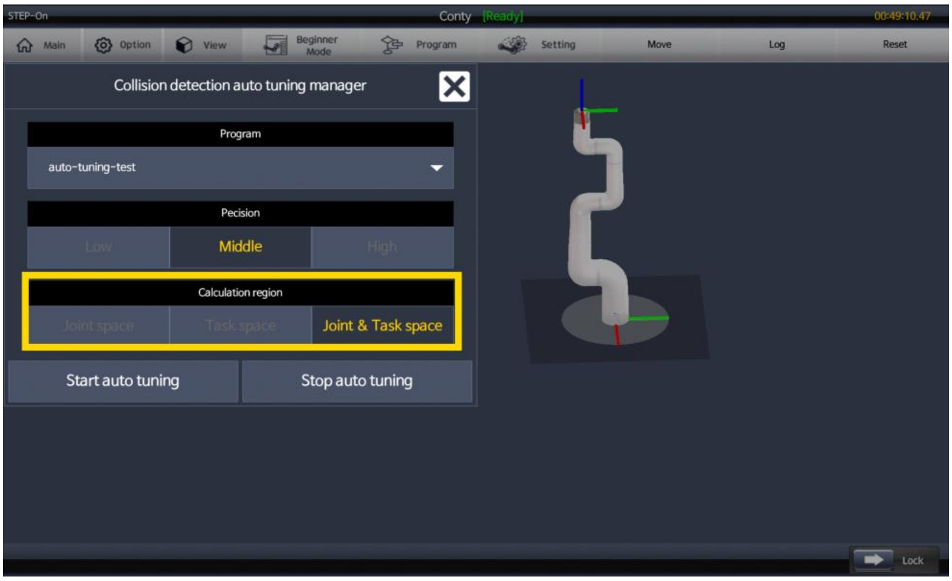


⑥ Choose the **precision level** of the collision detection threshold from **Low**, **Medium**, or **High** in **Precision** menu.



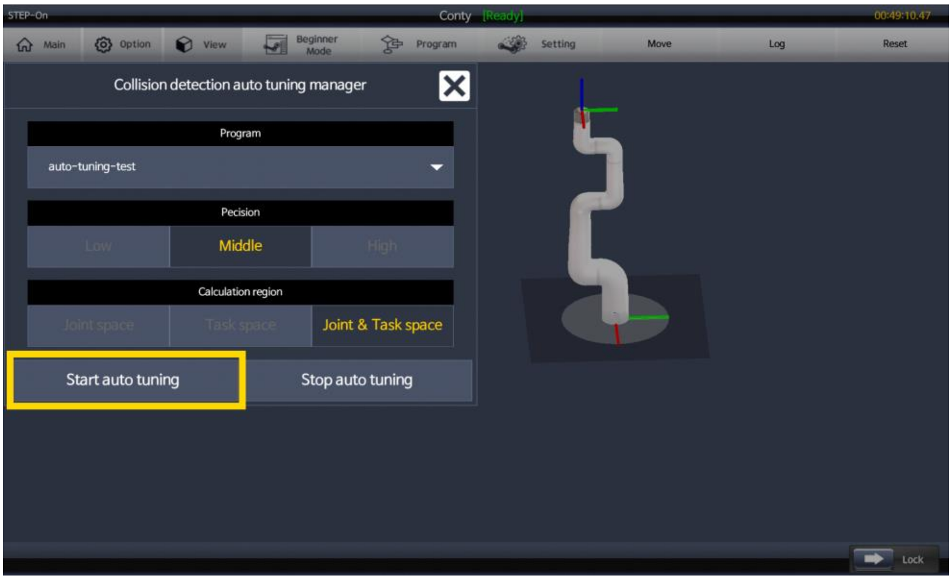
The higher the precision, the closer the collision detection threshold is set to the torque generated by the robot motion, so that minute collisions can be detected. However, collision detection is optimized for the motion in the program, so the collision may be detected frequently if the robot motion is different from the programmed motion that was used to calculate the collision detection threshold.

⑦ Select the **motion type** in Calculation region menu to apply the collision detection threshold.

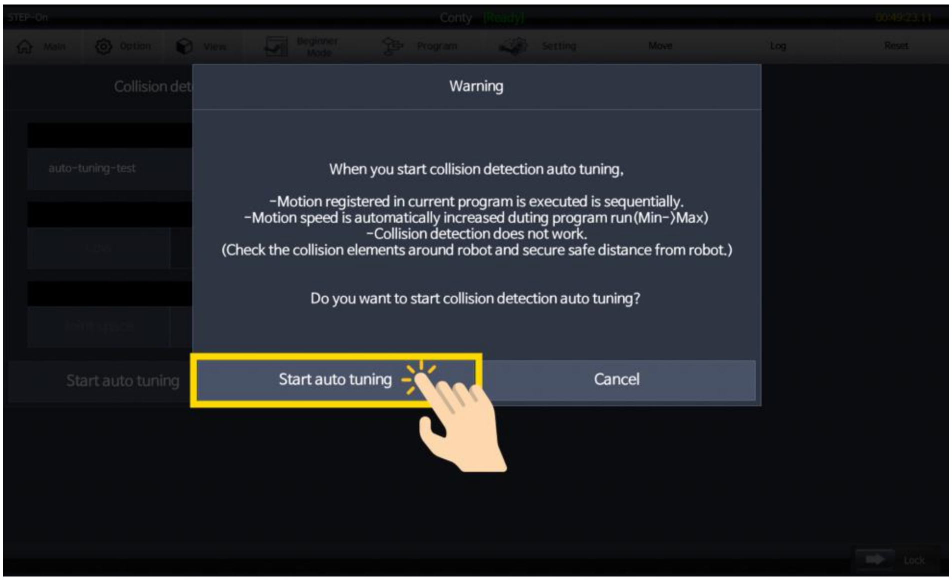


If you select the joint space, it calculates the collision detection threshold that applies to all jointMove used within the program. On the other hand, the task space will calculate the collision detection threshold that applies to all frameMove. Select joint & task space to recalculate the collision detection threshold, which will be applied to all jointMove and frameMove.

⑧ When all settings are complete, touch **Start auto tuning**.



⑨ Check the warning message and touch **Start auto tuning**.

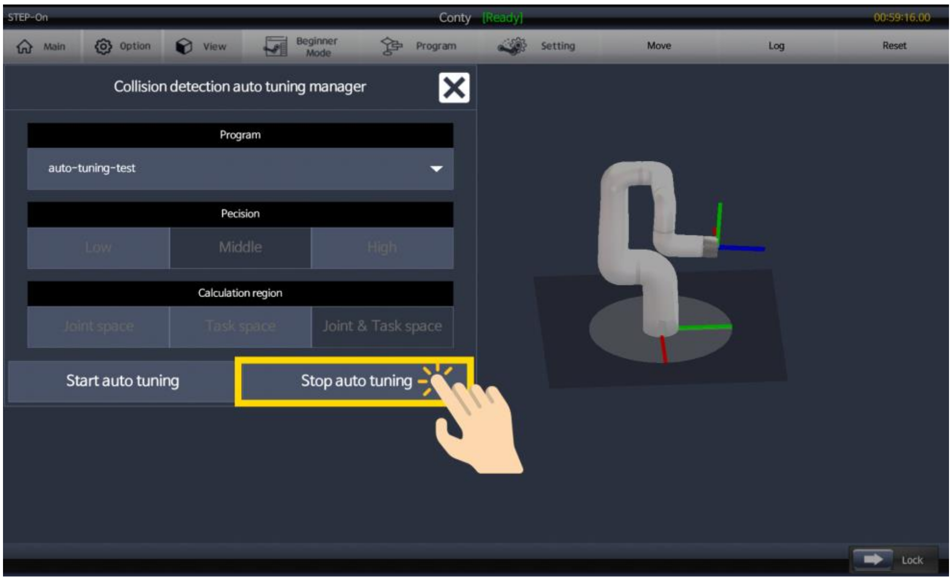


Warning

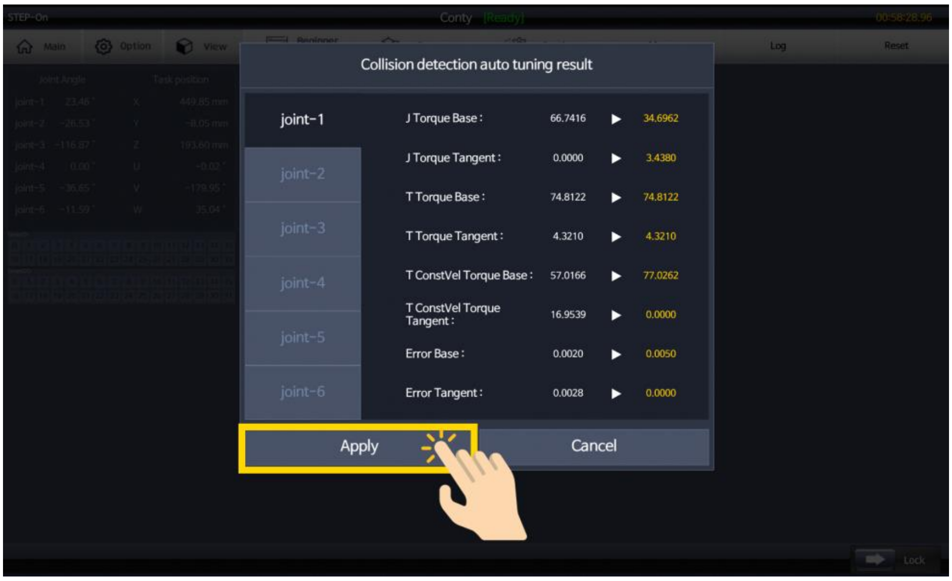
Warning

When the auto tuning for collision detection starts, the motion programmed in the program is executed sequentially, and is repeated five times with increasing speed automatically for every iteration. During tuning the collision detection function does not work temporarily, so it is necessary to proceed tuning without any colliding objects around the robot, and not to approach the robot while it is in progress.

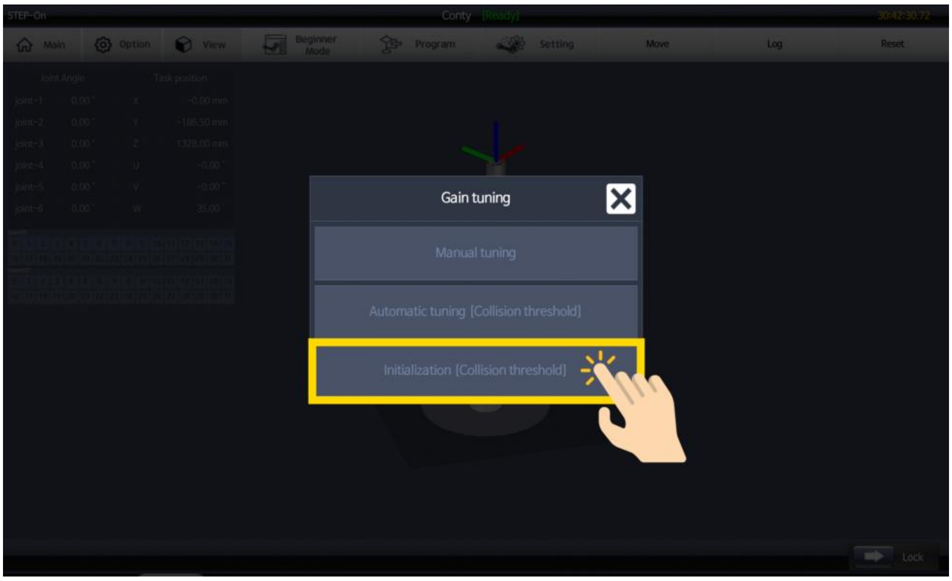
If you want to stop the robot operation while the auto tuning is running, touch **Stop auto tuning**.



⑩ When all necessary actions for auto tuning are completed, the automatically computed collision detection threshold is displayed as follows. After confirming the value set for each joint, touch **Apply**.



If you want to reset the automatically calculated collision detection threshold to the factory defaults, touch the **Initialization [Collision threshold]** in the list of **Gain tuning** as follows.



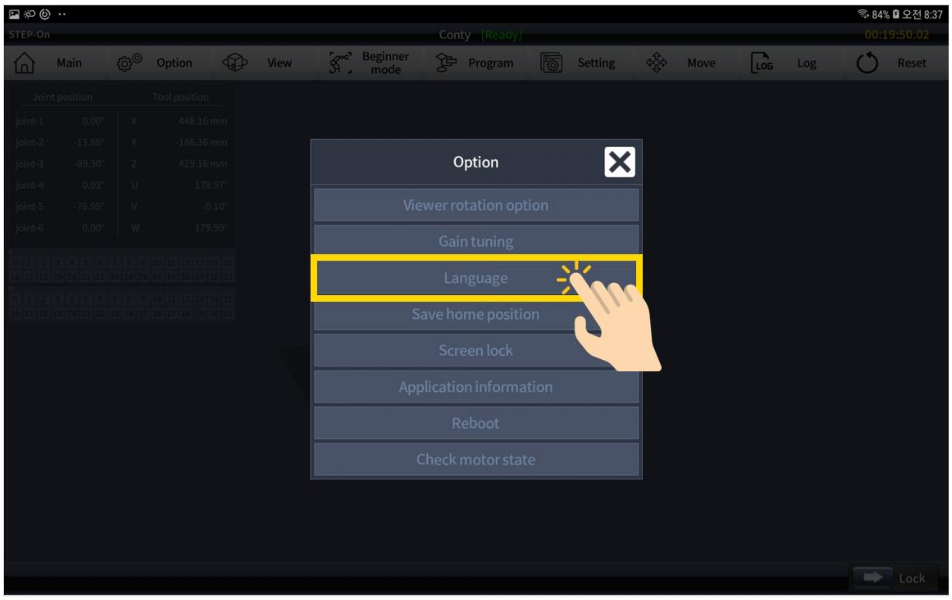
Caution

Using automatically calculated collision detection threshold can cause frequent collision detection in motion other than those used in the user program. In this case, reset the collision detection threshold using Initialization [Collision threshold].

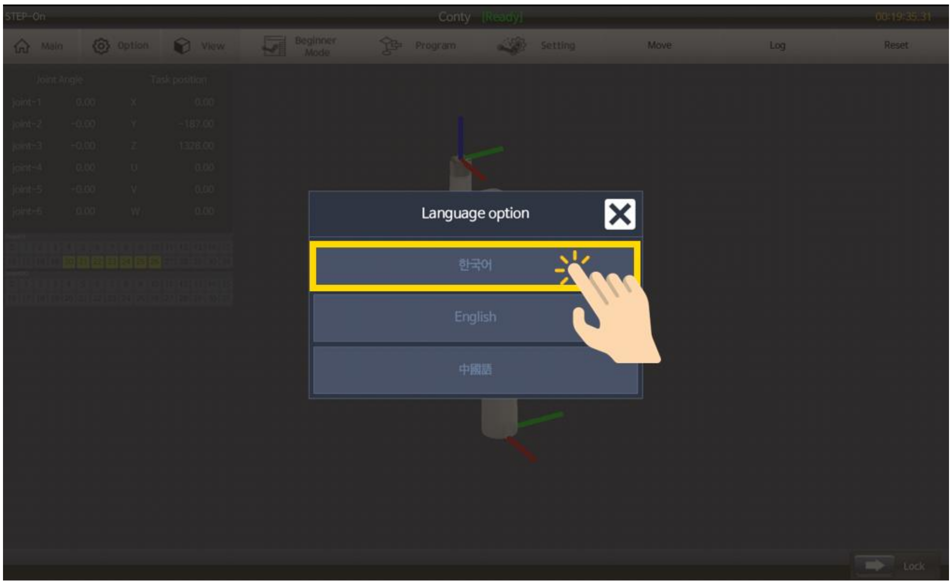
Language

It sets the language displayed on the Conty. We currently support three languages: Korean, English and Chinese. Conty will close in order to apply language change.

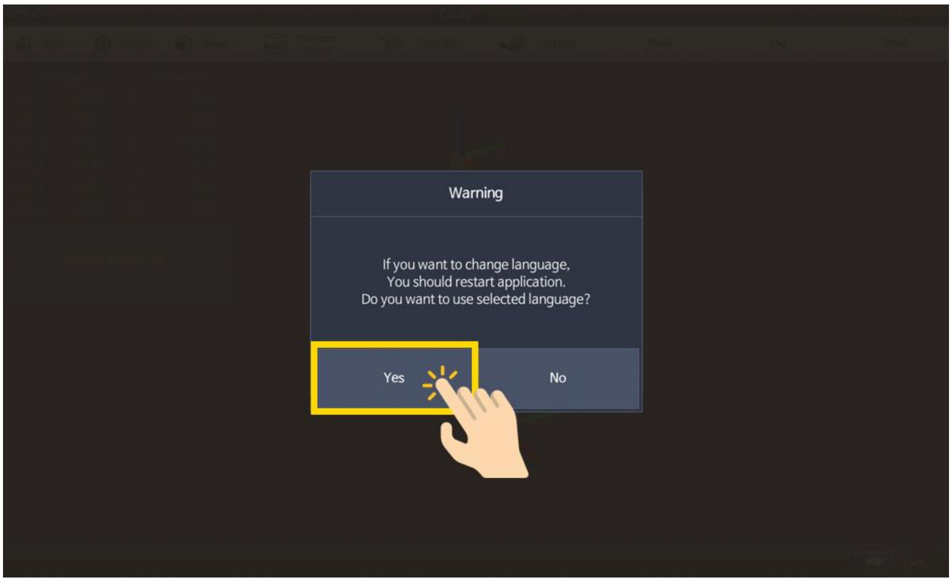
① Touch **Language** in the list of options.



