



HCR-5 Collaborative Robot User Manual

Nov. 2018

## Preface

Before installing the product, please read this manual fully and make sure you follow the instructions in it.

The content of the manual is maintained latest as of the date when it is written. The product information is subject to change without prior notice to users.

If you are uncertain about any requirements, recommendations or safety procedures described in the manual, please, consult with Hanwha Precision Machinery Co.

Users are responsible for any damages caused by their misuse neglecting these instructions below.

Note		nanual intends to help users in ncepts and installation issues. The actual manual.
	Please keep this manual in a	safe place for future reference.
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	<ul> <li>Any plants and cells with the negative influence such a robot and system.</li> </ul>	B to check the location of grounding line.) the inappropriate grounding line may have s noise on the communication line between lled with the equipment requiring large
	1 1	r, separate additional grounding line is

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# Chapter 1 Product Overview

#### 1.1 Collaborative Robot System

Hanwha Precision Machinery's collaborative robot, HCR-5 is a user-friendly robot that provides an automation environment where it can safely collaborate next to humans in various fields.

#### **Easy setting**

By using the direct teaching feature and the intuitive S/W GUI, users can easily configure and control the robot.

- While holding the robot gently, users can implement desired movements, so that the robot can detect and memorize movements.
- Users can preview the robot movement in a real time 3D and use the icon based intuitive GUI for easy operation.
- As the installation method is simple, even if users are not robot engineers, they can easily configure the initial setting and program the robot.

#### Flexible rearrangement

Users can easily rearrange the robot, so that it can be applied to various processes easily and quickly.

- Since users can operate the robot in small space, it is possible to rearrange the robot without changing the layout of the manufacturing line.
- The robot is light weighted and easy to move, and its simple programming environment allows the robot to be easily adapted to high-mix, low-volume production.

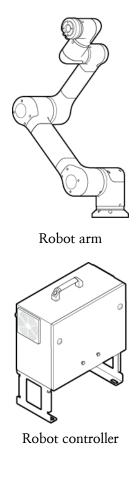
#### **Safe collaboration**

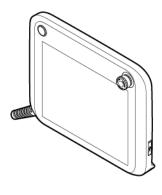
Using the various safety features, users can safely work next to the robot without using additional safety tools or devices.

• The robot is automatically stopped when it detects an impact, so as long as the working range of the robot and the user are guaranteed, it can be installed anywhere for safe use.

## 1.2 System Components

The following is a list of system components.





Teaching pendant



Teaching pendant fixing bracket



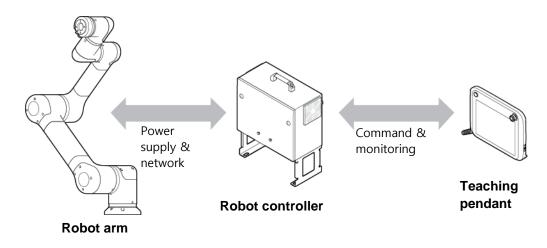
12 pin tool cable

User manual

Robot	Robot arm	1 EA
	Robot controller	1 EA
Controller and teaching pendant	Teaching pendant	1 EA
Pondanie	Teaching pendant fixing bracket	1 EA
0.1	12 pin tool cable	1 EA
Others	User manual	1 EA

The following list indicates the quantity of each component.



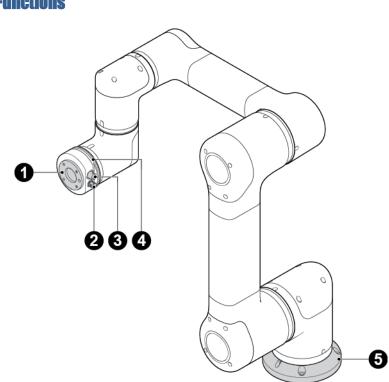


- Robot arm: It is an industrial collaborative robot that can be used to convey objects or assemble parts, and it can be used by attaching various tools such as grippers.
- Robot controller: Can control the robot arm's various movements according to the program prepared by the user. It can be connected with various devices and equipment through its various I/O ports.
- Teaching pendant(TP): It is a device used for system operation. It can teach the robot a specific position or control and configure the robot in many ways.

## 1.4 **Overview of Robot Arms**

#### 6 6 4 6 0 0 0 8 Ð 9 1 Tool Flange 6 Lower Arm 9 J2 Shoulder 0 J6 Wrist3 **D** J1 Elbow 2 6 **3** J5 Wrist2 7 J3 Base Base 4 J4 Wrist1 8 Upper Arm

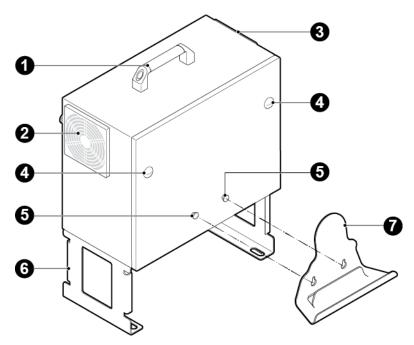
### **Parts and joints**



No.	Name	Description
0	Tool flange	It is the area in the robot where a tool is mounted. For more details, refer to <b>3.4 Connecting Tools to</b> <b>Robots</b> .
0	Tool I/O	It is the I/O port used to control a tool. For more details about specifications, refer to <b>Appendix E Port Pin Map</b> .
€	EtherCAT	It is the Ethernet based port used for communication with a tool. For more details about specifications, refer to <b>Appendix E Port Pin Map</b> .
4	LED	<ul><li>Indicates the status of robot.</li><li>Green: Operation mode</li><li>Blue: Direct teaching mode</li><li>Red: Emergency stop mode</li></ul>
6	Robot base	It is the area in the robot that is fixed to the ground or wall.

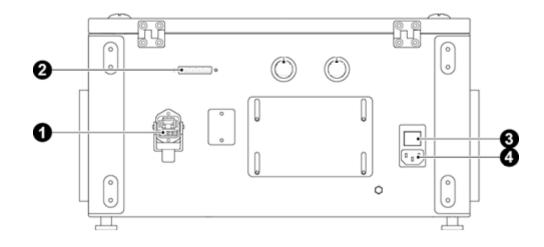
## 1.5 **Overview of Robot Controller**

## Front



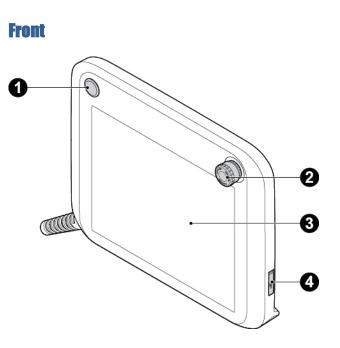
No.	Name
0	Handle
2	Air exhaust hole (exhaust hole filter)
₿	Air intake hole (intake hole filter)
4	Controller cover locking screw
6	Teaching pendant fixing hook
6	Controller fixing bracket
7	Teaching pendant fixing bracket

## Bottom



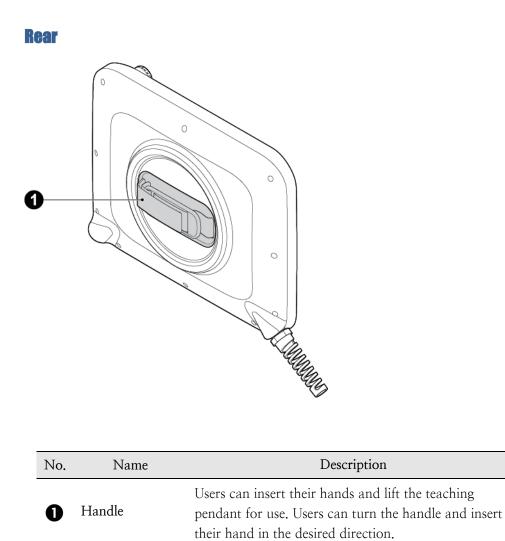
No.	Name
0	Robot connector
0	Teaching pendant connector
€	Power button
4	AC power socket

# 1.6 **Overview of Teaching Pendant**



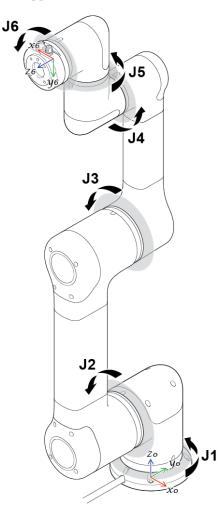
No.	Name	Description
0	Power button	Turn on/off the power of the teaching pendant.
		For more details, refer to <b>4.2 Turning on the Teaching</b>
		Pendant.
0	Emergency stop	Press it to stop the robot.
	button	For more details, refer to <b>2.7 Emergency Stop</b> .
₿	Touch screen	A resistive touch screen that detects a touch even if user
		wears a glove.
4	USB port	USB 2.0 port that can be used by plugging in a USB
		memory, keyboard, mouse, etc. <sup>1</sup>

<sup>1</sup>Some devices may not be compatible with the teaching pendant.

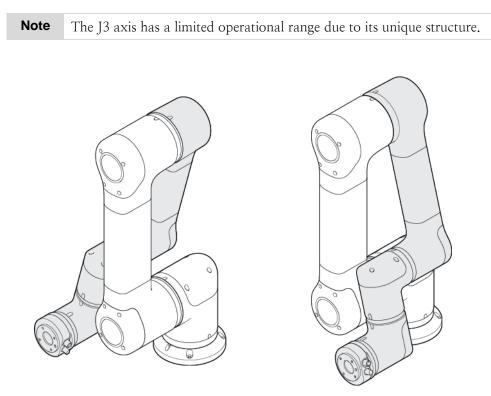


## 1.7 Axial Coordinates and Operational Range

It consists of a total of six axes and an axis of each joint has the following coordinates and operational ranges. The direction of arrow indicates the (+) rotational angle and the opposite direction of arrow indicates the (-) rotational angle.



Operational axis	Operational range
J1 axis	-360° < rz₁ ≤ +360°
J2 axis	-360° < rz₂ ≤ +360°
J3 axis	-165° < rz <sub>3</sub> ≤ +165°
J4 axis	-360° < rz₄ ≤ +360°
J5 axis	-360° < rz₅ ≤ +360°
J6 axis	-360° < rz <sub>6</sub> ≤ +360°

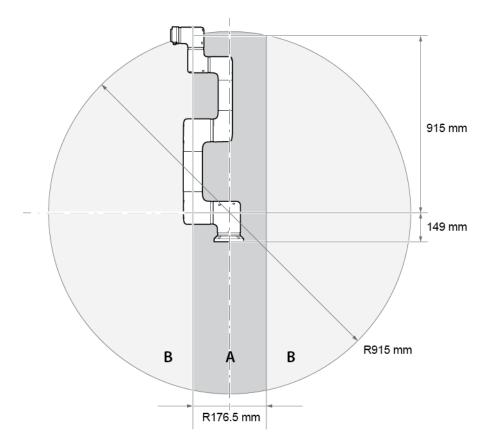


When the J3 axis is at +165°

When the J3 axis is at  $-165^{\circ}$ 

## 1.8 **Robot's Working Range**

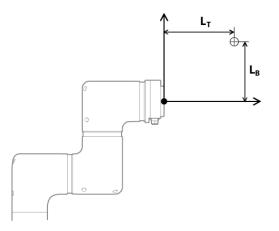
The radius of rotation for the robot when its arm is fully stretched is 915 mm. The radius of 176.5 mm from the center axis of the base is the area where the robot arm cannot reach due to its structure.