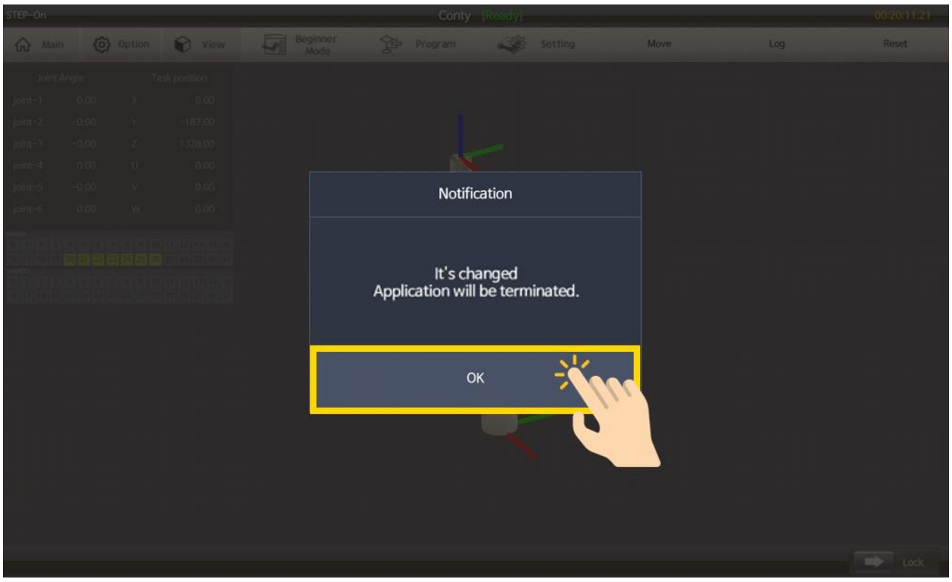
② Select one of the following languages for your preference.



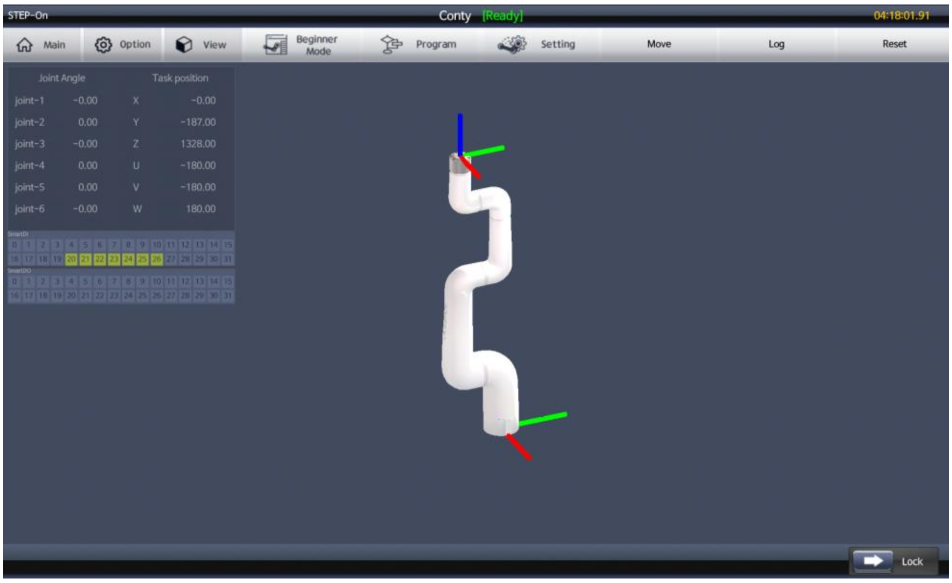
③ You must restart Conty in order to use the selected language. When the warning message "**Do you want to use selected language?**" is displayed, touch **Yes**.



④ Upon the message "**It's changed. Application will be terminated.**" touch **OK** to close Conty. Restart Conty.



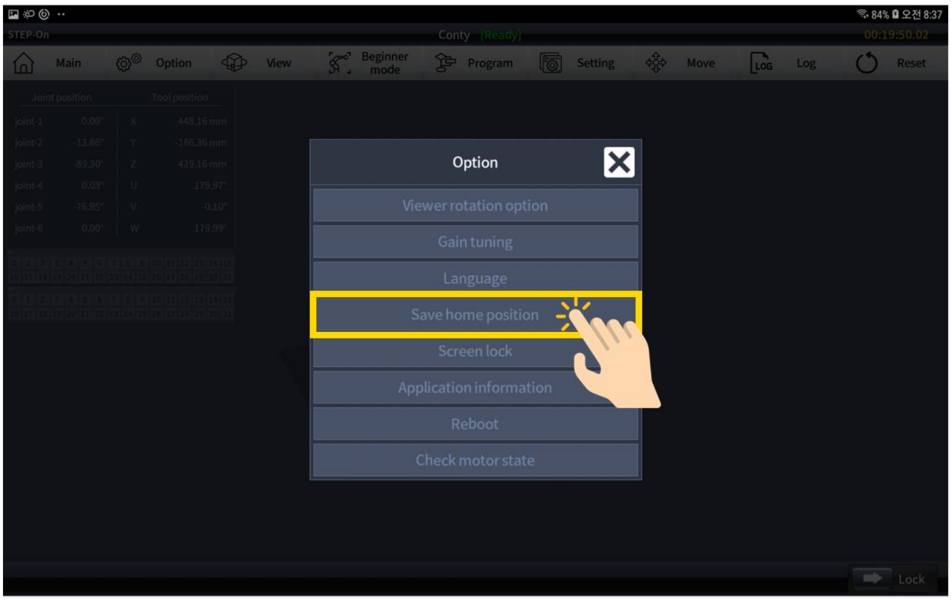
⑤ If you run Conty again, the language is changed and shown as follows:



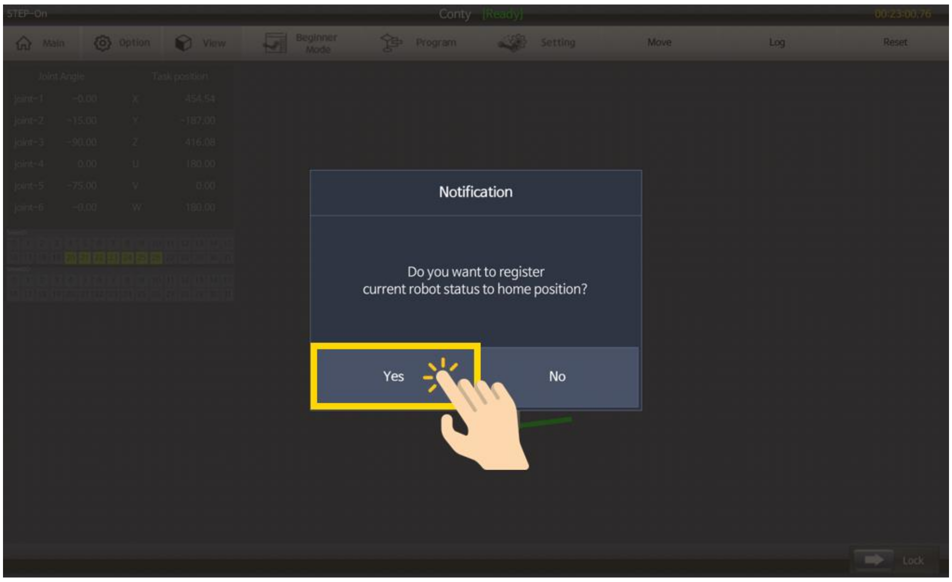
Save Home Position

It sets the current position as the home position. The home position of the robot is usually used as the starting or ending position of the task, or it is the position where the robot returns when an error occurs. You can specify your home position according to the purpose.

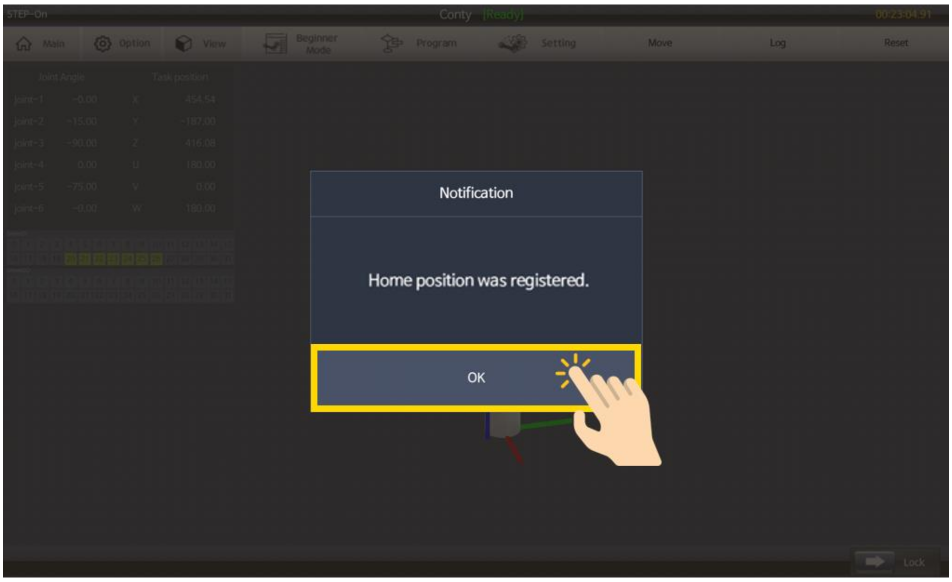
① Use direct teaching or jog move to move the robot to the desired position, then touch **Save home position** in the options list. Refer to **Section 4.2 Basic Operations** for details on manual movement of the robot.



② Touch **Yes** upon the message "**Do you want to register current robot status to home position?**".



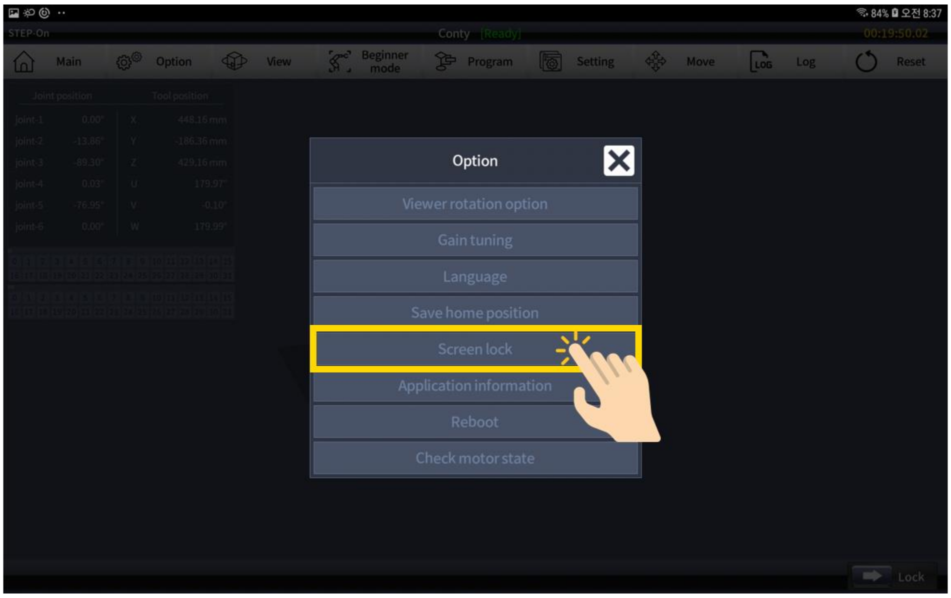
③ If your home position changes normally, you will see the message "**Home position was registered.**" Touch **OK**. You can confirm the changed home position by the **home** command. Refer to **Section 4.2 Basic Operations** for a description of the home command.



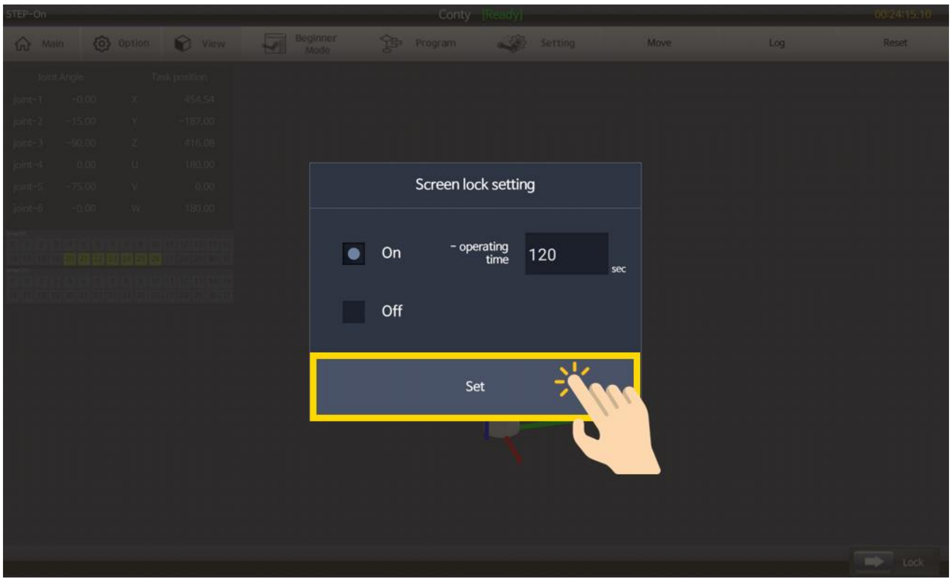
Screen Lock

It configures the setting for Conty's lock screen. The lock screen is provided to prevent unintentional user inputs. Lock screen setting allows you to set the time to lock the normal Conty user screen, or even to disable lock screen, if necessary.

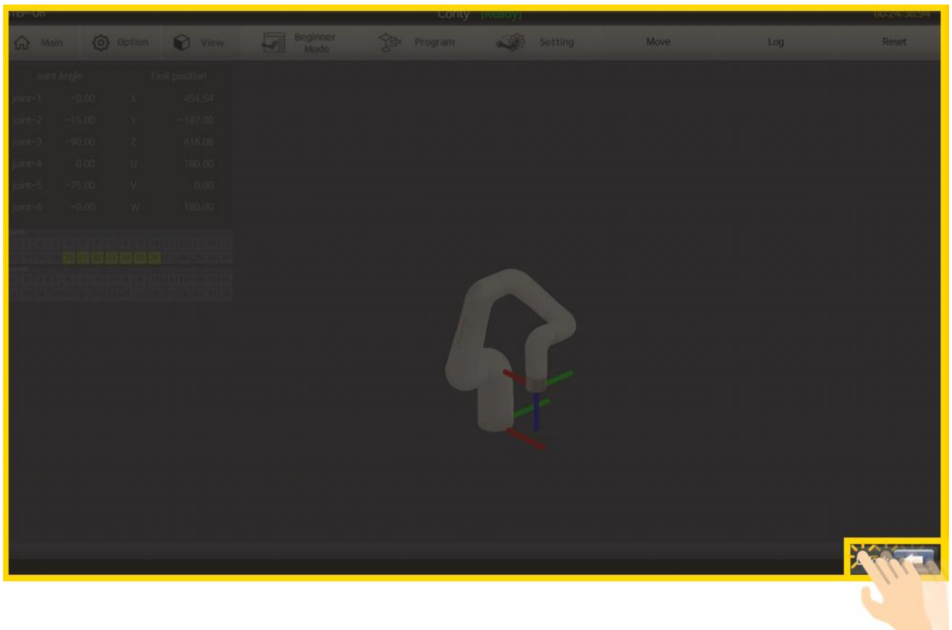
① Touch **Screen lock** from the list of options.



② Select either On or Off option. For On, you can enter the time in seconds to lock Conty screen. Touch **Set** to complete the setting.



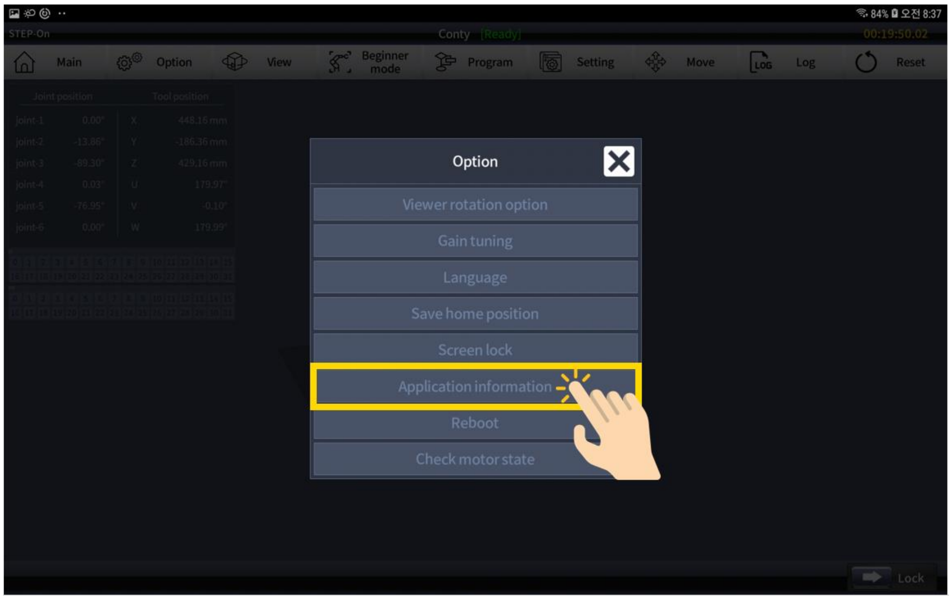
③ The following shows the screen locked. In the locked screen, all user input is disabled. To release the lock, touch the arrow on the bottom right and slide to **unlock**.



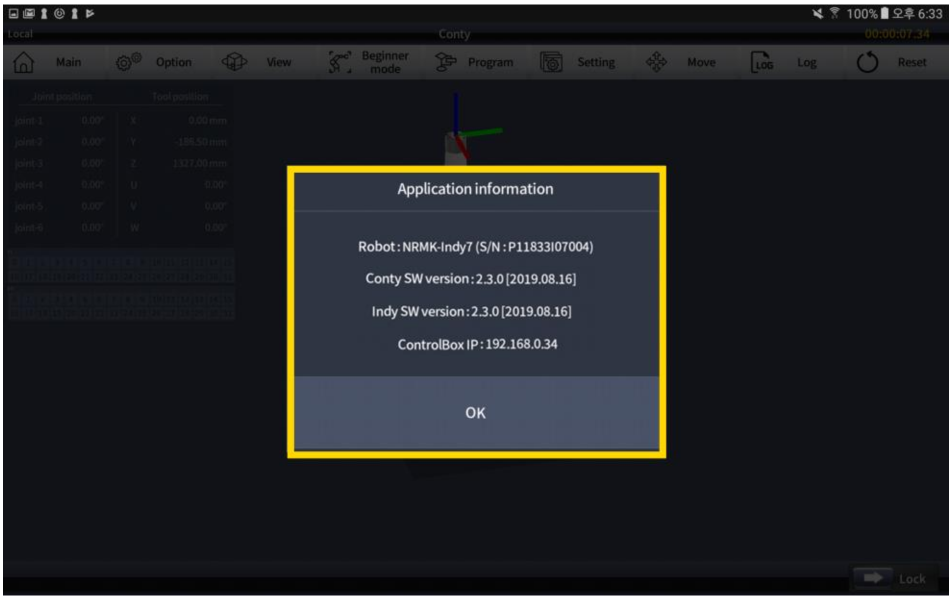
Application Information

It displays the information on the product currently in use.

① Touch **Application information** in the list of options.



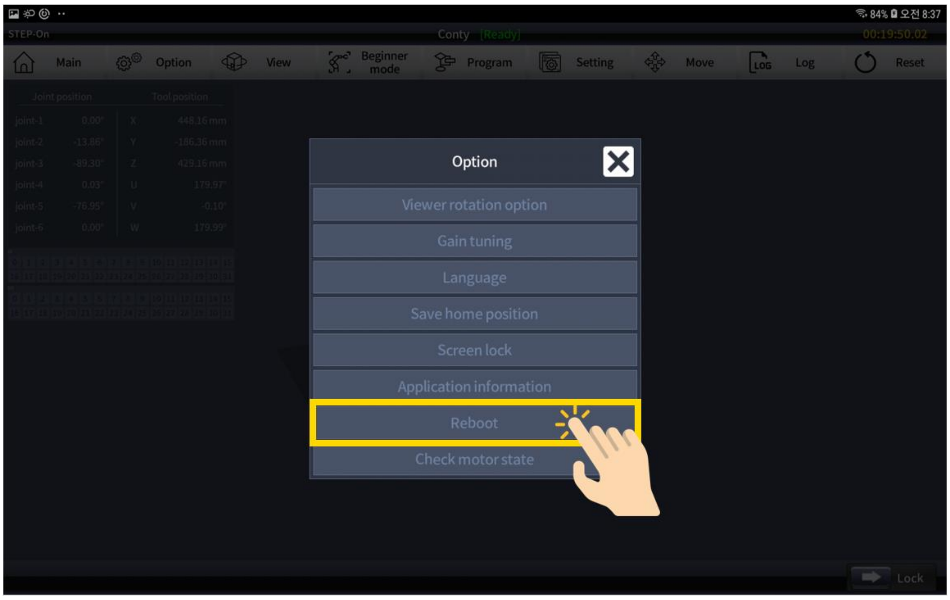
② The software version is displayed with the model name of the product you are using, as follows. If the control box is connected to the network, its IP information is also displayed. Note that Conty application and the control box software should have the same version in order for the robot to run normally.



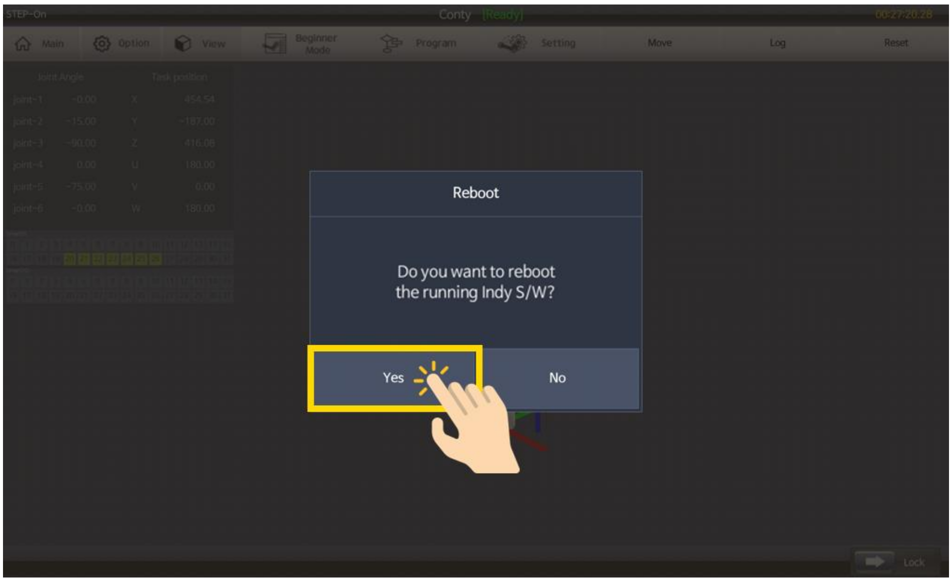
Reboot

Reboot is one of the recovery functions that shuts down and restarts the control system. Upon rebooting the robot arm is reconnected to the control box as the motor is powered off and back on.

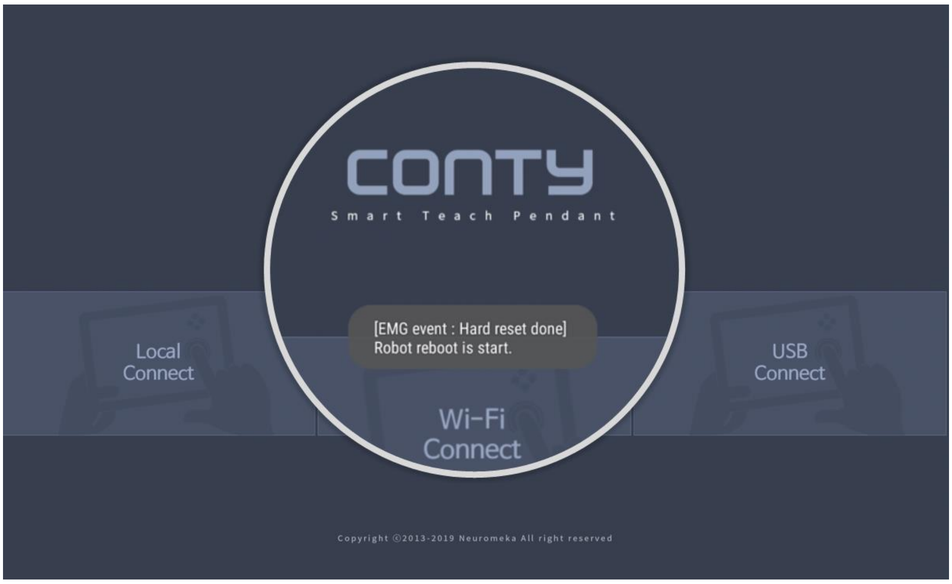
① Touch **Reboot** in the list of options.



② Select **Yes** upon the message "**Do you want to reboot the running Indy S/W?**"



③ The endtool indicator turns off the light and the system reboots. At the same time Conty moves to the start screen automatically when communication is terminated.



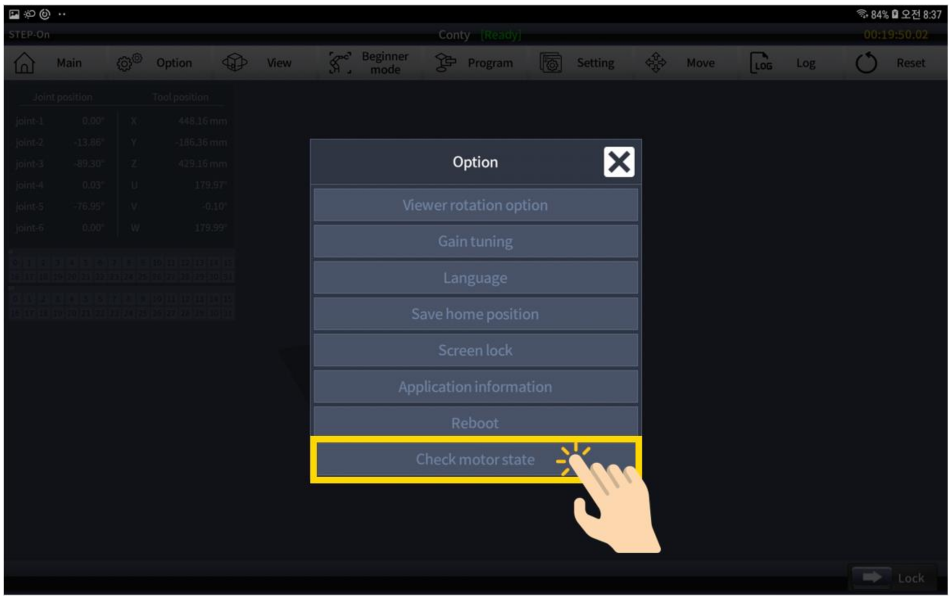
④ After approximately two to three minutes, the endtool indicator is flashing in red. Soon, it changes to red or green depending on the startup mode setting and the robot is recovered.

⑤ Connect the robot again from Conty's start screen.

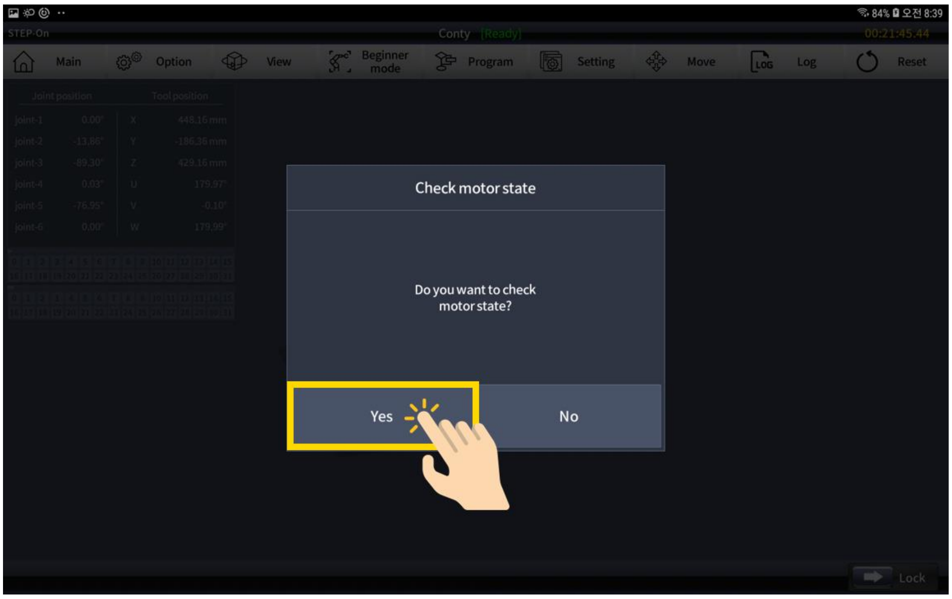
Motor Status

It displays information on the current status and error code of each joint motor.

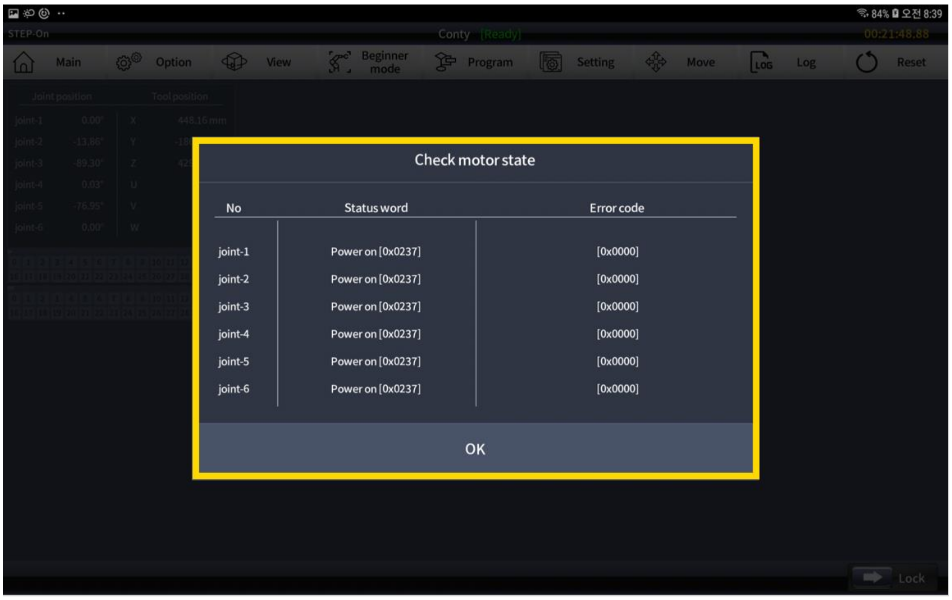
① Touch **Motor Status** in the list of options.



② In the alarm message "**Do you want to check motor status?**" touch **Yes**.



③ As shown below the left column shows the current motor status, and the right column shows the detailed error code, if any.