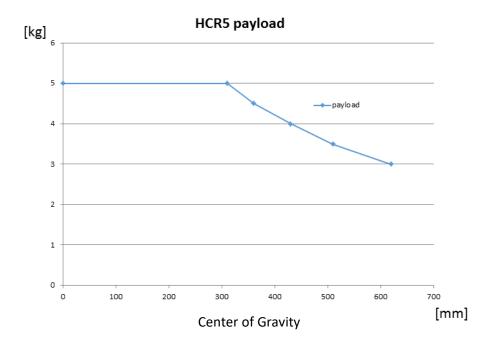


- A: Working range where the robot arm cannot reach
- B: Working range where the robot arm can reach

## 1.9 Maximum load capacity for the tool

The load capacity of the robot arm may vary depending on the distance between the tool flange and the payload's center of gravity. The load capacity per distance is as follows:





# Chapter 2 Safety

## 2.1 Safety Marks in the User Manual

The user manual contains the following safety marks.

## **A** Danger

If a user does not obey the safety mark, then it can cause a severe accident including death or serious injury of a user.

## ⚠ Warning

If a user does not obey the safety mark, then it can cause an accident including serious injury of a user.

## ⚠ Caution

If a user does not obey the safety mark, then it can cause a damage to the product or injury of a user.

#### 2.2 General Safety Cautions

## \Lambda Danger

User needs to install the robot and the electrical equipment by complying with the instructions given in Chapter 3 Installation.

## 🗥 Warning

- Robot application system manufacturers and robot users should be familiar with this manual and complete the robot operation training.
- Make sure sufficient space is available so the robot arm can move freely.
- When using the robot, a user should not wear loose clothes or accessories. If you have long hairs, then tie it in the back so that it does not stuck in the robot's joints.
- Do not ever use a damaged robot.
- If a fatal error occurs in the software, then immediately stop it and contact the product supplier.
- Check if values such as the robot installation angle, tool settings and safety settings are correctly inputted.
- Do not connect the safety device to a general I/O. Safety device is used only for safety related I/O.
- When using the teaching pendant, pay close attention to the robot's movements.
- When the robot is operating, do not enter the working range of the robot or touch the robot.
- Do not modify the robot on your own. If a user causes a problem by modifying or remodeling the product on their own, then Hanwha Precision Machinery will not be responsible for it in any sort of way.
- The robot and the controller can generate heat after long hours of use. Do not touch the robot after long hours of use. If you need to touch the robot, then power off the controller and cool down the robot first.
- When the robot collides with an external object, a significant level of kinetic energy is generated, which is proportional to the speed and the payload. (Kinetic energy = 1/2 × mass × speed<sup>2</sup>)
- Regarding the robot installation, make sure to use a proper configuration for installation. If robot mounting, tool weight, tool's center of gravity, tool length, safety configuration, etc. are not correctly entered, the direct teaching or collision detection function may not work properly.
- You should use the direct teaching function in a safe environment. DO NOT use it if there is a sharp part or cause of jamming in a tool or surrounding installations.

- Correctly enter tool related information (the length, weight, center of gravity of the tool, etc.) before using the direct teaching function. If you enter information different from the actual specification of the tool, you may experience malfunction when using the direct teaching function.
- If a joint is operated at the speed beyond a certain limit when using the direct teaching function, it may make an emergency stop for the safety of operators.



- It is recommended that you test all the functions separately before using the machine or other robot that can damage the robot. If other machine or robot is damaged by programming errors or robot failures, Hanwha Precision Machinery will not be responsible for it.
- Do not expose the robot to a strong magnetic field. Your robot can be damaged.

#### 2.3 Intended Use

This robot may be used for transport, and assembly of objects with tools. However, use it only under the environment specified by its specifications.

Since the safety function is built in, the collaborative work is possible without physical protective fence. However, for the final system applied with robot, the risk assessment should be conducted on the whole system before use.

The system integrator or the end user who implements the robot applied final system shall take the responsibilities as follows:

(These are examples and are not limited to them.)

- Use in potentially explosive environment.
- Medical applications and human life related applications
- Use in human and animal transportation
- Use without the risk assessment
- Use in places where the performance of the safety function is not sufficient
- Use beyond its performance and environmental specifications

#### 2.4 **Potential Dangers**

If the risk assessment, conducted by the final system manufacturer who applied the robot, concludes that it is not possible to fully reduce the risk only with the built-in safety function, additional protective measures should be established.

Consider potential dangers as follows:

- Injuries that may occur if the human body part such as finger is caught in the robot joints (confinement).
- Injuries caused by sharp edges or corners of tools (stab or penetration)
- Injuries caused by objects around the robot (stab, penetration, or falling)
- Injuries that may occur when working on toxic or hazardous materials (skin damage or dyspnea)
- Injuries caused by collisions with the robot (bruise or fracture)
- Injuries caused by loosely coupled parts.
- Injuries caused by objects separated or fallen from the tool.

**Note** Potential dangers that may occur vary depending on the final system.

#### 2.5 Limitation of Liability

This user manual does not cover all of the peripherals affecting the safety. A system installer must comply with the safety requirements according to the safety rules and laws of the country where the robot is installed.

The robot is configured as the final system interconnected with peripherals. This user manual covers neither the design, installation, operation of the final system nor all of the peripherals including the safety device.

The final system which applied the robot shall be designed and installed according to the safety requirements in compliance with laws and regulations of the country where it is installed.

The system integrator or the end user who implements the robot applied final system shall take the responsibilities as follows:

(These are examples and are not limited to them.)

• Risk assessment on the final system

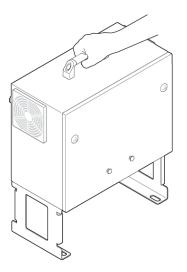
- · Addition of safety devices according to the risk assessment results
- To check whether the system is correctly designed, set up and installed
- Definition on how to use the system
- Providing information on operation and safety as well as contact information
- Provision of technical documents including the user manual

Complying with the safety items in the user manual does not mean that all possible risks are prevented.

### 2.6 Transportation

The weight of the robot arm is 20.8 kg and that of the controller box is 20.2 kg. A minimum of two people is required for moving it safely.

Carry the controller box by holding the handle at the top.



# **Warning**

During transportation, avoid damages caused by falling accidents. The warranty does not cover any damage caused during transportation.

## 2.7 Emergency Stop

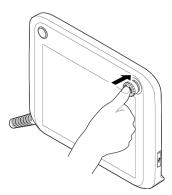
You can press the emergency stop button to immediately stop the robot in case of emergency. The emergency stop button is basically located in the teaching pendant and you can stop the robot by connecting another emergency stop button to the robot controller.

## 1 Caution

In the event of a collision or an emergency stop while driving over the speed of 120°/sec, check the zeroing of the robot joint and calibrate it if needed. After that, check if the movement path of the tool set in the operating program is correct. Contact the manufacturer or the service representative if you need the zeroing adjustment.

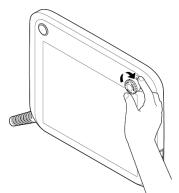
#### **Using emergency stop**

You can press the emergency stop button in the teaching pendant to immediately stop the robot.



#### **Canceling emergency stop**

Turn the emergency stop button clockwise to cancel emergency stop.



#### 2.8 Safety Fence

Unlike other kinds of industrial robots that adopt physical fences, virtual fences are implemented to make sure that the robot arm does not reach out of certain limits. For more details, refer to 8.2 Setting Safety Boundaries.

#### 2.9 Limits of Speed and Rotational Angles

By limiting the rotational angle and speed of each joint, you can secure your safety. For more details, refer to 8.1 Limiting Robot Movement.

#### 2.10 Operating Robots without Driving Power

In case of emergency, when the robot is not driven by power, an adult can move each axis with their own force.

## 🗥 Caution

If you use excessive force to move the axis when the robot is not being driven by power, it can overload the driving unit. The manufacturer is not responsible for the failure caused by excessive force.

#### 2.11 Safety Controller

The safety controller for HCR-5 complies with the ISO13849 Cat3. PLd class.

#### 2.12 Risk Assessment

The risk assessment is one of the important factors when configuring a robot configured system. The degree of safety regarding robot installation varies depending on the way of integrating it into the entire system, so it is not possible to perform the risk assessment with the robot alone.

The person who configures the robot included system to perform the risk assessment of the robot should install and operate it according to instructions of ISO 12100 and ISO10218–2 standards. For further information, refer to the Technical Specification ISO/TS15066.

You must perform the risk assessment right after the robot is installed. The main objectives of the risk assessment are to set up safety configuration suitable for the surrounding environment and robot settings and to find out the need for additional emergency stop buttons and protective measures.

It is possible to configure functions related to safety of the collaborative robot from the Safety Configuration Setting menu. Available functions are as follows:

- Joint Rotation Limit: You can limit the angle of each joint.
- Joint Speed Limit: You can limit the speed of each joint.
- TCP Speed Limit: You can limit the max speed for the TCP's linear movement.
- Force Limit: You can limit the maximum force that stops the robot when it detects a collision with a surrounding object.
- Safety Boundary Limit: You can build a virtual fence within the robot working area to prevent robot arms or tools from moving beyond the boundary for the safety of users.
- Redundant I/O Setting: You can set up redundancy to an I/O terminal to input/output important safety-related information.

If dangers are not sufficiently reduced or removed through the safety related functions above, add more protective measures to remove them. The manufacturer is not responsible for accidents caused by noncompliance with relevant requirements of international standards and local laws and regulations in relation to installation or due to not performing review on those requirements during the risk assessment as above.

# Chapter 3 Installation

The installer should install and operate the robot according to instructions of ISO 12100 and ISO10218–2 standards and comply with relevant requirements of international standards such as ISO/TS 15066 and local laws and regulations.

The manufacturer is not responsible for accidents caused by noncompliance with relevant requirements of international standards and local laws and regulations or due to not performing review on the risk assessment as mentioned in Section 2.12.

## 3.1 Installation Locations

It is recommended to install the system in a place which meets conditions as follows:

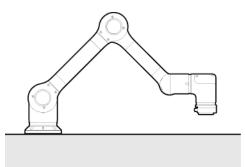
- A building with earthquake-resistant design
- A place without water leaks
- A place free of flammability or explosives
- A place that maintains the constant temperature and humidity
- A place with little dusts

# 🗥 Caution

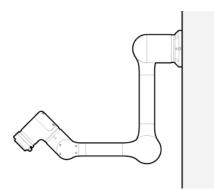
If the system is not installed in a recommended place, the performance and the life span of the robot may be reduced.

# 3.2 Installation Types

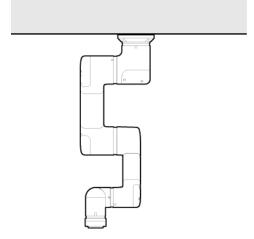
You can install the robot arm on ceiling, wall or floor as follows.



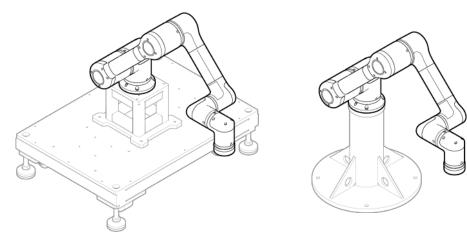
Example of installation on floor



Example of installation on wall



Example of installation on ceiling



You can also install it on a moving dolly or fixed post.

Example of installation on a moving dolly

Example of installation on a fixed post

# 🗥 Warning

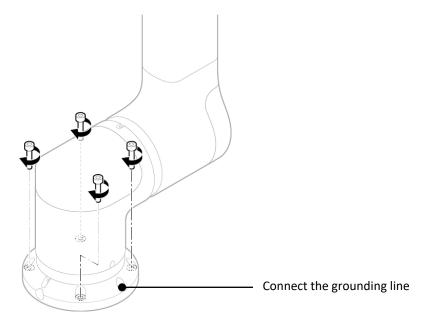
If you install the robot on a moving dolly, you must make sure the moving dolly is fixed to the ground when operating the robot.

**Note** The moving dolly or fixed post is not included in the product package.

After installing the robot, you must configure the robot installation information depending on each type of installation. For more details, refer to 7.1 Setting the Robot Installation Angles.