The error codes imply the following message.

error code	message
0x2310	Over-current occured (rebooting required for restarting)
0x3110	Too high voltage input to the motor (normal: 48V, exceeding 63V)
0x3120	Too low voltage input to the motor (normal: 48V, lower than 41V)
0x3210	Too high voltage input to the driver (normal: 48V, exceeding 62V)
0x3220	Too low voltage input to the driver (normal: 48V, lower than 40V)
0x7310	Overspeed in the driver (automatic recovery)
0xFF10	Encoder battery is discharged (replacement required)
0xFF11	Encoder generates alarm continuously (maintenance required)
0xFF20	Too high voltage input to the driver (normal: 5V, exceeding 5.5V)
0xFF21	Too low voltage input to the driver (normal: 5V, lower than 4V)
0xFF22	Too high voltage input to the driver (normal: 3.3V, exceeding 3.6V)
0xFF23	Too low voltage input to the driver (normal: 3.3V, lower than 3.0V)
0xFF24	Too high voltage in the gate driver (exceeding 13V)
0xFF25	Too low voltage in the gate driver (lower than 9V)
0xFF31	Damaged channel U in the low-side MOSFET
0xFF32	Damaged channel V in the low-side MOSFET
0xFF34	Damaged channel W in the low-side MOSFET
0xFF39	Damaged channel U in the high-side MOSFET
0xFF3A	Damaged channel V in the high-side MOSFET
0xFF3C	Damaged channel W in the high-side MOSFET
0xFF3F	Overcurrent occurred due to damaged MOSFET (maintenance required)

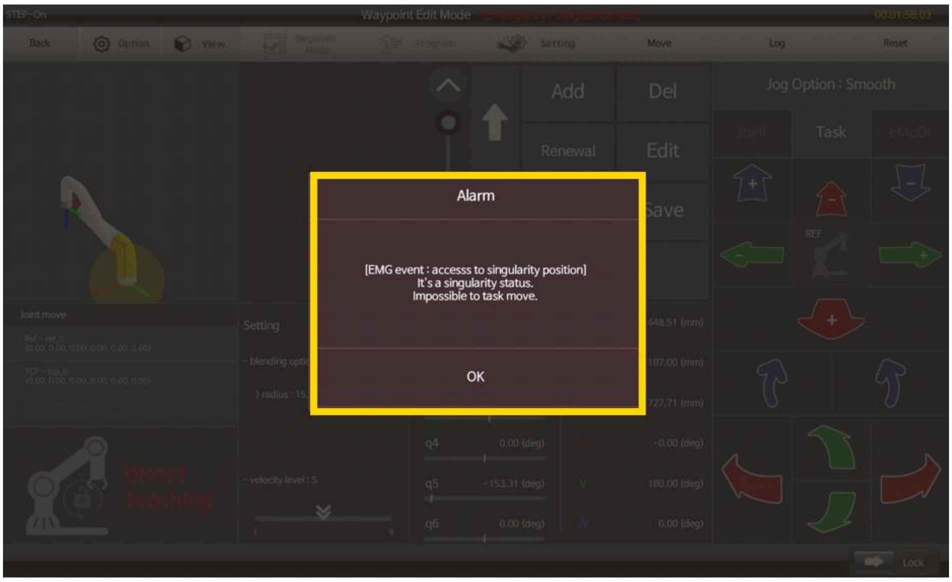
7 Trouble shooting

7.1 Message display mode

Information on major events that occur while the robot is running can be checked by messages displayed on Conty. There are two types of messages showing information: pop-up messages asking for user's confirmation and instant messages disappearing automatically.

Pop-up Messages

It displays the message in the center of the screen until you confirm.



Instant Messages

It displays the message in the center of the screen and disappears automatically after a certain period of time.

7.2 Message Type

The messages are largely classified into the alarm messages displayed upon detection by safety settings during operation, and status messages informing the user of the change of the robot states and the result of command execution performed by the robot.

Alarm Messages

In any occurrence of a situation that violates the safety setting during operation, the robot stops all operations with robot state change from normal to abnormal. Then, a pop-up message is displayed on Conty to inform the user of the current situation. These alarm messages include:

Type	Message	Additional info
Emergency Stop	emergency stopped	
Collision	collision detected	joint positions/torques
Position limit	joint travel limit violated	joint/task position
Velocity limit	joint velocity limit violated	joint position/velocity
Motor State Error	motor error	joint position, motor status
Torque limit	joint torque limit violated	joint positions/torques
Connection lost	EtherCAT connection lost	the number of slave drivers
Position error	next joint position calculation error	joint positions
Endtool emergency	emergency requested from the endtool	
Singular	reached singularity position	
Over current	over-current occurred	joint positions,
Access to position limit	approaching joint travel limit	joint/task position
Access to velocity limit	approaching joint velocity limit	joint position/velocity
Access to singularity position	approaching singular regions	
Access to torque limit	approaching joint torque limit	joint positions/torques
Motor firmware error	motor state error	joint positions, error code
Over heated	over-temperature occurred	joint positions, temperature
Fail to read robot spec	failed to read robot spec file	file type
Reset failed	reset command failed	
Reset refused	refuse to reset command	cause

Status Messages

Status messages are displayed either as a pop-up message or an instant message depending on the robot status or the execution result of the command. These status messages include:

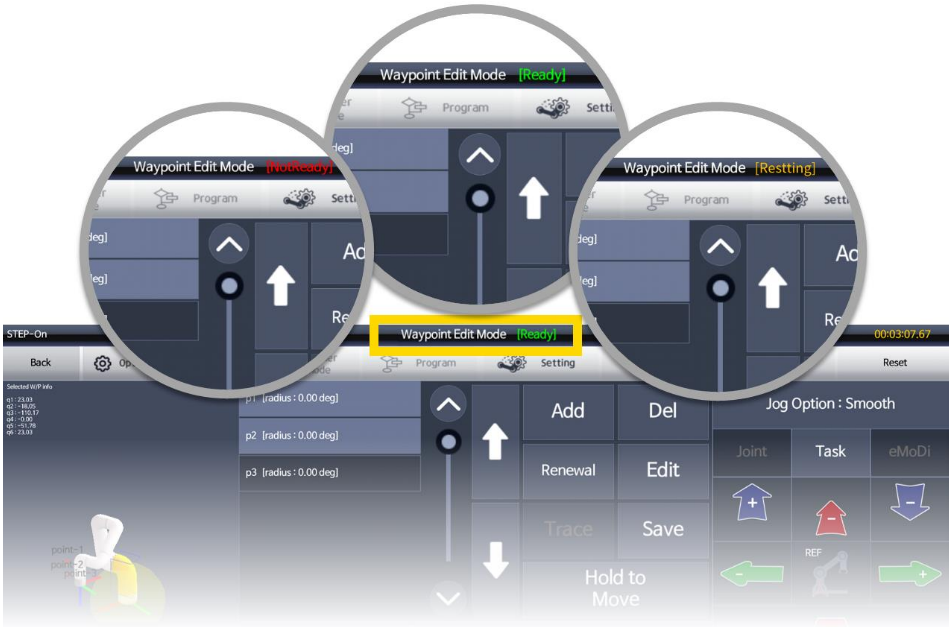
type	message	message mode
Soft Reset	soft reset requested	instant message
Hard Reset	hard reset detected	instant message
Soft reset done	soft reset done	instant message
Hard reset done	hard reset done (system restarted)	instant message
Configuraiton update failed	configuration update failed	pop-up message
Move finished	motion completed	instant message
Move canceled	motion canceled	pop-up message
Move failed	motion failed to start	pop-up message
Emergency stopped	motion stopped due to emergency	pop-up message
Singular stopped	motion stopped due to singularity	pop-up message
Program executing failed	program execution failed	pop-up message

7.3 Recovery

When an alarm message is generated during operation, the robot changes its state from normal to abnormal, and it stops all operations. Also, if the cause of the alarm is not removed, the robot will not perform any other commands. Therefore, in order to restart the robot properly, the user must check the cause of the alarm, remove, and repair it by proper procedures.

Robot Status

Current robot status can be retrieved in real time from Conty's status bar and can be one of three status: normal, abnormal, and recovery, as shown below.



- **Normal**

  All functions of the robot are readily available and Conty displays **[Ready]** in green in the status bar.

- **Abnormal**

  The robot will not be able to operate and Conty will display **[Emergency: Alarm Type]** in red in the status bar. Proper recovery procedure is required to operate the robot normally again.

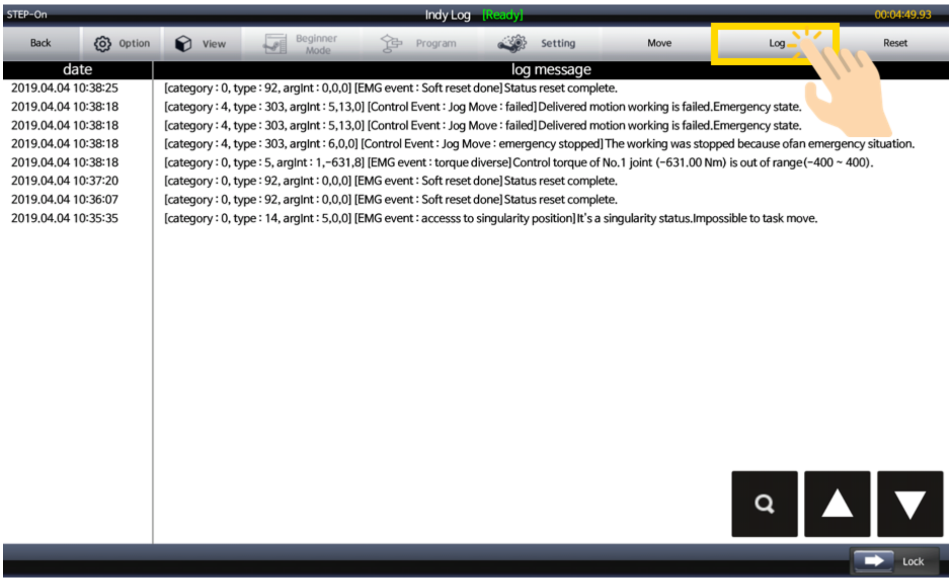
- **Recovery**

  Conty displays **[Resetting]** in magenta in the status bar while recovery procedure is in progress. In the recovery status, any operation of the robot on Conti is not available.

Logging

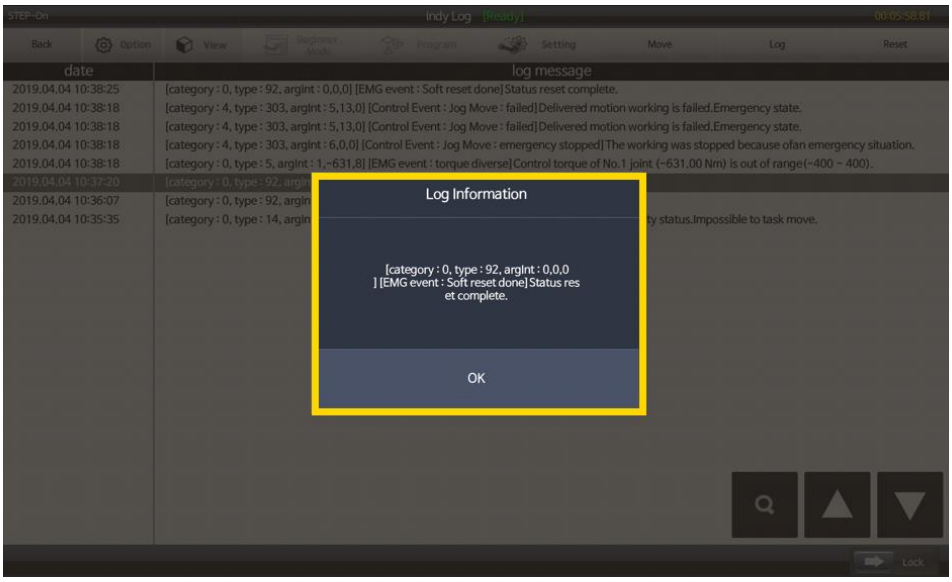
All messages generated during operation of the robot can be checked through the logging function. Here's how to check your logs:

① Touch **Log** in the top menu bar.



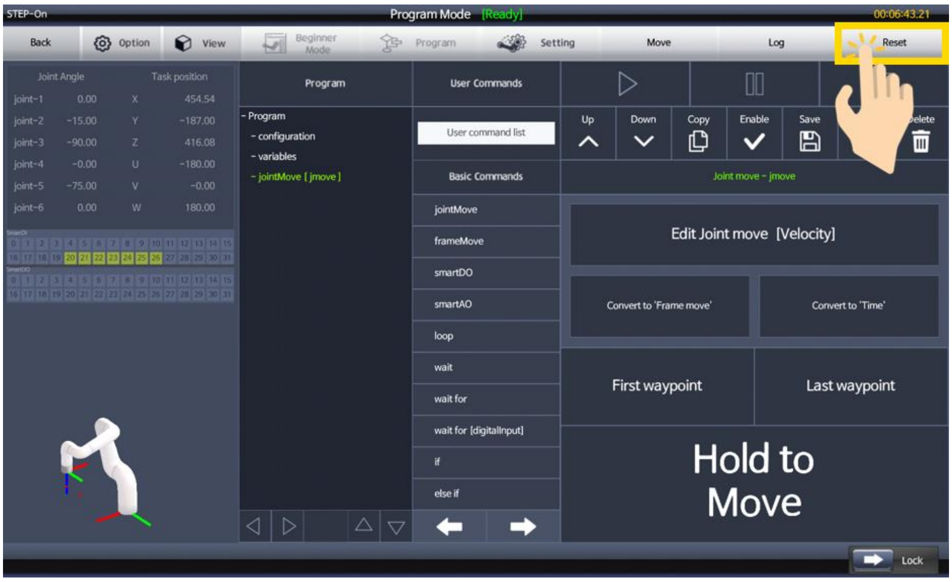
② Log information is recorded in chronological order. Use the △ / ▽ buttons to browse the page to find the log that occurred at a specific time.

③ Select a log information and touch **Magnifier button** to see detailed information.



Reset

Reset function is a procedural function for returning the robot status from abnormal to normal. Reset is carried out only in abnormal state and it is executed by pressing **Reset** located on the right side of the top menu. This reset function is performed by selecting automatically one of the following two methods according to the alarm type.



- **Soft reset**

  After five to ten seconds around without any change, the robot state will be restored to normal state by software reset.

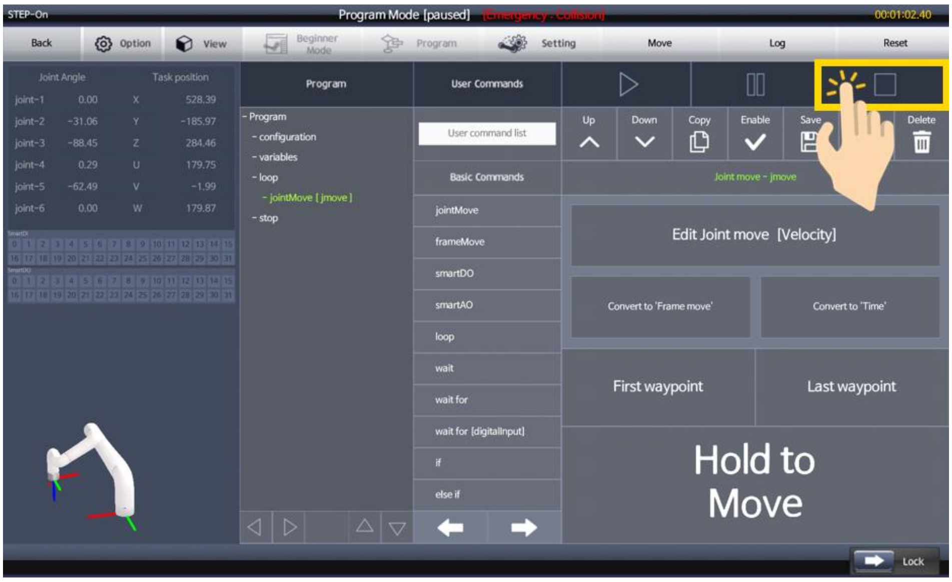
- **Hard reset**

  The motor power and the endtool indicator are turned off and restarted while the control box power remains on. It may take about two to three minutes. As the endtool indicator flashes red, the motor power is sequentially supplied and the brakes are released at the same time and the motor is restored to the normal state.

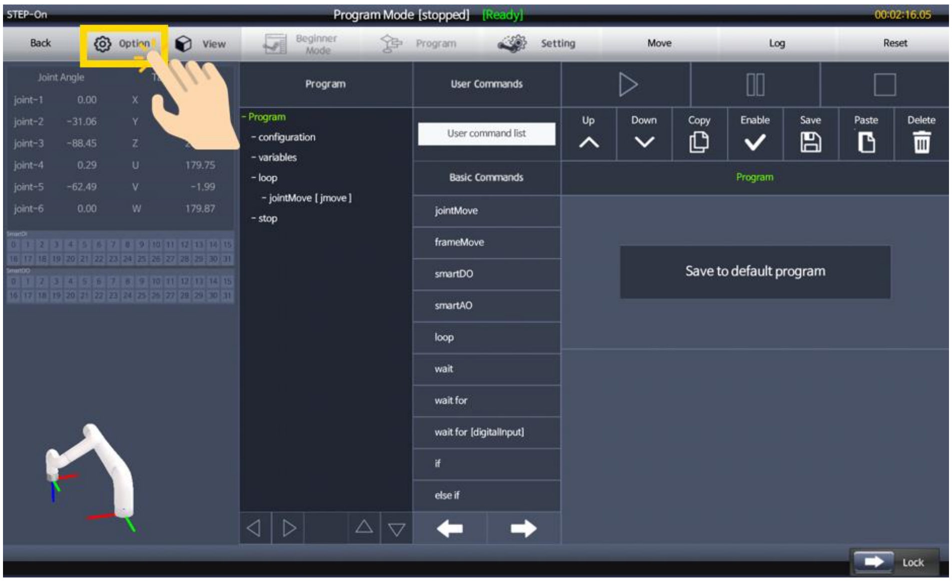
Reboot

Reboot is a function that terminates and restarts the system control software necessary for running the robot. This process is the same as a hard reset. If the robot cannot be restored to normal state even though the reset function has been executed, you can enforce the robot to reboot in the following order.