## 3.3 Fixing Robots

You can install the robot arm on the ceiling, wall or floor by using 4 pieces of M8 bolts not shorter than 15mm and it is recommended to fasten those bolts with 45 Nm torque. If the strength or levelness of the installation ground is not sufficient for supporting the robot arm, then you can use a fixing base for installation. In this case, if you want to install the robot arm in an accurate location, then you can use two  $\Phi$ 8 location determination pins to determine the location. In addition, to prevent electrostatic charges, you must connect the grounding line using a piece of M4 x 10 mm bolt.



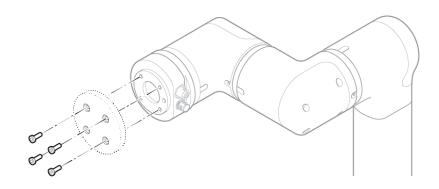
# (!) Warning

- When fixing the robot, securely fasten the bolts to prevent them from getting loose.
- Install it on a flat ground that can with withstand the robot's weight and the weight that is generated when the robot is operating.
- Check that the installation plane of the robot arm is completely in contact with its base plane.

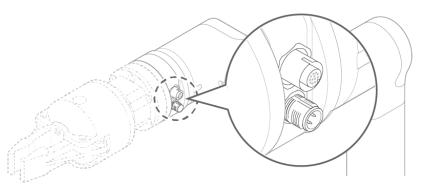
Note	•	The base fixing bolt is not included in the product package.
	•	For more details about specifications of the robot base, refer to
		Appendix C Dimensions for Installation.

# 3.4 Connecting Tools to Robots

1. Using four sets of M6 bolts, fix a tool to the tool flange.



- The tool combination method varies from tool to tool. For more detailed methods, refer to the user manual provided by the tool maker.
- For more details about specifications of tool flange, refer to Appendix D Tool Flange Cross Section.
- **2.** After fixing the tool, connect the necessary cables to the tool I/O or the EtherCAT port.
  - For the tool I/O, you can select one from the analog input (current (0 20 mA), voltage (0 10 V)), the digital input (4Ch) and the digital output (4Ch, 0, 12, 24 Vdc).

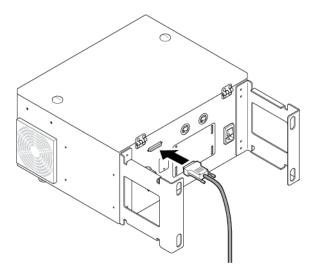


• For more details about specifications of the pin maps for the tool I/O and the EtherCAT, refer to Appendix E Port Pin Map.

# 3.5 Connecting Cables

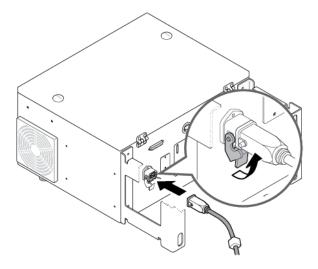
#### Connecting the teaching pendant to the robot controller

After connecting the teaching pendant cable, by using fixing bolts for the connector, securely fasten it, so that the cable does not slip out. Be careful of pin being bended while connecting.



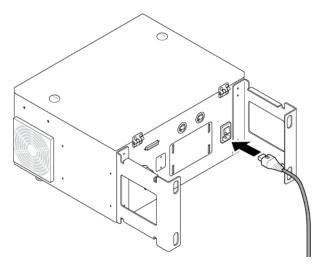
#### Connecting the robot arm to the robot controller

After connecting the robot arm cable to the robot controller, hook a fixing latch, so that the cable does not slip out.



#### Connecting the power supply to the robot controller

Connect the power cable approved in your country to the power terminal. Robot controller's power terminal accepts standard IEC plugs.



The minimum requirements for power supply are ground, main fuses and circuit breakers, and they should be prepared by the person who prepares for installation.

The following electrical specifications are applicable to power supplies.

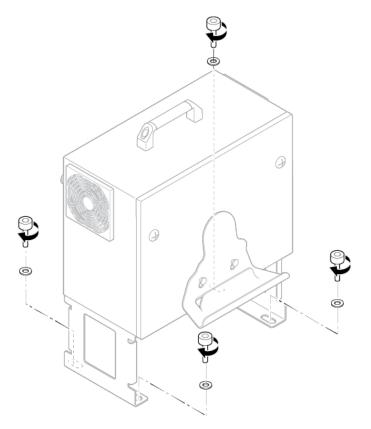
Input power	100 ~ 240 VAC
External power supply fuse	8 ~ 16 A (100 ~ 240 V)
Input frequency	47 ~ 63 Hz

# 1 Caution

While the robot is on, do not remove the robot connector, the power connector or the teaching pendant connector. When connecting teaching pendant to controller, pay attention to the pin of the connector.

## 3.6 Fixing the Controller Box

The controller box can be fixed to the ground by using the fixing bracket at the bottom. Fix it with M14 bolts not shorter than 45 mm in combination with flat washers.

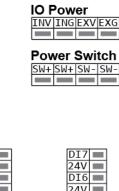


**Note** Bolts or screws fixing the controller box are not included in the product package.

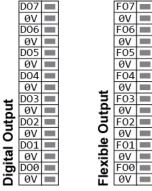
#### **Overview of Controller I/O** 3.7

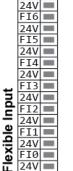
If you want to connect other external equipment to your controller, then you must first connect it to the I/O inside the controller box. The controller I/O is very flexible, so it can be connected to various equipment such as relays, PLC, and emergency stop buttons.

The following electrical interface layout exists for the area inside the controller box.

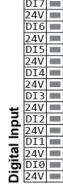








24V 🔳



#### 3.8 **Common Spec for Digital I/O**

The section defines the electrical specifications of the following 24V digital I/O for the controller box.

- Safety Input: 4 EA
- Flexible I/O: Input 8 EA, Output 8 EA ٠
- General I/O (Digital I/O): Input 8 EA, Output 8 EA ٠

By implementing the terminal block called IO Power (J8), you can supply power to the digital I/O from an internal 24V power supply or external power supply. The left two blocks are composed of internal 24V(INT\_24V), GND and the right two blocks are composed of external 24V(EXT\_24V), GND. They can supply power from the outside to the digital I/O.

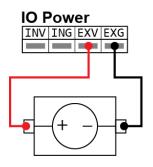
Basically, internal 24V power is supplied for use. The basic power supply configuration is as follows.

IO F	ow	er	
INV	ING	EXV	EXG

INV	Internal 24 V I/O power supply	Current limit: 2 A
ING	Internal 24 V I/O GND	Typ. DC 24 V
EXV	External 24 V I/O power supply	Min. DC 23 V
EXG	External 24 V I/O GND	Max. DC 26 V

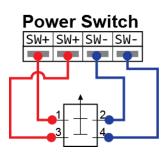
If the digital I/O power supply provided from the inside of the controller is not sufficient, then you can connect an additional power supply externally. If an internal/external power supply is used, then the current limit of 2A is applied.

If the digital I/O requires more current, then you can connect an external power supply as follows.



**Note** If the current is over the upper limit, then the digital I/O fuse can blow off. If the fuse is blown off, you need to replace it.

You can configure the terminal block called as Power Switch (J9) to use it as an external power supply switch.



SW+	Push Button Input
SW+	Push Button Input
SW-	GND
SW-	GND

The following electrical specifications apply to the internal or external power supply.

Terminal	Parameter	Minimum	Format	Maximum	Unit
	Interna	l 24V power s	supply		
INT_24V – INT_GND	Voltage	23	24	25	V
INT_24V – INT_GND	Current	0	_	2	А
	Externa	al 24V require	ements		
24V - 0V	Voltage	20	24	29	V
24V - 0V	Current	0	_	2	А

The digital I/O is manufactured by complying with the IEC 61131–2 standard. The following electrical specifications apply.

Terminal	Parameter	Minimum	Format	Maximum	Unit
	Di	igital output			
COx / DOx	Current	0	_	0.2	А
COx / DOx	Voltage dro	op 0	_	0.5	V
COx / DOx	Leakage	0	-	0.1	mA
	current				
COx / DOx	Functions	_	PNP	_	Format
COx / DOx	IEC 61131-	-2 -	1A	_	Format
	D	igital input			

Terminal	Parameter	Minimum	Format	Maximum	Unit
EIx/SIx/CIx/DIx	Voltage		_		V
EIx/SIx/CIx/DIx	OFF area		_		V
EIx/SIx/CIx/DIx	ON area		_		V
EIx/SIx/CIx/DIx	Current (11–30V)		_		mV
EIx/SIx/CIx/DIx	Functions	_	PNP	_	Format
EIx/SIx/CIx/DIx	IEC 61131-	2 –	3	_	Format

# 3.9 Configuring the Safety Input

Since a single signal loss should not lead to a loss of the safety function, all the I/O's related to the safety should be duplexed.

Safety Input should always comply with the common specs of the digital I/O.

When you install the safety device or equipment, you should comply with the instructions from Chapter 2 Safety and Chapter 3 Installation.

Safety inputs include emergency stop and safety protection stop. Emergency stop input is for emergency stopping of the robot and safety protection stop input is for protection of all the safety classes. Their functions are different from each other in this sense.

	Emergency Stop	Safety protection stop
Robot stops the movement	Example	Example
Run the program	Stop	Pause
Robot power	Off	On
Initialization	Manual	Auto or manual
Frequency of use	Low	Mid
Re-initialization required	Break release only	No
Stop category (IEC 60204)	1	2
Performance level (ISO 13849–1)	PLd	PLd

Using the Flexible I/O, you can set the Safety I/O additionally. For example, you can use the emergency stop output. In addition, you can configure the Flexible I/O for the safety function in the GUI.

# **A** Danger

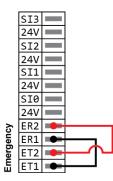
Do not connect safety signals to normal PLCs. Only safety PLCs must be connected to safety signals. If you do not comply with the warning, then the safety stop function may fail, causing severe injury or even death. The safety signal and the general I/O signal should be separated from each other.

# **Warning**

- All the safety class I/O's are duplexed. By separating the channels, you should make sure the safety function is not initiated by a signal failure.
- Before installing the robot, you must check the safety functions. In addition, the function should be checked for defects periodically.

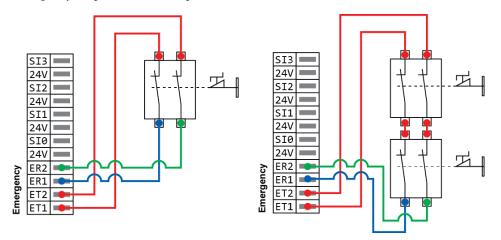
## **Initial safety configuration**

The safety configuration for the robot is set to default initially when it is shipped to you, so no additional configuration is required. The initial safety configuration is shown as follows.



#### **Connecting the emergency stop button**

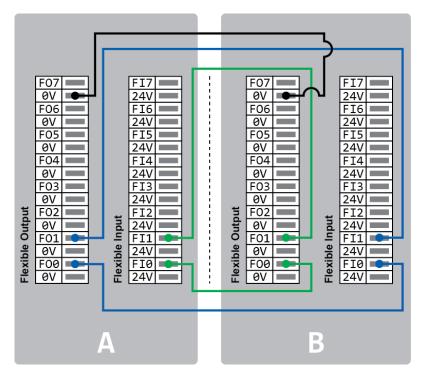
It is recommended that you connect one or more emergency stop button. The emergency stop button is composed as follows.



#### Sharing emergency stop circuits with other equipment

When you use the robot with other equipment, it is recommended that you share the same emergency stop circuits. If you do, then you will not have to check which emergency stop button you have to use in case of emergency.

Before sharing the emergency stop function with other equipment, you must configure the Flexible I/O functions in the GUI. You can configure the emergency stop function as follows.



# 3.10 Configuring the General Digital I/O

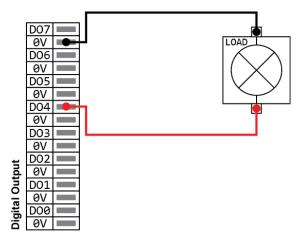
If not used as a safety function, then you can use the Flexible I/O as a general purpose digital I/O.

The general digital I/O should comply with the common specifications of digital I/O.

The general digital I/O can be used to configure relays or PLC systems. In this configuration, if the program is not running, the output is maintained low at all times.

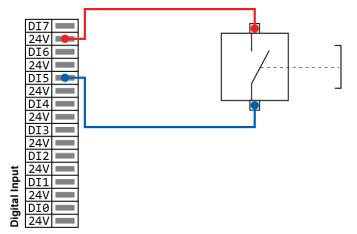
#### Load control with digital outputs

You can control loads with digital outputs. You can configure it as follows.



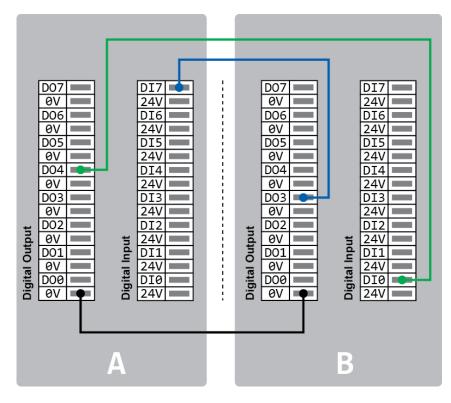
#### **Digital input control using buttons**

You can connect a simple button to a digital input. You can configure it as follows.



#### **Communicating with other equipment or PLC**

The digital I/O can be configured to communicate with other equipment if a common GND is established and if the equipment uses PNP technology. You can configure it as follows.



# 3.11 Configuring the General Analog I/O

It can be used to set or measure voltage (0-10V) or current (4-20mA) between two equipment.

For high reliability, it is recommended that you use the following method.

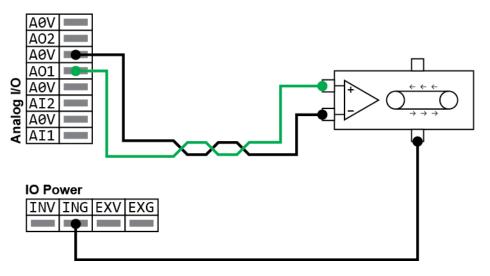
- Use the analog ground closes to the I/O.
- Equipment and control box should share the same ground. Analog I/O is not insulated in the control box.
- Use the cable that is shielded or twist paired. Connect it to the ground shield of the power (J12) terminal.
- The current signal is not sensitive to noise, so simply use an equipment operating in current mode.

The input mode can be set in the GUI. The following electrical specifications apply to the I/O.

Terminal	Parameter	Minimum	Format	Maximum	Unit
	Cur	rent mode in	put		
AIx – AG	Current	4	_	20	mA
AIx – AG	Resistance	_	20	_	Ohm
AIx – AG	Resolution	_	12	_	Beat
	Vol	tage mode in	put		
AIx – AG	Current	0	_	10	V
AIx – AG	Resistance	_	12	_	Kohm
AIx – AG	Resolution	_	12	_	Beat
	Curr	ent mode ou	tput		
AOx – AG	Current	4	_	20	mA
AOx – AG	Resistance	0	_	10	V
AOx – AG	Resolution	_	12	_	Beat
	Voltage mode output				
AOx – AG	Voltage	0	_	10	V
AOx – AG	Current	-20	_	20	mA
AOx – AG	Resistance	_	1	_	ohm
AOx – AG	Resolution	_	12	_	Beat

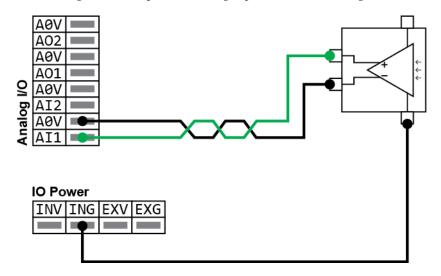
#### **Analog output**

You can use analog outputs as speed control inputs to the conveyor belt. You can configure it as follows.



# Analog input

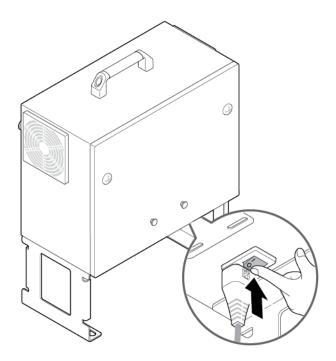
You can use analog sensor outputs as analog inputs. You can configure it as follows.



# Chapter 4 Getting Started

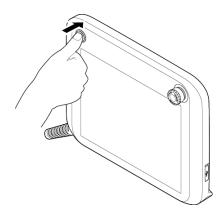
# 4.1 **Turning on the Robot Controller**

Turn on the power switch at the bottom of the controller. If you turn on the power switch for the controller, power will be supplied to the controller.



# 4.2 **Turning on the Teaching Pendant**

Turn on the power button at the left top of the teaching pendant.



# (1) Caution

- Do not turn on the teaching pendant with USB devices connected. It may cause problems with starting the system. Connect it after the system is booted completely.
- Do not unnecessarily touch the screen while booting the system. It may cause problems with starting the system.

# Chapter 5 Software Overview

## 5.1 Menu Overview

#### **Expanding menu**



Press the expanding menu button at the left top of the screen to expand the menu. You can check the name of each menu and if a sub menu exists, then you can select it as well.



#### **Robot Operation**



You can configure basic operation / control (start, pause) of your robot. For more details, refer to Chapter 10 Starting the Robot.

#### **Programming**



You can configure the robot's movements. For more details, refer to Chapter 9 Programming.

#### Monitoring



You can check the real time condition of the robot arm. For more details, refer to Chapter 11 Monitoring.

#### Report



You can check the running time of the robot arm. For more details, refer to Chapter 12 Report.

#### **Robot Setting**



You can configure the installation information before operating the robot. For more details, refer to Chapter 7 Setting Robots.

#### **Safety Setting**



You can configure the safety items before operating the robot safely. For more details, refer to Chapter 8 Safety Settings.

#### **Device Setting**



You can configure an external equipment that will be linked to the robot. For more details, refer to Chapter 12 Linking with External Equipment.

#### Management



You can register a robot or user and manage logs, etc. For more details, refer to Chapter 6 Registering Robots and Users, 16.4 Viewing and Managing Logs & 16.5 Managing the Robot System Configuration.

#### SW Configuration



You can configure the operation software environment. For more details, refer to Chapter 13 Environment Setting.

#### Message



You can select whether or not to display the message window that shows messages that have been set while the robot program is running.

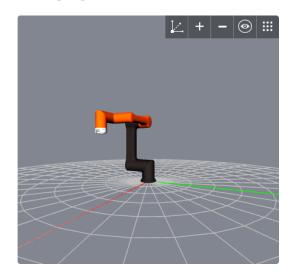
#### **Manual Move**



You can control the robot manually. For more details, refer to 5.3 Manual Move Scree.

# 5.2 **3D Preview Screen**

The system provides a screen where you can preview the robot's movement or coordinates in 3D. You can drag on the screen in the desired direction to change the screen perspectives.



## Screen display setting button

You can configure the information displayed on the preview screen and the screen layout.

Basic setting button				
${\bf L}$	Hide or unhide the TCP coordinates.			
$\odot$	Initialize the size of the preview screen.			
_	Decrease the size of the preview screen. (Level 10)			
+	Increase the size of the preview screen. (Level 10)			
	Unhide the additional setting button.			
$\times$	Hide the additional setting button.			

	Additional setting button
<b>9</b>	Hide or unhide the point of the movement path for the tool currently programmed.
۲	Hide or unhide the location/direction of the TCP currently set for the robot.
3	Hide or unhide the movement path currently programmed.
	Hide or unhide the safety borders currently set for the robot.
Note	Depending on the purpose of the menu, some buttons are not available in the preview screen.

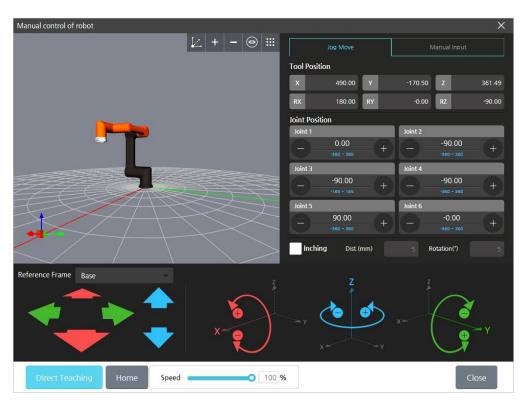
## **Robot task control button**

You can preview the programmed robot tasks.

►	Start the program from the beginning or at the selected task. When you press the Start button, it changes to the Pause button.
П	Pause the running program. When you press the Pause button, it changes to the Start button again.
$\triangleright$	Execute the unit command that are currently selected.
	Terminate an ongoing task.
Note	Depending on the purpose of the menu, some buttons are not available in the preview screen.

## 5.3 Manual Move Screen

On this screen, you can control the robot's positions. By using jog control or direct teaching, you can control the robot's position.



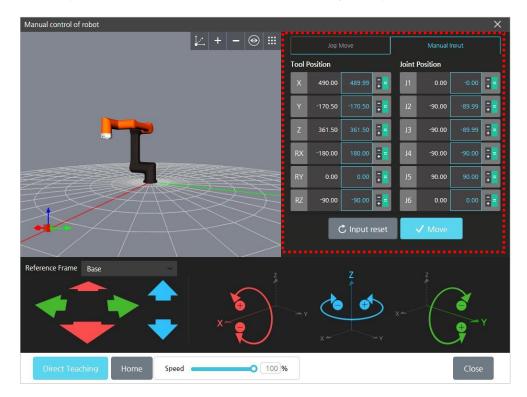
Press the Manual Move button in the main menu.

- **Coordinate System** : Selects Coordinate System for manual move. (View, Base, TCP)
- **Tool Position**: Displays the coordinates of TCP. You can modify it by entering specific coordinates.
- Joint Position: Displays the angle of the joints. You can modify it by entering a specific angle.
- **Move:** Adjusts the coordinates of TCP by using jog buttons.
- **Rotation:** Rotates the TCP by using jog buttons.
- **Direct Teaching:** If you manually adjust the robotic arm as you press this button, the system detects any changes in the joint position.
- **Home**: Shifts the robot to its initial position.
- **Speed**: Adjusts the movement speed of the robotic arm when you control the robotic arm manually.
- Inching: You can set the robot to move in increments of a certain distance or angle.
  - Default: 5mm, 5degree

- Moving Range : 0.01~10 mm
- Rotating Range : 0.01~ 10degree

**Note** Depending on the purpose of the menu that uses the manual robot control function, the screen layout may differ accordingly.

If you press the coordinate value on the screen, the screen will be changed as follows, and then you can enter the coordinates and the joint angles on your own.



- Press the Move button to move the robot arm to the preset position.
- Press the **Input reset** button to reset the coordinates and joints' angles you input to the current coordinate of the robot.

# 🗥 Warning

When controlling the robot manually, check that there is no obstacle or person around the robot before operating it.

# $\cancel{!}$ Caution

- When using the direct teaching function, check that the center of gravity of the TCP payload is correctly entered. Entering an incorrect value may cause malfunction.
- If you drive a joint beyond a certain speed while using the direct teaching function, it may make a noise and make an emergency stop for the safety of operators.

## 5.4 Virtual Keypad

The operation software accepts touch based inputs, so you can use a virtual keypad on the screen. Depending on the input types, there are three types of virtual keypads as follows.

#### Text keypad

You can enter or edit simple English texts or special characters. You can use the Shift key to toggle between uppercase/lowercase.



- If you want to display your inputted text, press the Accept key.
- If you want to delete the entire inputted text string, press the  $\square$  button.
- If you want to close the keypad, then press the  $\times$  button at the right top.