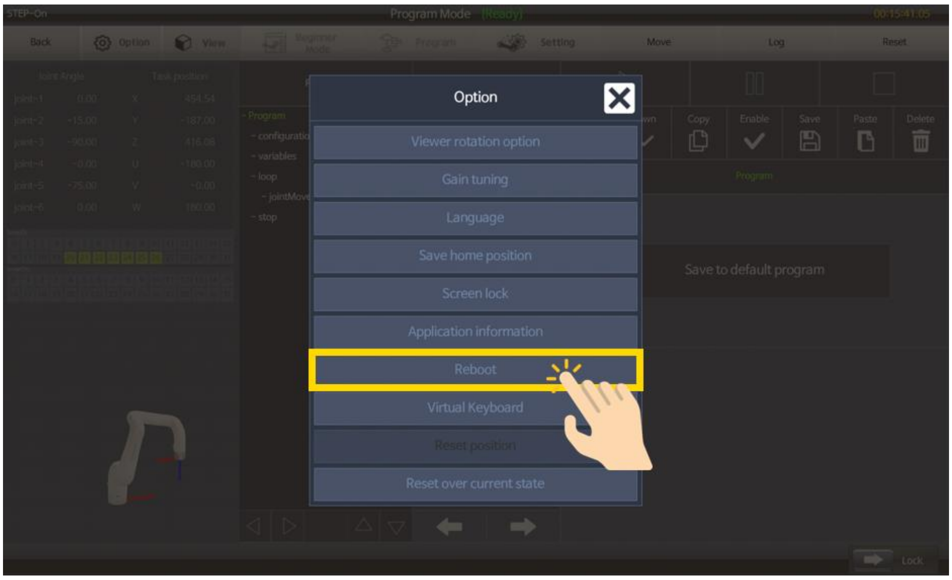
① Stop the program that is running.



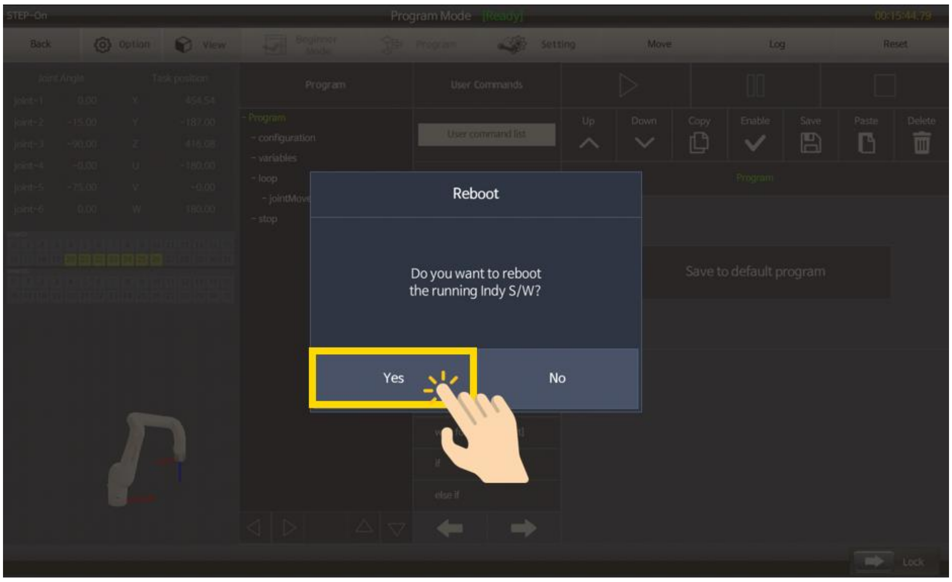
② Touch **Option** in the top menu bar.



③ Select **Reboot** in the option list.



④ Upon the alarm message "**Do you want to reboot the running Indy S/W?**", touch **Yes**.



⑤ The endtool indicator turns off and the system initiates rebooting. Then, Conty disconnects communication and moves automatically to the start screen.

⑥ After two to three minutes, the endtool indicator will be flashing red. Then, it turns to red or green depending on the startup mode setting, which indicates that the robot status is restored.

⑦ Connect the robot again from the Conty start screen

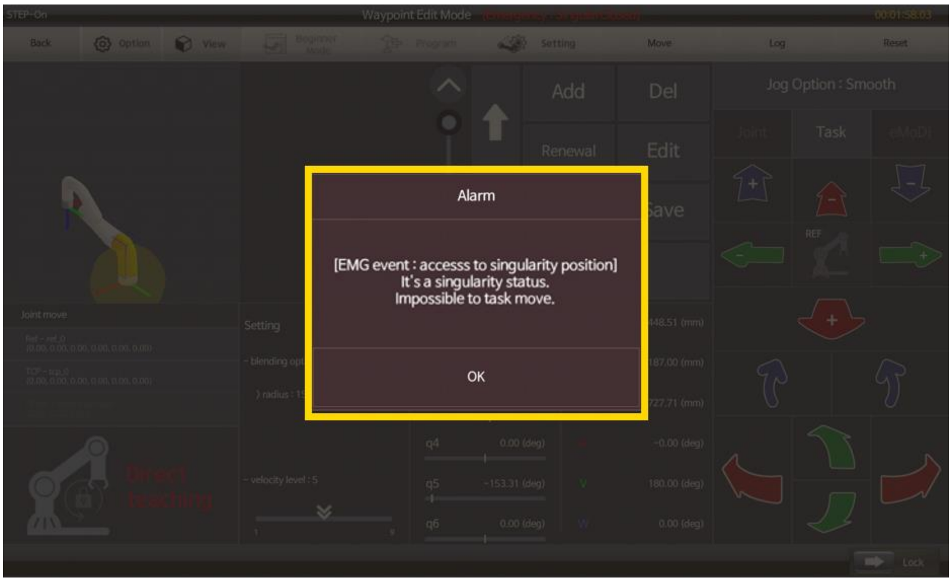
7.4 Troubleshooting

There may be situations where additional procedures are needed for recovery from a major alarm, and one still cannot operate the robot after proper reset or reboot. Then you have to apply the following troubleshooting case by case.

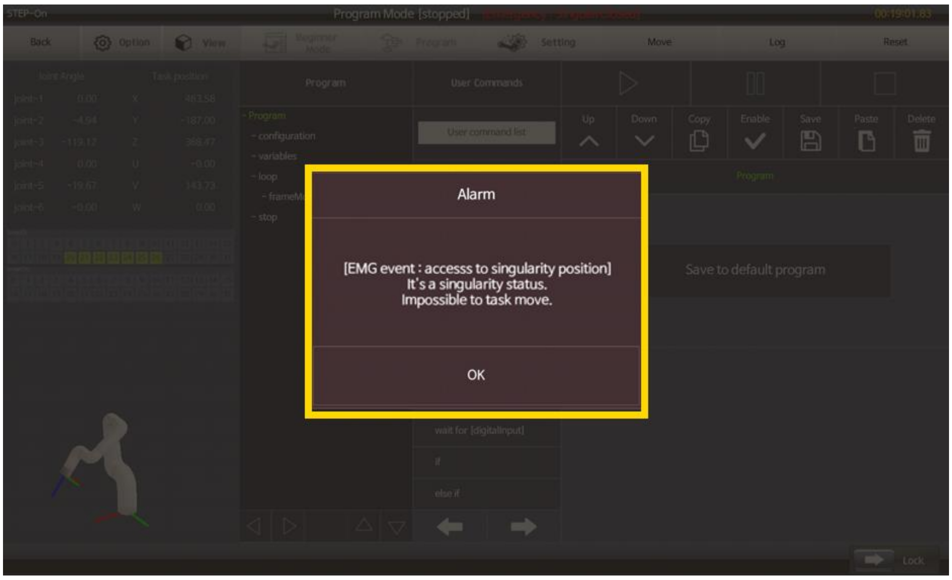
Singularity

This problem occurs when approaching singularity region during robot operation using task jog by a user or task move in program.

- **Occurrence of singularity while using task jog mode**



- **Occurrence of singularity during program execution in task move**



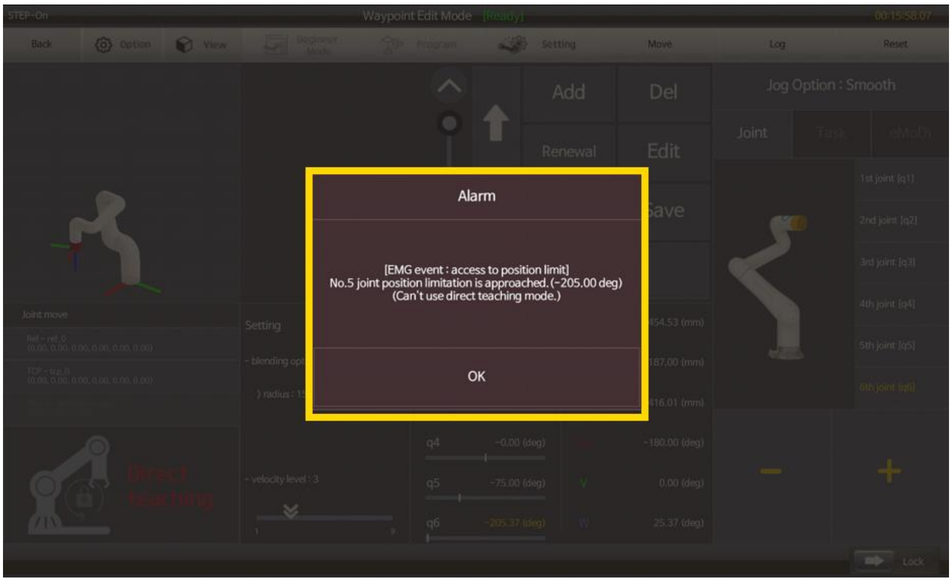
If the robot is stopped due to singularity, it can be recovered to normal by using recovery function. However, there are some cases where the robot cannot escape from the singularity region or it stops repeatedly due to the same alarm by attempting to move toward the singularity region over and over.

In these cases, the robot must be moved away from the vicinity of the singularity region by direct teaching or joint jog. If singularity issue happened due to the program, the frameMove causing this alarm should be changed to jointMove, or some waypoints can be added to detour the singularity region.

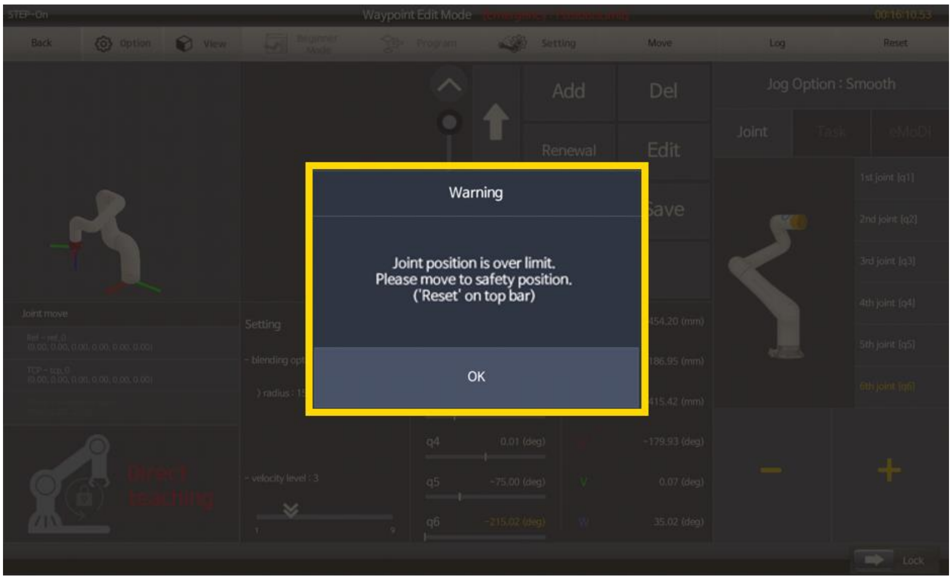
Joint Travel Limit

This is a problem that occurs when direct teaching or jog operation drives the robot beyond the allowable movement range of each joint.

Note that in direct teaching mode the allowed joint travel range is shrunk by 10 degrees at both boundaries of the actual physical travel range. For example, as the actual permissible range of motion for joint 6 is -215 degree to +215degree, it is limited to -205 degree to +205 degree in direct teaching mode. Upon exceeding this range during operation, direct teaching mode is automatically deactivated with the following alarm message and the robot stops. Even in this case, the user can still operate the robot using jog function.



In jog mode, if the user drives the robot out of the allowable range during operation, the robot status changes to abnormal with the following alarm message.



Now you need to apply the recovery function to restore the state of the robot to normal. Touch **Reset** in the upper right corner.

Then, those joints that are out of the physical joint travel range return automatically toward inside the feasible range with two degree margin. Upon normal completion of the automatic return the following instant message is displayed and the robot state gets restored normal.

Jamming

When the robot collides against the surrounding during operation, the robot tries to stop its operation immediately after the collision detection function. In spite of all this happening in really short time, the robot may have moved more due to the inertia of the robot and the finite time necessary for deceleration, and the final stopped position may be different from the initial collision position. Jamming between the robot and its surrounding causes a problem for this reason.

If there is a chance of secondary damage when the robot is restarted, e.g. the environment around the robot is very narrow, you had better operate the robot by direct teaching, or if this cannot be done due to any reason, you have to exert force by yourself to move the robot manually after releasing the motor power and joint brake, instead of using jog move or program move. In presence of significant jamming the robot is supposed to retract automatically due to the reaction forces caused by the stiffness of the jammed objects. Refer to **Section 4.2 Basic Operations** and **Section 6.1 Robot Settings** for details on how to operate the robot using direct teaching and how to manually release the motor power and brakes.

Failure to Recovery to Normal State

Most problems that arise during operation of the robot can be recovered automatically by the recovery function. Upon completion of the automatic recovery, an instant message and the status bar at the top will show the results of the recovery. If automatic recovery fails, retry the recovery function again. If you cannot recover the robot to normal even after repeated recovery attempts, shut down the control box and Conty and restart them. If all these attempts failed to recover the robot to normal, please apply for diagnosis and repair by our maintenance service procedure. For details on how to apply, refer to **Section 10.5 Service Guide** of this manual.

The following additional information provided together with the service request enables faster diagnosis and repair.

- **Conty message captures**
  Conty connected to the robot is saving every message occurred during operation on the log screen. Please capture this screen and send the image. For instructions on how to capture the screen of your tablet, refer to the Tablet PC Manufacturer's Guide.
- **Control box log files**
  All event messages and control data generated during robot operation are automatically saved in the control box storage device as log files. Therefore, if it is hard to understand the problem with only the log screen of Conty, you need to send the following log files. For more information on importing log files, see **Section 8.6 Managing Log Files**.

  ① Log_mm_dd.txt
  ② EventLog_mm_dd.txt
  ③ EventBuffLog_mm_dd_hh_mm_ss.csv

  Here, the suffixes after the file name mean months (mm), days (dd), hours (hh), minutes (mm), and seconds (ss). This allows you to identify the instant creating the log file.

8 Maintenance and Repair

Continuous maintenance is required in order to use all the functions of the robot normally and maintain the optimal performance for a long period of time. Proper maintenance helps sustain product performance and reliability, reduces maintenance costs, and extends the product life.

Maintenance must be carried out in accordance with all the safety instructions delineated in this manual and be sure to check the latest operation manual in the Neuromeka website https://www.neuromeka.com/. Furthermore, please contact the manufacturer for repair because it is handled directly by the manufacturer. Never attempt to repair or disassemble the product yourself.

8.1 Inspection Items and Intervals

Inspection items and inspection intervals of the product should be decided with enough consideration on the operational environment, e.g. loading condition. Inspection is usually carried out on a regular basis such as routine inspection, quarterly inspection, and periodical inspection. However, inspections should be made more frequently in the following environments: 1) with very dusty and humid condition; 2) where there is a high probability of accidents due to vibration or heat; 3) with longer operational hours with higher frequency or with severe loads.

Type	Interval	Objective	Inspection items	
Routine inspection	routinary	· Operational environment and alarm occurrence · anomalies	environment	dust, gas
				water, other liquids
				temperature, humidity
			robot arm	vibration, noise
				abnormal heat
				abnormal movement
Quarterly inspection	One or more times each quarter	· exterior and mounting condition	robot arm	appearance
			control box	cable appearance
				connector appearance
				connection sate
				cooling fan noise, vibration
Periodic inspection	One or more times every six months	· cleaning · checking various measurement values · testing various functions	robot arm	interior inspection
				function inspection
			control box	interior cleaning
				filter cleaning
				measurement of input power voltage
				measurement of insulation resistance
Update	Upon occurrence of events	· product update	software	IndyS/W
				Conty application
			documents	various user manuals
				Website notices

8.2 Routine Inspection

Routine inspections usually consist of visual and auditory inspections to check any change from normal states.