**Note** The **Accept** key is deactivated and cannot be used if there is no inputted text string.

#### **Number keypad**

You can enter or edit simple numbers.

123	3456		8	$\times$
7	8	9	×	
4	5	6	+/_	
1	2	3	لے Enter	
(	)		Enter	

- If you want to display your inputted numbers, press the **Enter** key.
- If you want to delete the entire inputted text string, press the  $\boxtimes$  button.
- If you want to close the keypad, then press the  $\times$  button at the right top.

**Note** The **Enter** key is deactivated and cannot be used if there is no inputted text string.

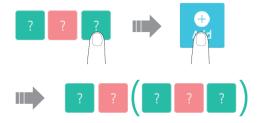
#### **Expression keypad**

You can enter or edit simple expression.

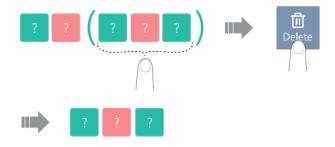
? ? ?			>		+ Add	Delete
ut Output Ovariables	and	or	High	Low	True	False
no	xor	not	7	8	9	
	- +	$\div$ ×	4	5	6	Clear
	< :	> +	1	2	3	Ψ
	<u> </u>	≥ ==	0	+/_		Enter

- Basically, an expression is composed of <sup>2</sup> <sup>2</sup> <sup>2</sup> three input items.
  - Green input field: You can enter fixed variables and numbers.
  - Orange input field: You can enter an arithmetic operator.

• Add an expression: Select a green input field and press the Add button. The selected green input items will be changed to the three basic input items and added into the parenthesis.



• Delete an expression: After selecting any item in the parenthesis, press the **Delete** button. The basic input item added into the parenthesis will be deleted.



- If you want to delete the selected input item, then press the **Clear** key.
- If you want to display the inputted expression, press the **Enter** key.
- If you want to close the keypad, then press the  $\times$  button at the right top.
- Clicking the script mode button allows you to enter a free-form equation, such as a script. If this mode is selected, a list of functions available in the script is displayed.

<							(	× >			<b>ב</b> ילי	団 삭제
입력 () 출력 (● 변수 (● 함수 Val203169 Val759212	&& (and) -		(or)		/ (÷)	! (not) <	true	e fa <= (≤)	alse >= ⊵			0 (Low) != (≠)
cnt	•	1	2	3	4	5	6	7	89			×
g_var_2	q	w	e	r	t	у	u	i	0	p	-	=
	a Sł	s nift	d z	f x	g c	h v	j b	k n	l m	[	Acce ]	pt ₩
					];		•	,	. /	'	Cle	ar

# Chapter 6 Registering Robots and Users

After installing the robot, turn on the system for the first time. Only the **Management** menu will be seen. If there is no robot registered, other menus will not be seen.

# 6.1 Managing Robots

You can register a new robot to be linked to the controller or change the robot name.

In the main menu, select **Management** > **Robot**.

HCR5	Specification	
	P Number of Joints	6 ea
<b>9</b>	T Payload	11.0231 lb
	Reach	36.02355 in
	C Rotation	±360'
	শ্বাঁুয় Arm Weight	44.0924 lb
e	Basic Information	
198 <sup>9</sup> 8	Robot Model	HCR5
	Robot Name	HCR5
Robot Add / Edit		Cancel Apply

## **Registering robots**

- 1. Press the **Add** button.
- 2. Add a robot and press the  $\mathbf{OK}$  button.



- 3. Enter the robot name and press the **Apply** button.
- 4. When the restart confirmation window appears, press the **OK** button.
  - You must restart the system for normal operation.

#### **Deleting robots**

- 1. In the list of registered robots, select a robot.
- 2. Press the **Delete** button.
- 3. When the confirmation window appears, press the **OK** button.
- 4. Press the **Apply** button.

**Note** If you want to delete a robot, then you must restart the system.

#### Modifying the robot name

- 1. In the list of registered robots, select a robot.
- 2. After pressing the text box having the robot name, modify it as you want.

Basic Information	
Robot Model	HCR5
Robot Name	HCR5

3. Press the **Apply** button.

## 6.2 Managing Users

You can make sure only specific users can use the software by registering them. Also, you can grant an individual right to each user to limit their access to the menus.

In the main menu, select **Management** > User.

ID	✓ Searce	h Keyword	Q All Users
	Name	ID	Authority Level
	user	user	Admin
	who	who_op	Operation
Add	Delete Edit Us	er	

## Adding users and setting authorities

- 1. Press the Add button.
- 2. Set the user information and their authorities and press the **OK** button.

Name		ID	
User Authority	Select		~
Password		Confirm Password	

- The length of text that can be inputted is limited as follows.
  - Name: 25 letters
  - **ID/Password**: 20 letters
  - E-Mail: 30 letters
- You can choose one of the following two authorities.
  - Admin: Can use all the functions of the software.
  - **Operation**: Cannot use the safety and the critical setting functions. Settings can be all inquired about.

Note	•	If you are an operation user who lost the password, ask the admin user.
		The admin user can modify the password for an operation user.
	•	If the admin user's password is lost, then contact local distributor.

#### Menu available to each authority

Depending on the authority set in User Management, the following menus become available. Even if you are not logged in, you can still use some menus.

Main menu	Sub menu	Admin	Operator	Log Off
<b>Robot Operation</b>		О	О	О
Programming		О	О	Х
Monitoring	Robot Status	О	О	О
monitoring	I/O Status	О	О	О
Report	Utilization	О	0	О
	TCP Setup	О	О	Х
	Mounting	Х	Х	Х
	I/O Setup	О	О	Х
<b>Robot Setting</b>	Coordinate	О	О	Х
	MODBUS TCP	О	О	Х
	Global Variables	О	О	Х
	I/O Bit Operation	О	О	Х
	Motion Limit	О	Δ	Х
Safety Setting	Safety I/O	О	Δ	Х
	Safety Boundary	О	Δ	Х
<b>Device Setting</b>	Vision System	О	0	Х
Management	User	О	Х	Х

Main menu	Sub menu	Admin	Operator	Log Off
	Robot	О	О	Х
	Log	О	О	О
	Setting Management	О	О	Х
	General	О	О	Х
SW	Network	О	О	О
Configuration	SW update	О	О	Х
	Shutdown	О	О	Х
Zeroing Robot		Х	Х	Х

Note	•	The Zeroing Robot menu and the Mounting menu are only				
		accessible by the Super Admin user.				
	•	If you need assistance with zeroing, contact the manufacturer or a local distributor.				

# 6.3 Login/Logout

## Logging in

While logged off, the  $\mathfrak{S}$  icon is displayed at the right top of the screen. After finishing registering a user, while logged off, press the  $\mathfrak{S}$  icon and enter your ID/password and press the **Login** button.

		රි	<b>i</b>	
User ID				
PASSWORD				
Login				

#### **Logging out**

While logged in, the  $\stackrel{\circ}{\sim}$  icon is displayed at the right top of the screen. While logged in, press the  $\stackrel{\circ}{\sim}$  icon and press the **Logout** button.

	-	2	<b>i</b>
ID	user		
	Log-O	ut	

## 6.4 Checking Status

## **Checking Robot Status**

You can check the status of the robot through the robot icon  $\leq$  next to the robot name and the status icon  $\bigtriangledown$  in the upper right of the screen.

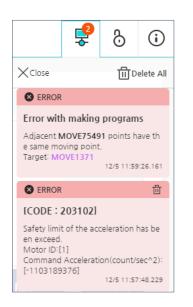
- Green : Servo On
- Red : Servo Off

### **Checking errors**

You can check errors that occur while the robot is in operation or being programmed when error status is shown by the status icon on the top right of the screen.

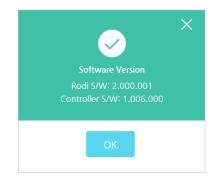
• Red number: Shows the number of errors that occurred

When you click the icon, an error message is displayed, as shown in the figure below. The error message shows the error title, error details, error target, and error time.



## Checking the software version

You can check the current version of the operating software and control software by clicking the (i) information display icon at the top of the screen.



- Operating software: Displays the operating software version.
- Control software: Displays the control software version.

# Chapter 7 Setting Robots

## 7.1 Setting the Robot Installation Angles

After installing a robot, you must set the robot installation angle.

The purpose of this process is to make sure that actual operation of the robot arm looks same as what we saw in the preview screen and let the controller know the direction of gravity.

# 🗥 Warning

The system is unable to automatically recognize the tilt of the ground where the robot arm's base is installed and the working range, so before operating the robot, you must enter accurate inputs depending on the installation type.

 Image: constrained on the second of the s

In the main menu, select the **C** Robot Setting > Mounting menu.

- **3.** Depending on the tilt of the ground where the robot arm's base is installed, set the angle accordingly.
  - If installed on the ground, then press 0°, if installed on the wall, press 90°, or if installed on the ceiling, press 180° to set the tilt value more quickly.



• You can touch the gauge or press the left/right ⓒ ் buttons to fine tune the tilt for the X/Y axis.



- <sup>o</sup> You can touch the input window to enter the angle value directly.
- 4. Press the **Apply** button to apply the settings to the system.

Press the **Cancel** button to revert to the previous settings.

## 7.2 Setting TCP

When you mount a tool in the robot arm for the first time, you must also set the TCP (Tool Center Point). By setting the tip location/direction and the weight of the mounted tool, you can calculate the robot's motion.

You can set a different TCP for each of multiple robots linked, and if you want to use multiple tools for a single robot, then you can save different settings and retrieve and apply them to a newly replaced tool.

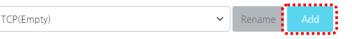
To set the TCP, in the main menu, select **Setting** > **TCP Setup**.

# 🕂 Warning

If the TCP profile is incorrectly entered, accidents such as collision and jamming may occur while operating the robot and the robot may operate incorrectly while using the direct teaching function. In addition, as the singularity of the robot arm may vary depending on the TCP, the program previously prepared may not work or the robot arm may not operate as expected. Make sure to enter the correct value according to the TCP type before operating the robot.

#### **Creating a new TCP profile**

#### 1. Press the Add button.

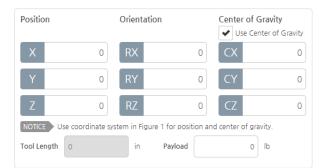


2. Enter the new TCP name and press the **OK** button.

You may enter up to 25 characters. Special characters other than '-' and '\_' are not allowed.

Add TCP		×
TCP Name		
	ОК	

**3.** Enter the TCP information.



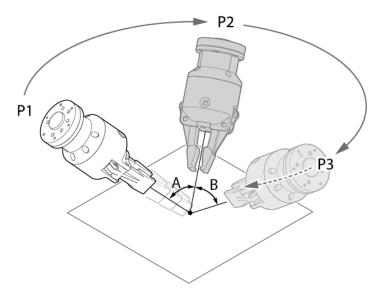
- **Position**: Enter the coordinate values (X, Y, Z) with respect to the center of the cross section of the location where a tool is mounted. The unit is in mm.
- Orientation: Set the tool direction (Rx, Ry, Rz).
- Center of Gravity: Set the center of weight for a tool.
  - Check the checkbox to enable the option.
  - If you do not use the option, all the values are set to zero.
  - Min: -700, max: 700, The unit is in mm.

- **Tool Length**: Indicates the tool length.
  - The tool length is automatically calculated but users cannot enter it on their own.
- **Payload**: Set the tool weight.
  - If not specified, it is automatically set to 0.00.
- 4. Press the Save button.
  - If successfully saved, then the **Set Active TCP** button is activated.
- 5. If you want to apply the newly set TCP profile to the robot, press the **Set Active TCP** button.
  - The robot will receive the currently selected TCP profile setting values.
- Note If no TCP is set in the robot, then the "Empty" TCP is set by default.
  Default settings for Empty TCP: Position (0,0,0); Orientation (0,0,0); Center of Gravity (0,0,0) with the Use check box cleared.

## **Calculating the TCP position**

By using the direct teaching function, you can calculate the position of TCP.

To calculate the position of TCP accurately, receive the position data from various angles with respect to one point and analyze them.



After moving a tool to face a certain point at P1, enter the position data. After that, move to an arbitrary point, P2 and let it face the same point and enter the position data. Proceed this way until you have at least three points. The angle between each point (A, B) should be at least 10°.

Note	•	A tool is not included in the product package.
	•	The TCP location may not be calculated correctly depending on the
		tool shape or the TCP movement.
	•	Since only the TCP location is calculated, you should enter the weight
		and the center of gravity of the tool before direct teaching.

To calculate the position of TCP, proceed as follows.

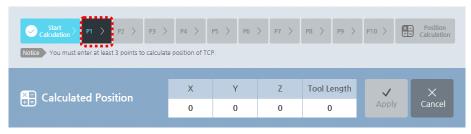
1. After pressing the  $\mbox{Edit}$  button, press the  $\mbox{Position}$  button.

<ul> <li>Default TCP</li> </ul>	TCP1				
		Gripper2		∽ Rer	name Add
	Robot	Position	Orientation		of Gravity e Center of Gravity
× ( ( ) )		Х	0 RX	0 CX	0
z		Υ	0 RY	0 CY	0
ţ		Z NOTICE Use coordi	0 RZ	0 CZ	0
Pic.1	/ 1	ool Length 0	in Payl		0 lb
TCP Calculatio	n the side to		ition	25 Orient	ation -
auto-calculate Position a of the tool.	ind Orientation		ilation	Orient Calcul	ation 📀
	1				
Delete Edit Save	2			Cancel	Set active TCP
·····					

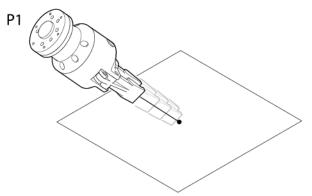
2. Press the **Teaching** button.

● Default TCP TCP	1					
	Gri	pper2			✓ Rename	Add
		ition	Orie	ntation	Center of G	i <b>ravity</b> Iter of Gravity
X ( ( ) )		K	0 RX	<b>(</b> 0	CX	0
z		(	0 RY	0	CY	0
Ŷ			0 RZ	C 0		0
Pic.2		Length 0		in Payload	0	lb
Start P1 > P2 > P3	> P4 >	P5 > P6	> P7 >	P8 > P9 >	P10 > 🗶	Position Calculation
Notice You must enter at least 3 points to calcu	late position of TC	Ρ.				
	х	Y	Z	Tool Length		×
Calculated Position	0	0	0	0	Apply	Cancel

- 3. Press the **P1** button when it is activated.
  - If you press the P1 button, the Manual Move screen will appear.



- 4. While pressing down the **Direct Teaching** button in the **Manual Move** screen, move the robot arm to place the tip of the tool right at the reference point.
  - For more descriptions on the **Manual Move** screen, refer to 5.3 Manual Move Screen.



- 5. In the Manual Move screen, press the OK button.
- 6. When the **P2** button is activated, repeat steps 3 through 5.
  - An error will occur if the previously inputted coordinate and the currently inputted coordinate do no differ by more than 10°. The point button with errors will be marked in red. If an error occurs, then you need to change and reset the angle for that point.



• The more the point data is, the more accurate the calculation result becomes. You can set the maximum 10 points.

- 7. Press the Calculate button.
  - The **Calculate** button will be activated only if the minimum three points are set properly.

Start Calculation P1 O P2 P3 P3 P3 Notice You must enter at least 3 points to calculate			; > P7 >	P8 > P9 >		Position Calculation
Calculated Position	X	Y	Z	Tool Length		×
	0	0	0	0	Apply	Cancel

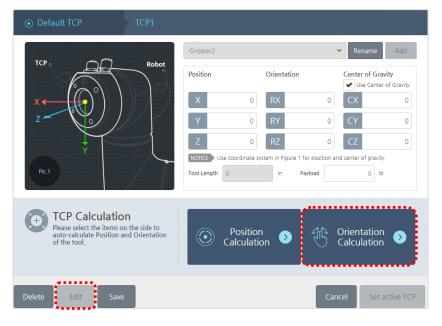
- 8. Check the calculated position result and press the **Apply** button.
  - Press the **Cancel** button to cancel the task.

E Calculated Position	х	Y	Z	Tool Length	~	×
	0	0	0	0	Apply	Cancel
					*******	

#### **Setting the TCP orientation**

You can calculate the orientation of the tool in the tool coordinate system automatically.

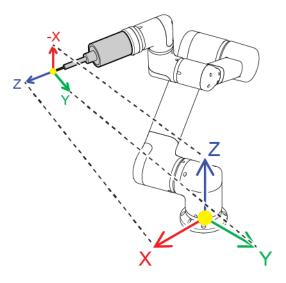
1. Press the Edit button and press the Orientation button.



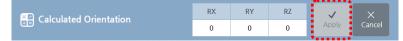
- 2. Press the Set Orientation button.
  - If you press the **Set Orientation** button, the **Manual Move** screen will appear.

⊙ Default TCP TCP1		
×	Gripper2	✓ Rename Add
	Position Orientation	Center of Gravity See Center of Gravity
Z	X 0 RX	0 CX 0
	Y 0 RY	0 CY 0
	Z O RZ	0 CZ 0
Pic2 X Robot	NOTICE Use coordinate system in Figure 1 for po Tool Length 0 in Payload	
Orientation Please align the orientation of XYZ axis of th coordinate, (see Figure 2)	e tool to the orientation of robot base's	Set Orientation <b>&gt;</b>
Tool Z Robot X Tool X(-X)	Robot -Z(Z) Tool Y Robot Y	
E Calculated Orientation	RX RY RZ	V X
Calculated Orientation	0 0 0	Apply Cancel

- **3.** In the **Manual Move** screen, use jog control and **Direct Teaching** button to adjust the tool orientation as follows.
  - For more details on the **Manual Move** screen, refer to 5.3 Manual Move Screen.
  - As shown in the figure below, let the Z, -X, and Y axes for the tool face the same direction as the X, Z, and Y axes for the robot base respectively.

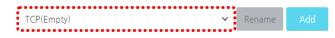


- 4. In the Manual Move screen, press the OK button.
- 5. Press the **Apply** button to apply the settings to the system.
  - Press the **Cancel** button to cancel the task.



#### **Changing the TCP profile name**

1. Select the TCP setting profile to modify.



- 2. Press the **Edit** button.
- 3. Press the **Rename** button.
- 4. Enter the desired name and press the **OK** button.
  - You can enter the max 25 letters but cannot use special characters.
- 5. Press the **Save** button.

#### **Editing the TCP profile**

After checking the name of TCP profile currently used by the selected robot, and proceed as follows.

- 1. Select the TCP profile to edit.
- 2. Press the **Edit** button.
  - You cannot edit the TCP profile currently being used by another robot.
  - You cannot edit an empty profile.
  - While you are editing it, the **Set Active TCP** button is deactivated.
- 3. When you are finished with modifications, press the **Save** button.
  - When you are finished with saving, the Set Active TCP button is activated.
  - If you want to revert the modified settings to the previous setting, then press the **Cancel** button.

# **Deleting the TCP profile**

After checking the name of TCP profile currently used by the selected robot, and proceed as follows.

1. Select the TCP profile to modify.

#### 2. Press the **Delete** button.

- You cannot delete the TCP profile currently being used by another robot.
- You cannot delete an empty profile.
- 3. Press the **OK** button.

# 7.3 Setting Inputs/Outputs

By changing the name of I/O used by the controller, you can make sure they are easily detected and also assign a function to be executed depending on the input/output signals.

In the main menu, select **C** Robot Setting > I/O Setup.

#### **Types of digital I/O**

There are three types of digital I/O as follows.

- **Redundant I/O**: Input and output with duplexed connections for the safety purposes.
- General I/O: Input and output for general purposes.
- **Tool I/O**: Input and output related to tools.

Digital input	Digital output	Analog input	Analog output
🚍 Redundant I/O	D Tool I/O		
Type No.	Name	Command	Edit
0	D_CONF_IN_0	None	$\oslash$
<b>=</b> 1	D_CONF_IN_1	None	Ø
2	D_CONF_IN_2	None	
3	D_CONF_IN_3	None	$\bigcirc$
= 4	D_CONF_IN_4	None	
5	D_CONF_IN_5	None	
	1 2 3	4 >	
			Cancel App

#### **Editing the digital inputs settings**

Press the **Edit** *i*con for the digital I/O item to modify. The following edit window will appear.

Digital input	setting		×
Name	D_GEN_IN_0		
Command	Unassigned	► Low	~
	Cancel	ОК	

- **Name**: Use a name easy for a user to identify or the existing name.
  - You cannot use the same name already in use by another I/O.
- Max 15 letters (30 bytes) are allowed. Special characters cannot be used.
- **Command**: Set the command to be executed when the preset value (**Low/High**) is inputted or outputted to the I/O terminal.
- **Unassigned**: The I/O is not used.
- **Program Play:** Start the program.
- **Program Stop**: Stop the program.
- **Program Pause**: Pause the program.
- **Reduced Mode**: Reduce Robot Speed.

**Note** You can only change the name, if it is a redundant I/O.

#### **Editing the digital outputs settings**

Press the **Edit** (2) icon for the digital I/O item to modify. The following edit window will appear.

Digital outpu	it setting	×
Name	D_GEN_OUT_0	
Command	Program Running	~
	Cancel	

- **Name**: Use a name easy for a user to identify or the existing name.
- You cannot use the same name already in use by another I/O.
- Max 15 letters (30 bytes) are allowed. Special characters cannot be used.

- **Command**: When the robot is in the state of the set command, the value set(**Low/High**) to the output terminal is output.
- **Unassigned**: The I/O is not used.
- **Program Running**: Outputs the set value when the program is executed.
- **Program Stopped**: Outputs the set value when the program stops.

**Note** You can only change the name, if it is a redundant I/O.

#### **Types of analog I/O**

There are three types of analog I/O as follows.

- **General I/O**: Input and output for general purposes.
- **Tool I/O**: Input and output related to tools.

Dig	ital input	Digital output	Analog input	Analog output
🛞 General I	I/O 🔼 Tool	I/O		
Туре	No.		Name	Edi
8	0		A_GEN_IN_0	Ø
8	1		A_GEN_IN_1	Ø
$\bigtriangleup$	0		A_TOOL_IN_0	Ø
$\bigtriangleup$	1		A_TOOL_IN_1	Ø
				Cancel

### **Editing the analog I/O setting**

Press the **Edit** (2) icon of the analog input or output item to modify and the editing window will appear as follows:

Analog ing	×	
Name	A_GEN_IN_0	
	Cancel	

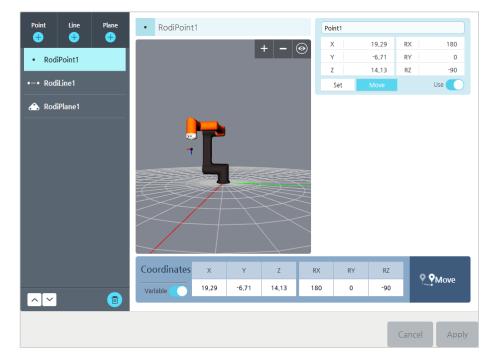
- **Name**: Use a name easy for a user to identify or change the existing name.
  - You cannot use the same name already in use by another I/O.
  - Max 15 letters (30 bytes) are allowed. Special characters cannot be used.

**Note** For analog I/O, you can only change its name.

## 7.4 **Coordinates**

You can set the location information that is available in the program and other setup menus.

From the main menu, select 😴 Robot Settings > coordinates.



- Point: Add a point.
- Line: Add a line consisting of two points.