Inspection Interval

Routinary

Inspection Method

- **Environment**

Check for variations in dust, gas, rain, room temperature, humidity, etc.

Inspection item	Inspection method
dust, water, other liquids	Check whether there is dust and water around.
gas	Check whether you smell something different than usual.
temperature, humidity	Use a thermometer and a hygrometer to check the ambient temperature and humidity. Appropriate temperature is within 0 to 40 ℃.

- **Robot arm**

Inspection item	Inspection method
vibration, noise	While repeating some motions, check whether noise or vibration occurs in the motor or the reducer.
abnormal heat	Check if high temperature of 80 ° C or more occurs around the motor.
abnormal movement	After moving the robot to the zero position, check whether the zero tick at each joint to see if they are aligned.
	Check whether the robot arm or tool falls excessively down when the power is turned off.

8.3 Quarterly Inspection

Quarterly inspections deal with inspection items that can be checked even during robot operation, and that must be inspected after by turning off the power. Be sure to disconnect the power cable from the power socket when powering off is necessary.

Inspection Interval

One or more times quarterly

Inspection Method

- **Robot arm**

  Check the exterior appearance of the robot and keep the joint connection gaps with frequent movements especially clean. Also, please check whether fastening condition of every part is not loose due to the vibration continuously generated by the robot operation.

Inspection item	Inspection method
exterior inspection	Check for contaminants such as dirt and dust.
	Make sure that there is no foreign material at each joint.
	Make sure that each joint is spaced in parallel, or at regular gap.
	Make sure that the bolts exposed outside or the bolts securing the base and the tool are not loose.

- **Control box**

  Check the exterior appearance of the control box and the appearance of the connectors and the cables connected to the control box. If necessary, check the control box for noise or vibration.

Inspection item	Inspection method
cable appearance	Make sure that the wire sheath is not peeled off.
connector appearance	Check the connector for cracks or damage.
connection status	Make sure that no connectors are loose or disconnected.
	Make sure that the cable is not disconnected from every connector.
noise, vibration	Check for noise or vibration around the cooling fan.

8.4 Periodic Inspection

In periodic inspection, inspections are made for the items that cannot be inspected during operation or requires a lot of time to check, and it should be made even when the operational state is good. Periodic inspection is mainly focused on cleaning parts and visual inspection of the components, but some items require specialized knowledge. In case you need such inspections, please contact the manufacturer.

Inspection Interval

Once per six months or year

Inspection Method

- **Robot arm**

  Check the interior state as well as the exterior appearance of the robot. As disassembling the robot arm for some parts is required, consult with the manufacturer.

Inspection item	Inspection method
interior	After disassembling the joint cover, check the tightness of screws.
	Measure the encoder battery voltage after disassembling the joint cover. Replacement is required if the voltage is less than 3.2V.
function	Check whether the functions provided by Conty are all working well.
	Make sure that the robot is moving exactly to the position you specified and that there is no vibration during movement.

- **Control box**

  If dust accumulates inside the control box, overheating due to non-smooth air circulation or static electricity may cause the product to malfunction or fail. Therefore, check the inside of the control box and the air circulation system to remove dust. Also, make sure that the cables connected inside are properly connected. When checking the control box, be sure to turn off the power and disconnect the power cable completely from the power socket before proceeding.

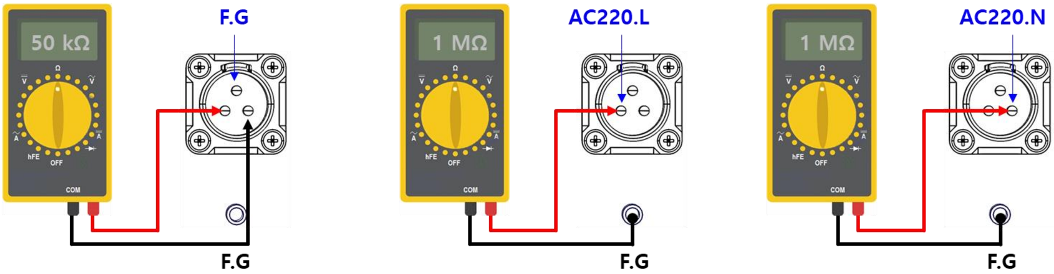
Inspection item	Inspection method
interior cleaning	Make sure that there is no dust accumulated inside, and use a vacuum cleaner to remove the dust carefully.
filter cleaning	Make sure that dust is not accumulated on the filter, and use a vacuum cleaner to remove the dust carefully.
filter replacement	Check the filter for damage.
	Check the period of use. For the replacement cycle, refer to **Section 8.6 Parts Replacement Cycle**.
input voltage measurement	Use a multimeter to measure the power supplied from the power distribution board. The normal range is within 100 to 240 VAC.
insulation resistance measurement	Refer to **Section 8.5 How to Measure Insulation Resistance**.

8.5 How to Measure Insulation Resistance

A multimeter is required to measure insulation resistance. When checking, turn off the power and disconnect the power cable completely from the power socket. Make a report after measurement to check the variation in resistance value at each inspection.

Measuring Insulation Resistance in AC Input Stage

Measure the AC input terminal with the multimeter as follows.

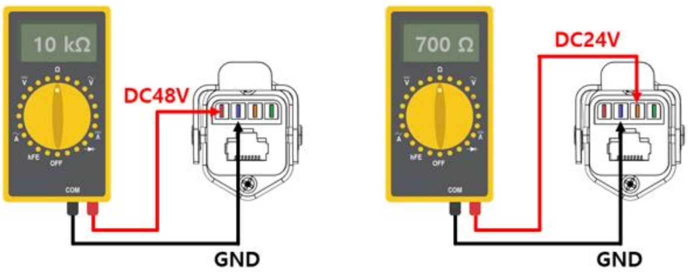


The normal range is as follows.

Inspection item	Connection terminal	Normal value
AC power input	AC220.L – AC220.N	50 kΩ or larger
	AC220.L – F.G.	1 MΩ or larger
	AC220.N – F.G.	1 MΩ or larger

Measuring Insulation Resistance in DC Output Stage

Measure the DC output terminal with a multimeter as follows.



The normal range is as follows.

Inspection item	Connection terminal	Normal value
DC power output	DC48V - GND	10 kΩ or larger
	DC24V - GND	700 Ω or larger

8.6 Part Replacement Period

In order to use the product safely for a long period of time, it is recommended that the following parts be replaced within a specified replacement period. The life of each part may vary depending on operating environment and conditions.

Category	Part name	Normal period		
		2 year	7 year	10 year
power supply	SMPS		●	
power filter	noise filter			●
fan	control box cooling fan	●		
battery	encoder battery	●		
others	relay			●
	circuit breaker			●
	electric contactor			●

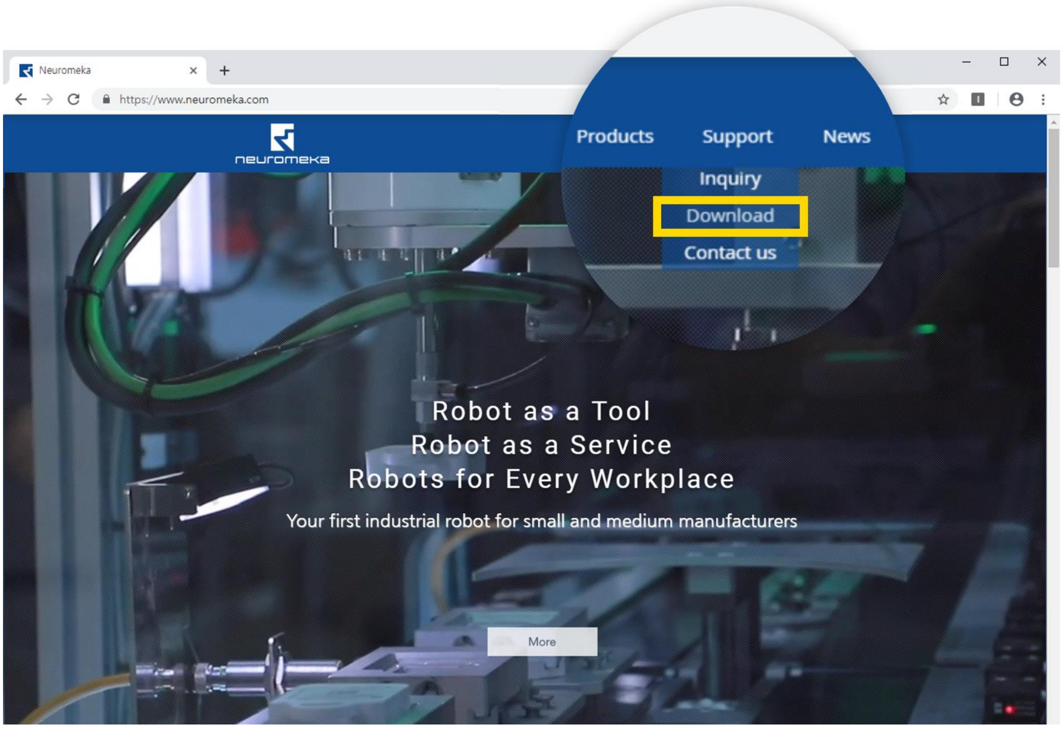
8.7 Update

Latest Software

The latest software can be found on the support page of the Neuromeka website (https://www.neuromeka.com/). Use Conty to compare with the current version. Refer to **Section 6.2 Options** for software version checking using Conty.

Latest Documents

Customer support page at the Neuromeka website (https://www.neuromeka.com/) always provides up-to-date information, and you can download the updated manuals and other documents.



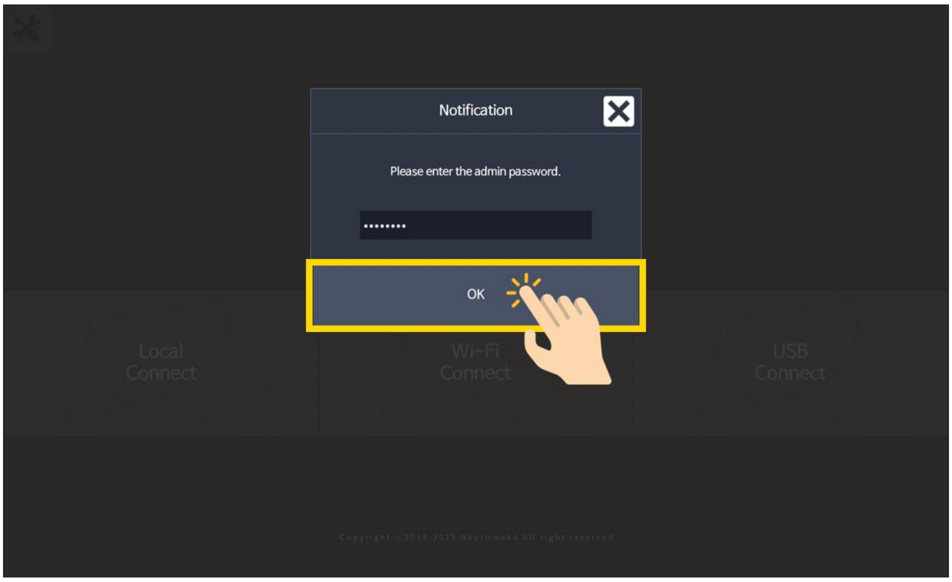
8.8 Managing Log Files

The Neuromeka's robot automatically records all event messages and control data generated during operation, and saves them as log files in the control box storage. These log files will be automatically deleted from the oldest log files when they exceed the allocated capacity of the control box's storage. Therefore, you may need to use Conty to copy the log files to an external storage device or delete them if unnecessary. Here's how to copy and delete log files.

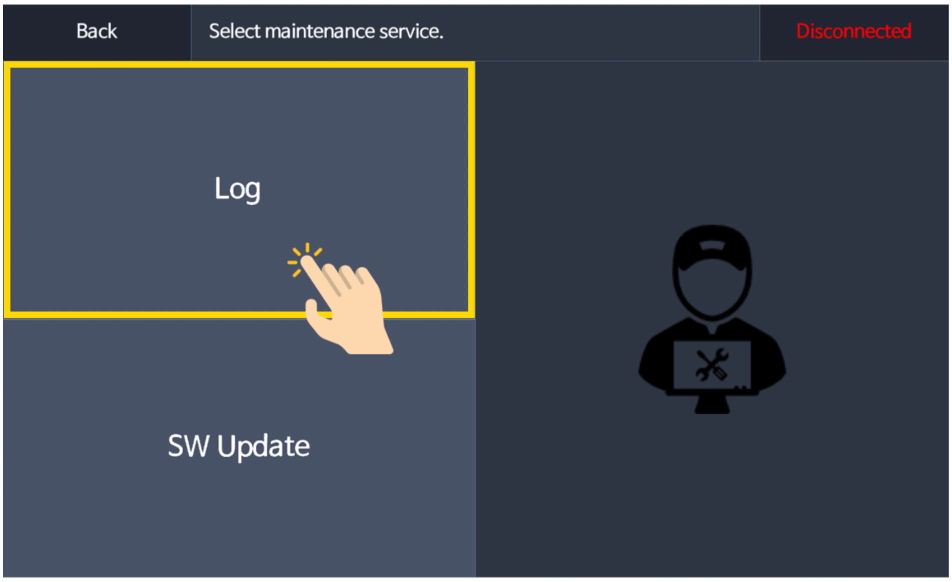
① Tap the upper left corner of Conty start screen five times consecutively.

② An instant message "**Maintenance mode is enabled.**" is displayed in the center of the screen, and the maintenance button that was hidden appears at the corner.

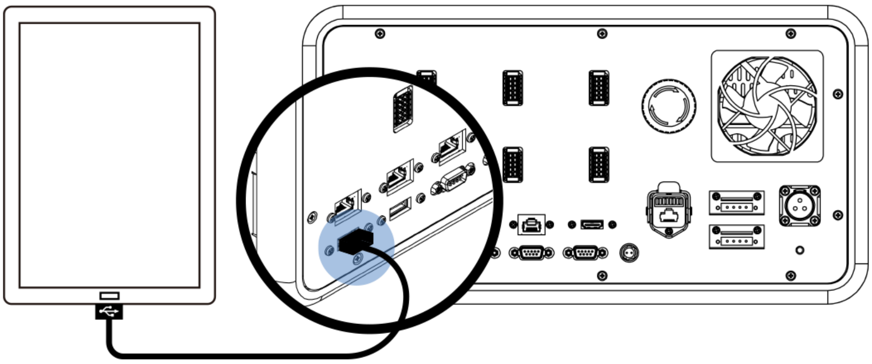
③ Touching the maintenance button, the pop-up dialog requiring password input appears as follows. Enter the password provided by the manufacturer in purchasing and touch **OK**.



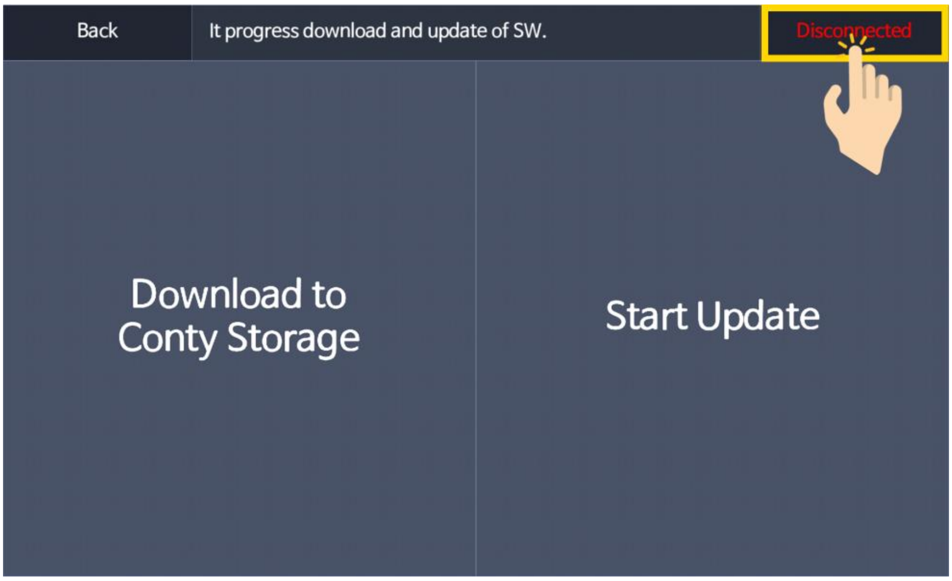
④ On the next Maintenance Service screen, touch **Log**.