- Plane: Add a plane consisting of 3 points.
- Coordinates generated by a point, a line, and a plane are available when you a variable is selected.

Points consisting of each of them are available when Enable is selected.

When you select the name of a point, the input tool that allows you to edit is displayed. (Up to 25 characters)

#### **Registering points**

You can add and set point coordinates.

• The position where the point coordinates are set becomes the reference position, and the coordinate system is set to the same coordinate system in which TCP was set.

#### **Registering line coordinates**

You can add and set line coordinates.

- Click point 1 and point 2 to set two points to define a line.
- Coordinate system information
  - Reference point: The first point becomes the reference point.
  - Y axis: The direction of the first point to the second point is the Y axis.
  - Z axis: This becomes the robot's Z axis.
  - X axis: This is set to the other axis.

#### **Registering plane coordinates**

You can add and set plane coordinates.

- To define a plane, set point 1, point 2, and point 3 in sequence.
- Coordinate system information
  - Reference point: The first point becomes the reference point.
  - Y axis: The direction of the first point to the second point is the Y axis.
  - Z axis: Select the Z axis using the right-hand rule in three rotation directions together with the third point.
  - X axis: This is set to the other axis.

# 7.5 Configuring MODBUS TCP

TCP based MODBUS is supported as an extended interface to communicate with external devices such as PLCs. It is implemented in software and enables to set lots of IOs.

From the main menu, select **Robot Setting** > **MODBUS TCP**.

DEVICE 🕂 🗊	MODBUS I/O				+ 6
⊘ local	Status Value	Response Type time(ms)	Address	Name	Edit
127.0.0.1	<b>-0-</b> 0	1 register_inpu	t 300	MODBUS_1	$\oslash$
	<b>-0-</b> 900	2 register_inpu	t 304	MODBUS_2	$\oslash$
	<b></b> 0	3 register_inpu	t 305	MODBUS_3	$\oslash$
		3 digital_outpu	t 17	MODBUS_4	$\oslash$
	<b>-</b> 25	1 register_outpo	ut 2	MODBUS_5	
	- <b>O</b> -Connected - <b>O</b>	-DisconnectedDinvalid inpu	t value 🔶 Devi	se busy <b>-O-</b> Invalid	address

### **Registering Devices**

To use MODBUS I/O, register a device to share I/O information with.

1. Press the Add + button.



- 2. Enter following information in the Add Device screen and press the Add button.
  - **Device Name**: Enter the device name to be displayed on the screen.
  - **IP Address**: Enter the IP address of the device.
  - **Slave ID**: Enter the slave ID of the device. Its input range is 0 to 255 in the 3-digit integer form.
  - **Description**: You may enter the description for the device. You can enter up to 25 characters.

Add Device		×
Device Name		
IP Address	Slave ID	255
Description		
	Cancel Add	

#### **Editing/copying the device settings**

You can modify settings for a device previously registered or copy the device settings to use as settings for a new device. When copying, I/O information of the device is also copied.

1. Press the Edit 🖉 button from the list of registered devices.



- 2. Modify items you want to change and press the **OK** button. Or, press the **Copy** button if you want to copy the device settings to use as settings for a new device.
  - When you press the **Copy** button, the settings of the device currently selected and information of I/Os under the device are also copied and added to the list. The name of the newly created device is the name of the device copied from with '\_number' added.

E	dit Device		×
	Device Name	local	
	IP Address	127 0 0 1 Slave ID	255
	Description		200
	beschpaton		
		Cancel OK Copy	

### **Deleting a device in the list**

- 1. Select a device to delete from the list.
  - Check the check box for the device.



- 2. Press the Delete 💼 button, and then press the **OK** button.
  - When you delete a device, I/Os for the device will be deleted as well.



### **Registering I/O**

After you registered a device, you must set an I/O or I/Os for it. The I/O(s) added is(are) used to read a certain value from the device or to send HCR status values to it.

The type of I/Os for the MODBUS are as follows:

- **Digital Input**: Reads digital values (High/Low) from a device.
- **Digital Output**: Sends digital values (High/Low) to a device.
- **Register Input**: Reads 2-byte values (0-65535) from a device.
- **Register Output:** Sends 2-byte values (0-65535) to a device.
  - 1. Select a device to add an I/O to from the device list.
    - When a device is selected, I/Os currently added to it are displayed.
  - 2. Press the Add + button.

DEVICE	+	• MOD	BUS I/O					4	
(√) local			Status	Value	Response time(ms)	Туре	Address	Name	Edit
127,0,0,1			-0-	0	1	register_input	300	MODBUS_1	$\oslash$
			-0-	900	1	register_input	304	MODBUS_2	$\oslash$
			-0-	0	1	register_input	305	MODBUS_3	$\oslash$

- 3. Enter information of the I/O and press the **OK** button.
  - **Name**: Enter the user identifiable name of the I/O.
  - Signal Address: Enter the pre-defined address to be used for the I/O.
  - **Type**: Select Digital I/O or Register I/O.
  - **Frequency**: Select the frequency of data transmission for the I/O. Available frequency values are 0, 1, 2, 5 and 10.

MODBUS Setting	)		×
Name	MODBUS_2	Signal Address	0
Туре	Register Input		•
Advanced Option			
Frequency[Hz]	10		-
	Cancel	ОК	

**Note** You can use I/Os when you make a program. Especially, you can use register-type I/Os as variables in a program.

#### **Viewing the communication status**

Response time(ms) Status Value Address Edit Туре Name Ø ~ -0-27 0 Register Input 300 MODBUS\_1 0 -0-MODBUS\_5 ¥ 1567 0 Register Input 304 -0-MODBUS\_6 Ø 27 0 305 Register Input -0-Θ 0 MODBUS\_7 0 Digital Output 0 0 0 MODBUS\_8 0 0 1 Register Output

After an I/O is registered, you can view its communication status.

-0-	Normal
-0-	Unable to connect
-0-	Input value error
-0-	Device response delay
-0-	Address error

### **Viewing and setting the I/O values**

After an I/O is registered, you can view or set its value.

	Status	Value	Response time(ms)	Туре	Address	Name	Edit
✓	-0-	27	0	Register Input	300	MODBUS_1	
~	-0-	1567	0	Register Input	304	MODBUS_5	
	-0-	27	0	Register Input	305	MODBUS_6	
	-0-	$\bigcirc$	0	Digital Output	0	MODBUS_7	
	-0-	0	1	Register Output	0	MODBUS_8	

- Digital Input: Indicates an icon for the digital value (High/Low) currently being input.
  - 🔘: High
    - ⊖: Low

- Digital Output: Indicates an icon for the digital value (High/Low) currently being output. Press the value to change it.
  - 🔘: High
  - 🔘: Low
- Register Input: Indicates the value currently read from the device.
- Register Output: Indicates the value being currently sent to the device. Press the value to change it.

#### **Editing I/O settings**

- 1. Press the Edit 🖉 button of an I/O to be modified from the I/O list.
- 2. Modify the settings and press the **OK** button.
- **Note** It is not allowed to change the I/O type. To change the type, you must delete the I/O setting and add it again.

## **Deleting I/O**

1. Select an I/O to delete from the I/O list.

MOI	DBUS I/(	e					
	Status	Value	Response time(ms)	Туре	Address	Name	Edit
•	•	27	0	Register Input	300	MODBUS_1	
•	-0-	1567	0	Register Input	304	MODBUS_5	Ø
	<b>-</b>	27	0	Register Input	305	MODBUS_6	
	•	$\bigcirc$	0	Digital Output	0	MODBUS_7	
	•	0	1	Register Output	0	MODBUS_8	

2. Press the Delete 🔟 icon.

MO	•						
	Status	Value	Response time(ms)	Туре	Address	Name	Edit
•	-0-	27	0	Register Input	300	MODBUS_1	
•	-0-	1567	0	Register Input	304	MODBUS_5	$\oslash$
	-0-	27	0	Register Input	305	MODBUS_6	$\oslash$
	-0-	$\bigcirc$	0	Digital Output	0	MODBUS_7	
	-0-	0	1	Register Output	0	MODBUS_8	$\oslash$

# 7.6 Setting Global Variables

You can set the global variables that are available and shared by many programs by restarting the system.

	Name	Туре	Value	Edit
	g_var_1	number	5	Ø
	g_var_2	number	41	$\oslash$
		Add global varia Name g_var_3 Value Cancel		
		« <	1 > >>	
Add	Delete			

- Variable name: Specifies a variable name.
  - Up to 10 characters (20 bytes) can be entered.
- Variable value: Specifies a variable value.
  - Range: -2147483647 2147483647

# 7.7 I/O Bit Operation

You can combine the values of multiple digital I/O inputs, and assign them to variables or assign them to actions.

	D_GEN_IN _0	D_GEN_IN _1	D_GEN_IN _2	D_GEN_IN _3	D_GEN_IN _4	D_GEN_IN _5	D_GEN_IN _6	D_GEN_IN _7	Value	Function
	$\bigcirc$	0	1	Program Stop 🗸						
	$\bigcirc$	$\bigcirc$	$\bigcirc$	$\bigcirc$	$\bigcirc$	$\bigcirc$	0	0	3	Program Play V
	$\bigcirc$	$\bigcirc$	$\bigcirc$	$\bigcirc$	$\bigcirc$	0	$\bigcirc$	$\bigcirc$	4	Program Pause V
	$\bigcirc$	0	Unassigned 🗸							
Add	Dele	ete								Cancel

#### **Add/Delete**

Add or delete bit operation settings.

- Clicking the Add button adds one setting, and the initial value of each IO is displayed as Low.
- The Delete button is enabled when any check box in a row is selected. If it is clicked, the selected row will be deleted.
- Settings cannot be added while the program is running or started.

#### I/O bit operation settings

Set I/O bit operation value and assign a function.

- Each time you click the I/O bit icon, it changes, through a sequence of Low/High/Disable.
- High is assigned to 1, Low is assigned to 0, and the bit operated value is displayed in the value field.
- The IO of the bit set to Disable is treated as '0' regardless of the actual value received.

# Chapter 8 Safety Settings

After configuring the installation settings, you must configure the safety settings to protect users against the dangerous situation that can arise during robot operation.

# **Warning**

Make sure to check safety settings immediately after the robot is installed. In addition, all of the functions for safety settings must be regularly checked.

# 8.1 Limiting Robot Movement

To guarantee the user's safety while interacting with the robot, you can make sure that the angle and speed of robot joint does not exceed a certain limit.

Press Safety Setting > Motion Limit in the main menu.

Preset	High-lin	nit 🖉 🚽	(V	(V		Low-limit
Force	(Nm)	Speed(in/s)	Coll	ision mitigation	Speed(Reduced m	iode)(%)
25	150 35 0.	<b>0</b> 39.37	7 🗸 Ena	ble Disable	1 100	50
Joint Rot	ation(°)	Joint Speed(°/s)				
	Min	Ma	x	Min		Max
Joint1	-360	360	Joint4	-360		60
Joint2	-360	360	Joint5	-360		60
Joint3	-165	0 165	Joint6	-360		60

#### **Default settings**

Depending on the limitation on each item, four sets of default settings are provided.

If you want to use the default setting, check **Preset** and select one out of the four choices.

Preset	High-limit		$\bigcirc$	$\bigcirc$		Low-limit
--------	------------	--	------------	------------	--	-----------

### **Manual setting method**

If you want to set each item on your own, you can use the adjustment bar to change the value while **Preset** is not checked. Or, after pressing the input box, you can enter your own inputs.

Force(Nm)	Speed(in/s)	Collision mitigation	Speed(Reduced mode)(%)
25 150 35	0.1 39.37 39.37	✓ Enable Disable	1 100 50
Joint Rotation(*)	Joint Speed(*/s)		
Min	Max	Min	Max
Joint1 -360	360	Joint4 -360	360
Joint2 -360	360	Joint5 -360	360
Joint3 -165	165	Joint6 -360	<b>O</b> 360

There are several ways to limit the robot's movement.