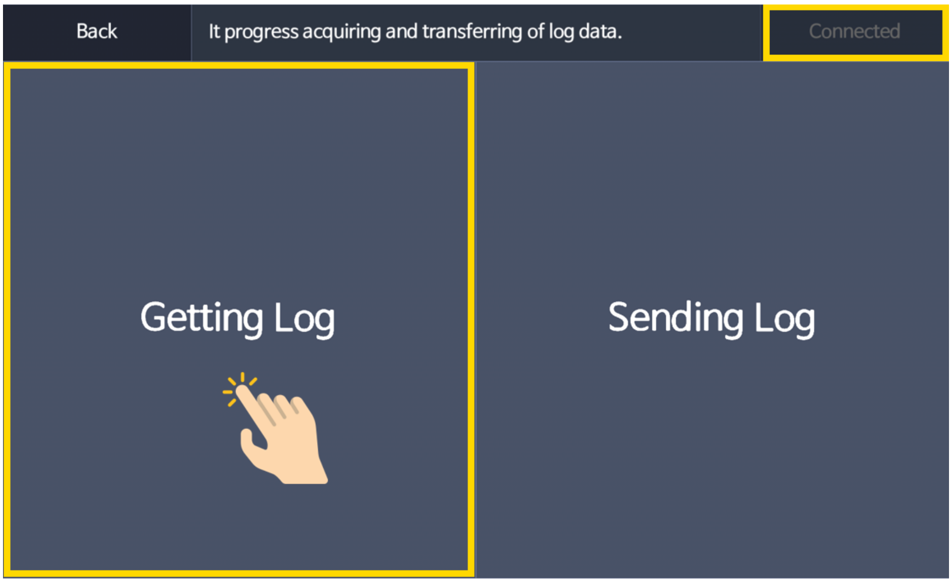
⑤ Connect the control box to the Conty tablet with a USB cable.



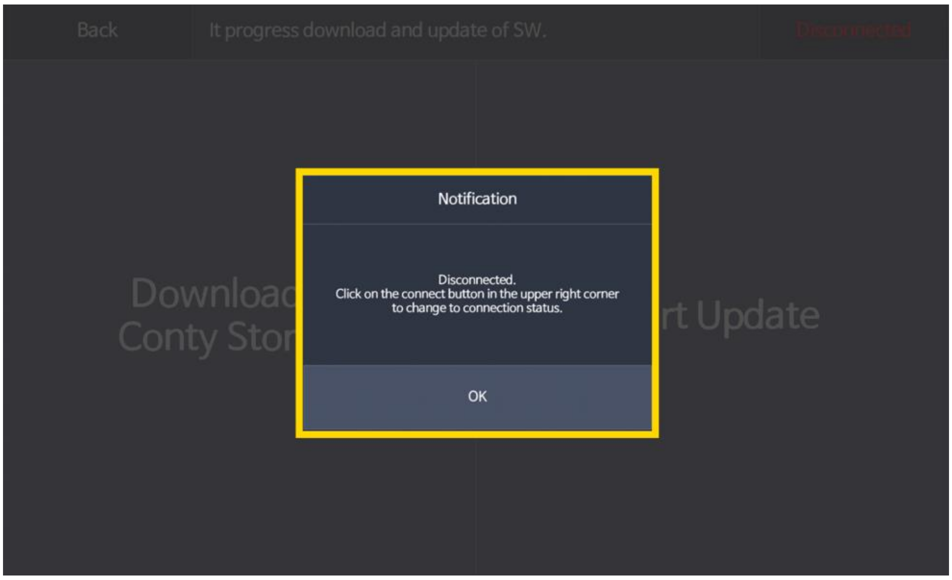
⑥ Touch **Disconnected** in the top right corner to establish connection.



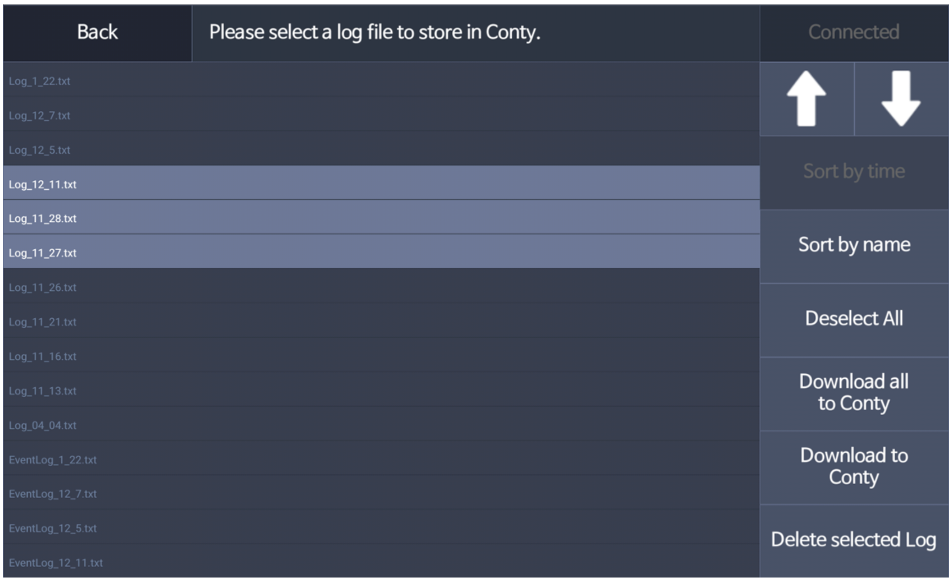
⑦ If the communication between Conty and the control box is properly connected, the upper right display changes from **Disconnected** to **Connected**. Touch **Getting Log** on the left.



In case that Conty and the control box is not normally connected, the following alarm message will be generated. Check the USB cable connection and try again.

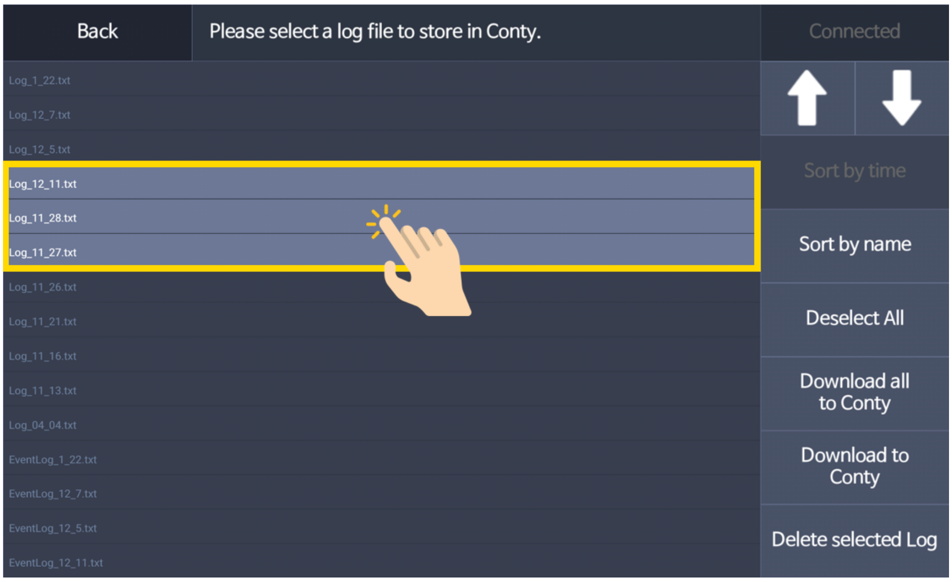


⑧ The log files stored in the control box storage can be browsed in Conty as follows and can be deleted or copied to the storage on the tablet.



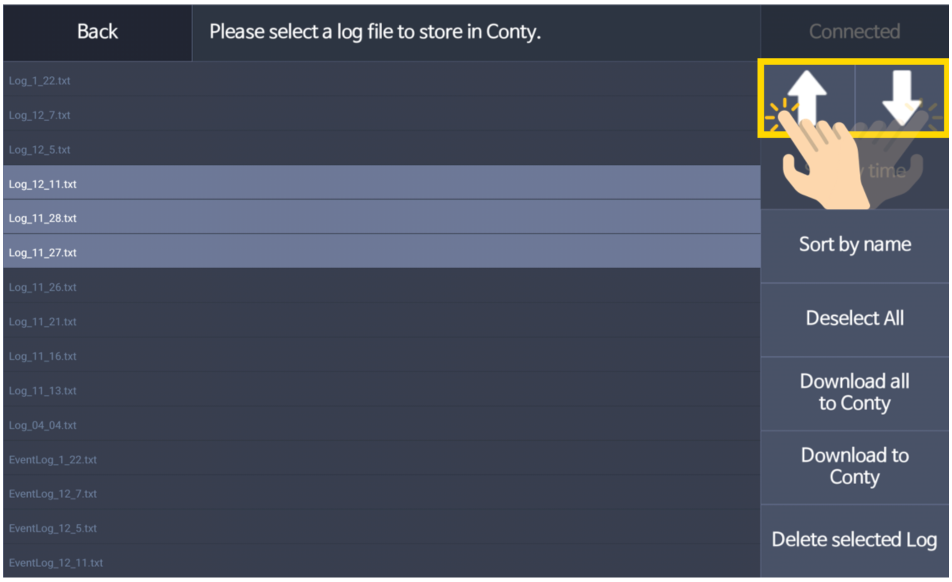
- **Log file list**

  Conty displays information on all the log files. Touch a log file to select it, and touch it again to deselect it. Multiple selection is also supported.



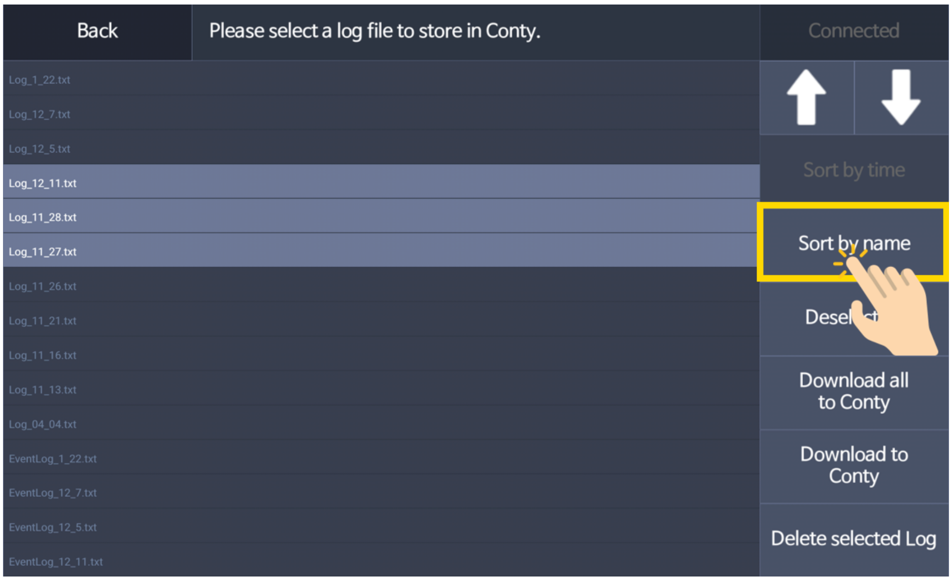
- **Log page browse**

  Touch the upward or downward arrow in the top right corner to browse the previous or the next log page.



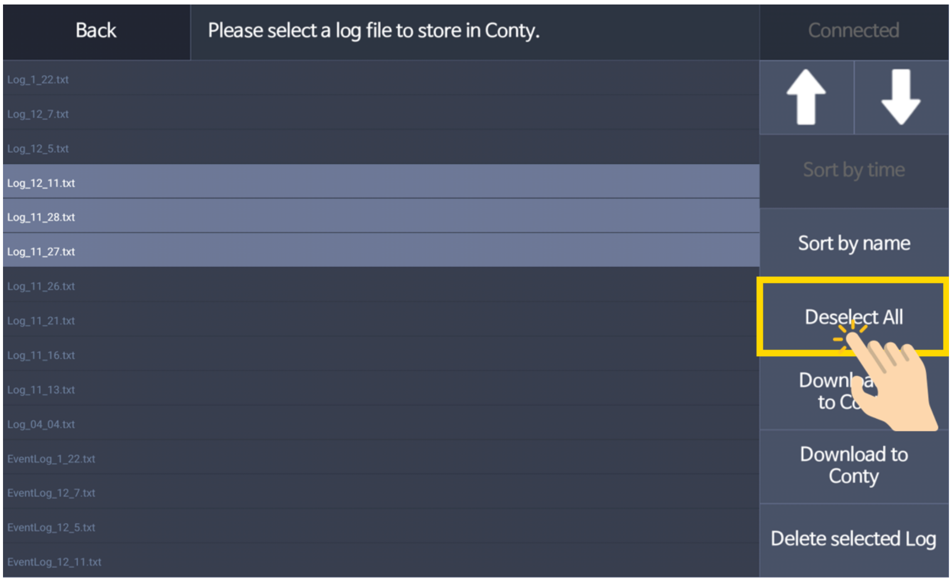
- **Sort by name**

  All log files are sorted by names, that is in alphabetical order.



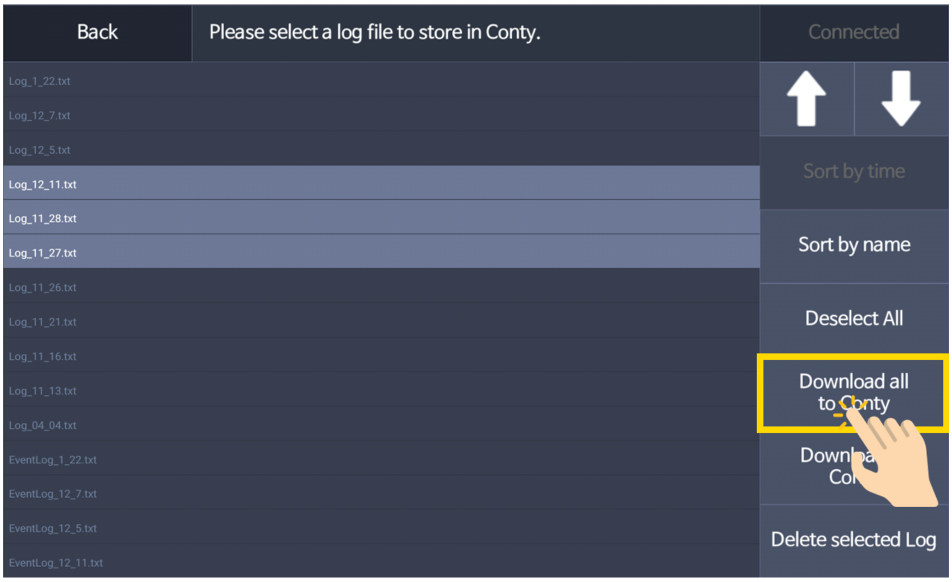
- **Deselect All**

  All selected log files can be deselected.



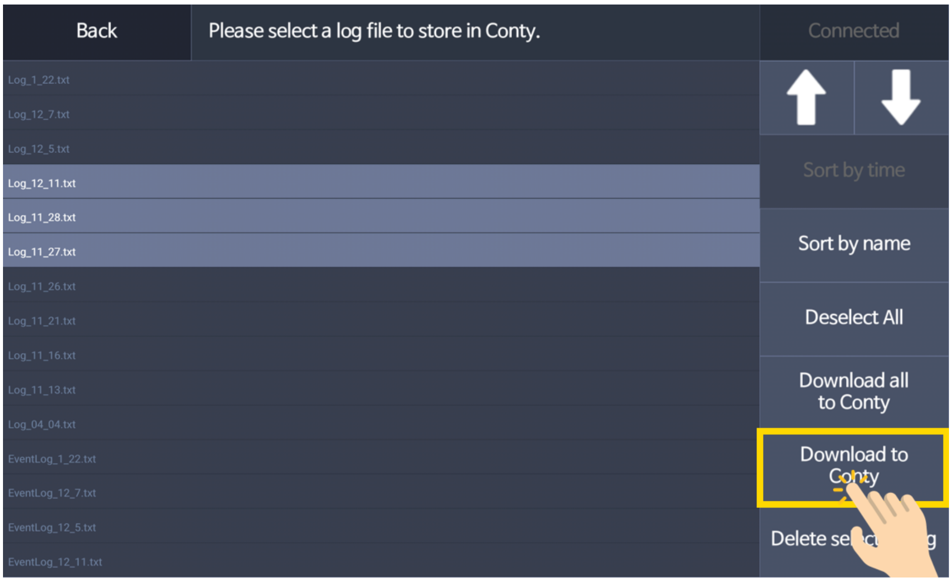
- **Download all to Conty**

  One can copy all the log files to the tablet's storage. The storage folder in the tablet is Tablet ▶ Conty ▶ log.



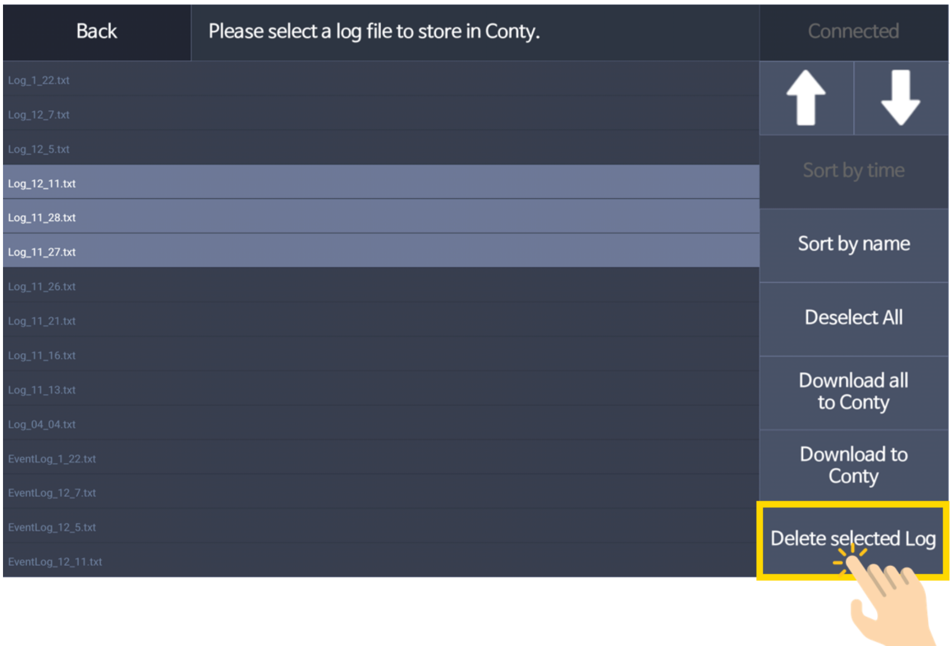
- **Download to Conty**

  Only the selected log files are copied to the tablet's storage. They are copied into the folder on the table, i.e. Tablet ▶ Conty ▶ log.



- **Delete selected Log**

  It deletes all the selected log files from the control box storage.




Caution

Caution

The log files are permanently deleted from the control box storage. Please be careful in using it because the deleted files cannot be recovered.

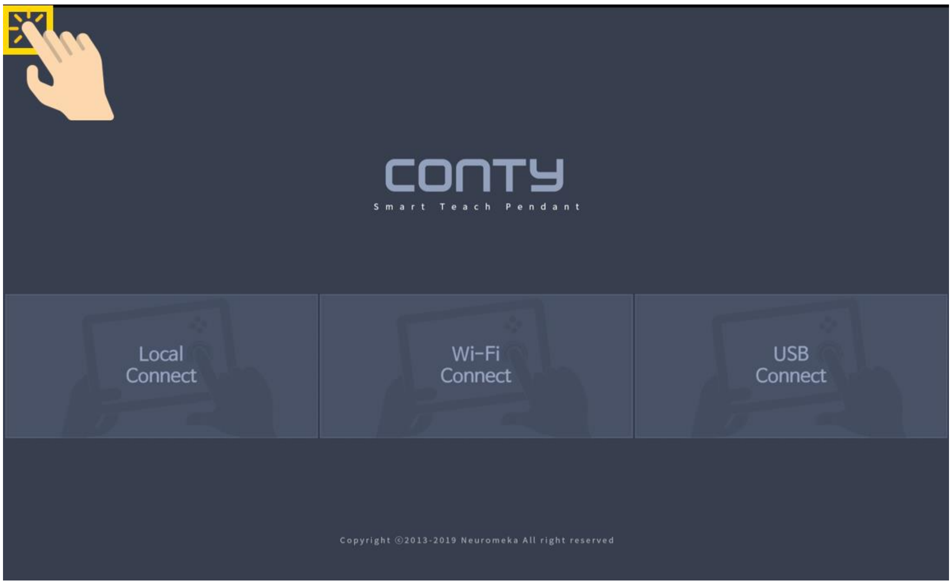
8.9 Transferring Log Files

The log files copied to the log folder of Conty tablet can be transferred to our service team more easily if you make use of Conty's log transfer function. Note that the maximum size of the log files that can be transferred is 20 MB, and this function can be used only in an environment with wireless internet.

To use the log transfer, follow the following steps.

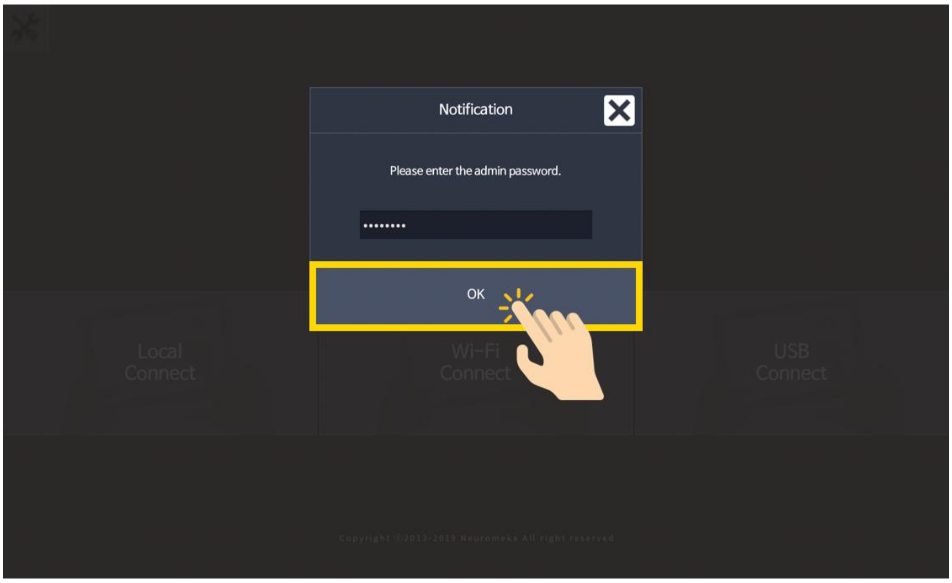
① Connect your tablet to Wi-Fi.

② On the Conty's start screen, tap the upper left corner five times consecutively as follows.

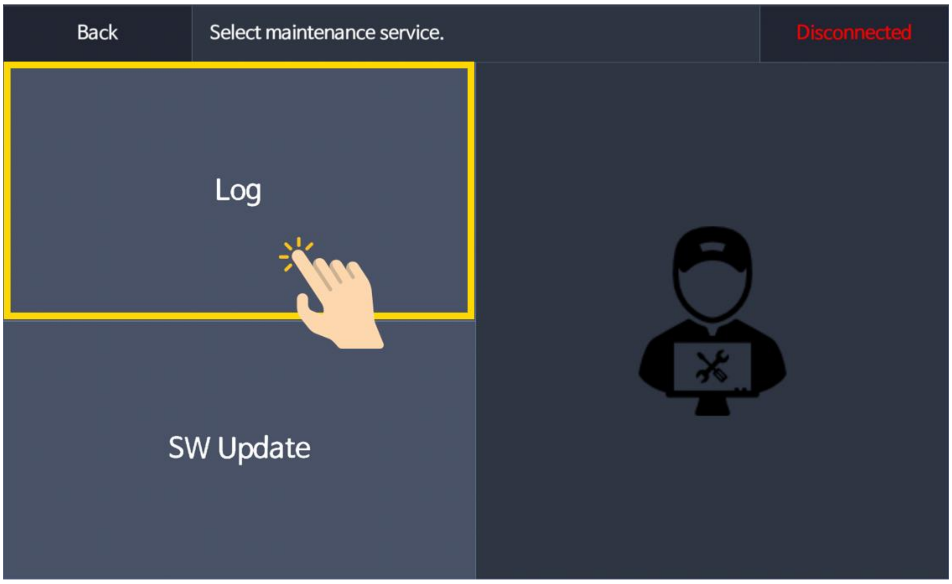


③ An instant message "**Maintenance mode is enabled.**" is displayed in the center of the screen, and the maintenance button that was hidden appears at the corner.

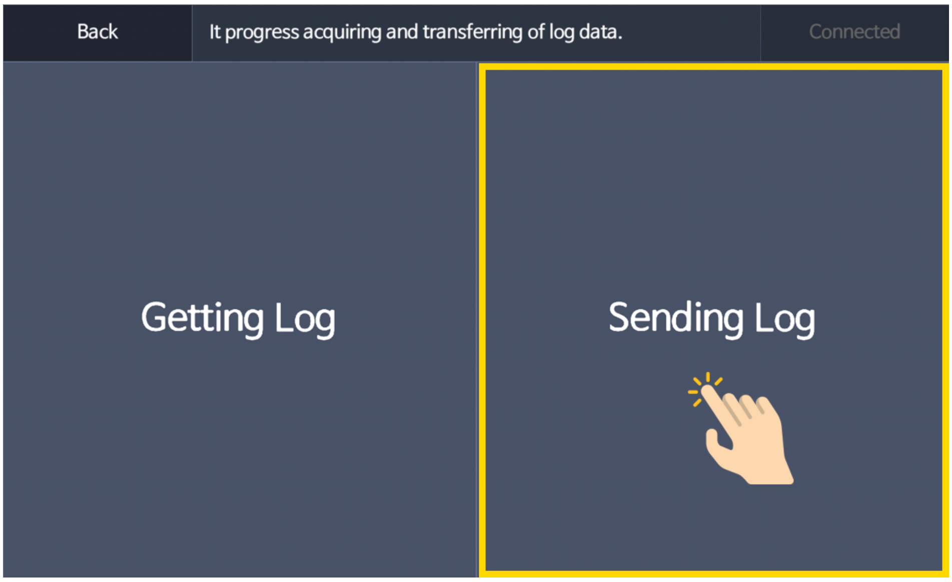
④ Touching the maintenance button, the pop-up dialog requiring password input appears as follows. Enter the password provided by the manufacturer in purchasing and touch **OK**.



⑤ On the next Maintenance Service screen, touch **Log**.

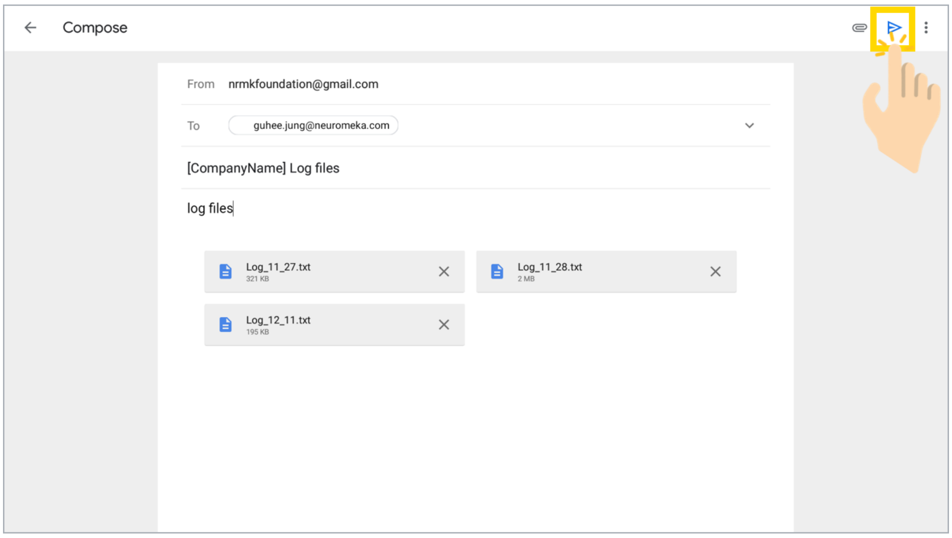


⑥ Touch **Sending Log**.



⑦ The log files copied to the tablet's storage are displayed. Select the log files you want to transfer and touch **Send** at the bottom right. Multiple selection is supported.

⑧ The screen will automatically move from Conty to Google email service. The selected log files are automatically attached to the email. After completing the email with proper contact information, including your e-mail address and specific inquiries for support, the user should touch **Send** in the top right corner of Google email service.



9 Certification

9.1 Machinery Directive

TÜV NORD

Certificate
of conformity with the following
European Directives

Registered No.:
K11578/M18

Machinery Directive 2006/42/EC

Reference of applicant	Date of application	File reference	Test report No.	Date of issue
-	01.08.2018	KP-18-440	K10995/M18	10.08.2018

This is to certify that the following products comply to the essential requirements (Annex 1) of the above mentioned European Directive and the following standards, taking into account the German national deviations:

Product: Collaborative Robot

Type designation: Indy7

Applicant: NEUROMEKA
5th Floor, 859, Eonju-ro, Gangnam-gu, Seoul 06023, Korea

Standard(s): EN ISO 12100:2010
EN 60204-1:2006 + A1:2009
EN ISO 10218-1:2011

This Certificate of conformity is based on the evaluation of samples of the product. It does not imply an assessment of the production and it does not permit the use of a mark of conformity or of a safety mark of the TÜV NORD CERT. The holder of this certificate may use this Certificate together with his EC-Declaration of Conformity.

Certification Body for Product Certification

TÜV NORD Korea Ltd.
Tel.: +82-2-2188-0070
Fax: +82-2-556-3065
E-mail: tnk@tuv-nord.com

TNK A4 01.01 pct

The CE marking can be affixed on the product if all relevant and effective Directives are complied with.

9.2 Electromagnetic Compatibility Directive

TÜV NORD

Certificate
of conformity to the following
European Directives

Registered No.:
K11579/E18

Electromagnetic Compatibility Directive 2014/30/EU

Reference of applicant	Date of application	File reference	Test report No.	Date of issue
-	01.08.2018	KP-18-441	K10996/E18	24.08.2018

This is to certify that the following products comply with the essential requirements (Annex 1) of the above mentioned European Directive and the following standards:

Product:	Collaborative Robot
Type designation:	Indy7
Applicant:	NEUROMEKA 5th Floor, 859, Eonju-ro, Gangnam-gu, Seoul 06023, Korea
Manufacturer:	Same as above
Standard(s):	EN 61000-6-4:2007 + A1:2011 EN 61000-6-2:2005

This Certificate of conformity is based on the evaluation of samples of the product. It does not imply an assessment of the production and it does not permit the use of a mark of conformity or of a safety mark of the TÜV NORD CERT. The holder of this certificate may use this Certificate together with his EC-Declaration of Conformity.

Certification Body for Product Certification

TÜV NORD Korea Ltd.
Tel.: +82-2-2188-0070
Fax: +82-2-556-3065
E-mail: tnk@tuv-nord.com

CE **The CE marking can be affixed on the product if all relevant and effective Directives are complied with.** CE

10 Warranty

Neuromeka warrants the quality of its products in accordance with the provisions of this warranty.

10.1 Quality Guarantee

To protect the interests of customers who purchased our products, Neuromeka guarantees fixing those defects due to production of manufacturer error or damage free of charge during the warranty period set forth in this warranty.

10.2 Warranty Period

Neuromeka guarantees the quality of the product for twelve months from the date the customer purchases or the product is provided. However, if the contract date differs from the delivery date (date of completion of installation trial operation), the delivery date is the base. If the product is exchanged for a new finished product, the remaining warranty period applies to the product.

10.3 Warranty Service

Neuromeka provides the following warranty service during the warranty period.

Repair or Exchange Free of Charge

- In the event of a defect in the product under normal use during the warranty period from the date of purchase, the product will be repaired or exchanged free of charge.
- All services will be handled by the end-sales dealer.

Warranty Invalidation

The warranty becomes invalid in the following cases:

- Any disassembly or modification of the product
- Use of non-genuine parts or software, not provided by the manufacturer
- Inadequate use, exceeding recommended payload, drop, submersion, shock, improper environment and handling
- Fault and negligence of the user
- Exceeded consumable parts life
- Expired warranty period
- Natural disasters (fire, flood, abnormal power supply, etc.)

10.4 Limitations of Liability and Legal Notices

Neuromeka shall not be responsible or liable for any indirect, incidental, special, or consequential damages, including but not limited to loss of revenue, loss of use, lost production, or damage to other peripherals resulting from defects in the product.

10.5 Service Reception Guide

Neuromeka operates the following warranty service.

Service Hour

- Mon ~ Fri: 09:00 ~ 18:00 (Sat, Sun, legal holidays off)

Contact

- Phone: +82-70-8680-3958
- E-mail: sales@neuromeka.com

Application procedure

- Download the C/S form from the homepage and fill it out.
- Attach the completed form via email to sales@neuromeka.com.

C/S Form

neuromeka

Customer Service

Please fill out the form below and write down your inquiry.

Company name	
Address	Company address and the address of product in use.
Person in charge	**Department:** **Title:** **Name:** **Contact:** **E-mail:**
Product information	**Date of delivery:** **Model name:** **Product S/N:** Robot, CB (Please check the label on the product.) **Version information:** Robot, Conty (You can check it in the Conty Option)
Your inquiry	Please write down the details of your inquiry.

For product related issues, please attach pictures and videos for detailed description.

We will contact you soon.
Thank you.

Neuromeka Official Channal

www.neuromeka.com