- Force: You can limit the max force that the robot(TCP) is exerting to the outside.
- **Speed**: You can limit the max speed for the TCP's linear movement.
- **Collision mitigation**: This can be set to mitigate the impact of a target object in the event of a collision.
- **Deceleration mode speed (%)**: Sets the speed in deceleration mode. When deceleration mode is applied, a red alarm occurs at the top of the screen. Clicking the alarm moves you to the initial screen.
- Joint Rotation: You can limit the angle of each joint.
- Joint Speed: You can limit the speed of each joint.

Press the **Cancel** button to revert the settings newly changed by a user in the current tab (general mode or deceleration mode) to the previous value.

When the settings are complete, press the Apply button to apply it to the robot.

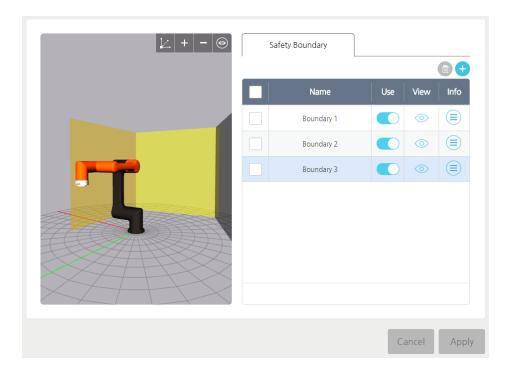
# $\cancel{!}$ Caution

- The joint speed cannot be limited with the **Speed** option. You can limit the joint speed only with the options in the **Joint Speed** tab.
- If the temperature of the operating environment for the robot arm is not greater than 10 °C during the initial start, collision detection may occur due to the limited force. If such problem occurs, increase the limit value of Force sufficiently, operate it at a low speed for about 30 to 60 minutes for preheating, and lower the Force value to use it.

## 8.2 Setting Safety Boundaries

To improve user safety, you can build virtual fences around the robot to prevent the robotic arm or tool from moving beyond the boundary of these virtual fences.

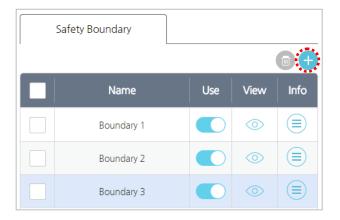
Press Safety Setting > Safety Boundary in the main menu.



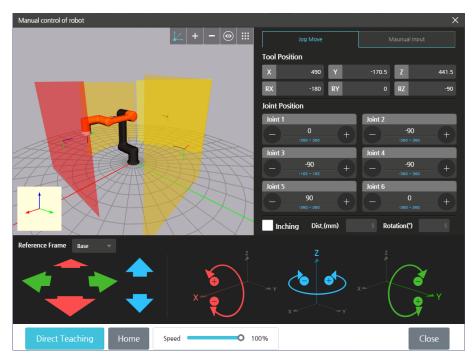
#### **Adding safety boundary planes**

After adding multiple safety boundary planes, if necessary, you can select one of them and use it.

- 1. To add a boundary plane, press the Add 🛨 button.
  - If you press the Add  $\oplus$  button, the **Manual Move** screen will appear.



2. In the **Manual Move** screen, use jog control and **Direct Teaching** button to set the boundary position.



- For more details on the **Manual Move** screen, refer to 5.3 Manual Move Screen.
- Your safety boundary will be created in a location that is separated from the center axis of the flange as much as the TCP length set in the TCP.
- 3. To save the settings, press the **OK** button.

#### **Viewing safety boundary planes**

Press the icon in the **View** column to hide or unhide the safety boundary plane in the preview screen.

Name	Use	View	Info
Boundary 1		$\odot$	
Boundary 2		0	
Boundary 3		$\odot$	

- : To display in the preview screen.
- Ø: Not to display in the preview screen.

Press the Info  $\bigcirc$  icon to check the coordinates for the safety boundary.



- **Point**: Indicates the center of the 3–D where the center of the safety boundary is located.
- **Direction**: Indicates the direction(vector) for the border plane that can indicate a collision with the safety border in the controller. (Blue Z-axis on the screen)

#### **Applying safety boundaries**

1. Activate the boundary for use.

Name	Use	View	Info
Boundary 1		$\odot$	
Boundary 2		$\odot$	
Boundary 3		$\odot$	

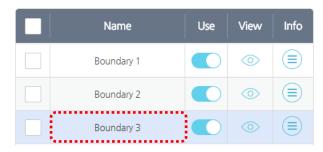
- C: To use
- O : Not to use
- 2. Press the **Apply** button.
  - Press the **Cancel** button to cancel the modifications and revert to the previous settings.

**Note** If there are eight or more safety boundary planes in the list, press the up/ down button to scroll.

#### **Changing the name of safety boundaries**

If you add a safety boundary, it will save as "Boundary" and a number by default.

1. Press the name of boundary to modify.



2. Enter the desired name and press the **OK** button.

Bounda	ary Name Edit	×
Name	new name	
	ОК	

## **Deleting safety boundary settings**

1. Select the safety boundary to delete.

	Name	Use	View	Info
<ul><li>✓</li></ul>	Boundary 1		$\odot$	
•	Boundary 2		0	
	Boundary 3		Þ	

2. Press the Delete 🔟 button.



3. Press the **OK** button.

# 8.3 Setting Tool Boundaries

The user sets the safety boundary of the set tool, so that the tool does not go beyond the safety boundary of the set working area.

Safety Boundary Tool Boundary	
Name Use	
📀 aaa 💽	
Coordinate	
	0
Width 100 mm V 0 RY	0
Height 100 mm Z 0 RZ	0

## **Adding Tool Safety Boundary Surfaces**

The safety boundary of the tool can be set only for TCP settings that have already been set.

- **4.** Select the Tool Boundary tab and select an item with the name of the TCP you want to set from the list.
- 5. When you set the selected TCP to **Use**, a box-shaped tool safety boundary is created on the screen by default.



6. The tool boundary surfaces can be set in the following 4 types:

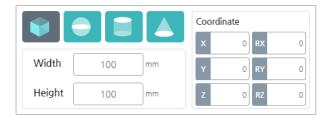


- Box: Box-shaped boundary surface with TCP as the center having the Z axis of the TCP as the height and the X axis as the width
- Sphere: Spherical boundary surface with constant radius and with TCP as the center
- Cylinder: Cylindrical boundary surface with TCP as the center, having a height in the Z-axis of TCP
- Cone: Cone-shaped boundary surface with TCP as the center, having a height and direction in the Z-axis of TCP

For<br/>referenceThe TCP currently applied to the robot is marked with the Each boundary surface of the tool has the same coordinate axes as TCP's<br/>coordinate axes.

#### **Setting Tool Safety Boundary Surfaces**

- **7.** The boundary surfaces of the tool set to Use are set to a box by default. The user selects one of the four boundaries for the shape of the tool or the desired shape.
- 8. The selected boundaries are displayed on the screen, and the radius, height, width, etc. are set according to the selected form. In addition, you can move and set them based on the TCP coordinates, and enter the rotation angle along the coordinate axis.



#### **Applying Tool Safety Boundary Surfaces**

- 9. Switch the boundary surface you want to set to the TCP to Use or Not Use.
- **10.** Press the **Apply** button.

Press the **Cancel** button to cancel the current settings and return to the previous setting.

For	Pressing the Apply/Cancel buttons simultaneously applies the safety
reference	boundary of the working area $\operatorname{to}$ the safety boundary of the
	tool.

## 8.4 Setting Redundant I/O

To guarantee the safety of the I/O terminal or input/output the important data, you can opt for using a redundant I/O, not a single I/O. If you set the redundant I/O, you are no longer checking a single I/O value. Instead, the two designated inputs or outputs check the High or Low signals to determine validity of values.

In	the mai	n menu,	press 🥝	Safety	Setting)	Redundant I/O.
----	---------	---------	---------	--------	----------	----------------

Input 1		Input 2		Function	
D_CONF_IN_0	~	D_CONF_IN_1	~	Unassigned	``
D_CONF_IN_2	~	D_CONF_IN_3	~	Unassigned	~
D_CONF_IN_4	~	D_CONF_IN_5	~	Unassigned	~
D_CONF_IN_6	~	D_CONF_IN_7	•	Unassigned	~

There are two tabs – digital input and digital output. Select the tab to set and proceed as follows.

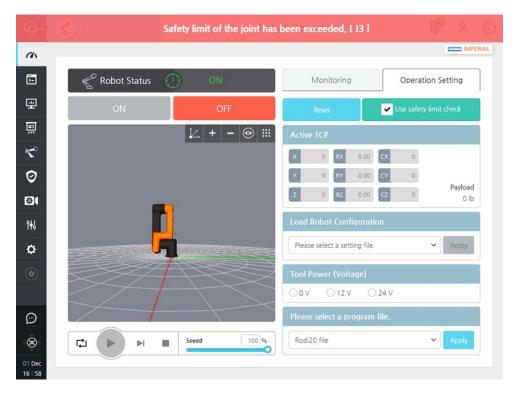
- In case of digital inputs, the function will operate if the input is high or low.
- In case of digital outputs, the high or low signal is sent for the assigned function.
  - 1. Press the Add button.
  - 2. Select an I/O terminal to be used as redundant I/O.
  - 3. Set the function to be assigned.
    - You can assign the following functions to digital inputs.

- **Unassigned**: The function is not assigned.
- **Emergency Stop:** If the two designated inputs are all Low (0) and the actual emergency stop button is released, it operates as if the emergency stop button is released; and if any of the inputs is High (1), it operates as if the emergency button is pressed.
- You can assign the following functions to digital outputs.
  - **Unassigned**: The function is not assigned.
  - **Emergency Stop**: If the two designated IOs are in the emergency stop state, Low (0) is output. Otherwise, High (1) is output. When a physical emergency stop button is pressed, it operates even when the designated IO is in the emergency stop state.
  - **Robot Moving**: If the robot moves, the designated output terminal outputs Low (0). Otherwise, it outputs High (1).
  - **Robot Not Stopping**: The designated output terminal outputs High (1) till the time point when the stop command is performed after the stop command is ordered to the robot. Otherwise it outputs Low (0).
- 4. Press the **Apply** button.
  - Press the **Cancel** button to revert to the previous settings.

Note	User can name each I/O on their own. For more details, refer to 7.3 Setting
	Inputs/Outputs.

# 8.5 Exceeding Safety Limit of Joints

If the safety limit of any joint is exceeded, information on the joint exceeding the safety limit is displayed at the top of the screen, as shown in the figure below.



If the safety limit of a joint is exceeded, the system will not operate normally. Therefore, the operating range must be safely set to the normal range, through the following procedure.

- **1.** Go to the administration screen by selecting the administration menu or clicking the top guidance message.
- 2. Uncheck 'Use Safe Settings.'
- **3.** Click the 'Reset' button to perform a reset, then click the 'Start' button.
- **4.** Click Manual Manipulation at the bottom left to go to the manual control screen.
- 5. Joints that exceed the safety limit are controlled to be within the normal range by using the jog button.
- 6. If they are within the normal range, return to the operating screen.
- 7. Check 'Use Safe Settings'.

# Chapter 9 Programming

You need to program the movement ahead of time if you want your robot to perform a certain task.

To program your robot, select 🖻 **Programming** in the main menu.

# 9.1 How to Use Commands

#### **Selecting a flowchart**

There are two types of flow charts - main and sub.

6	3 Sub	2 تیت Thread	•	<b>e</b>	°℃₊° ĭf	CX loop		<b>ූ</b> witch	(C) wait	<b>K</b>	<b>≯</b> ≥t su	<> bprogram	ı	(x) Variables	Comn	الم Edit
Main Pro 24.2(s)	ogram	\$	<b>0</b>	<b>LQ</b>	J 0.1s	205	R R 0.1s	0.85	J <b>Q</b> 0.8s	1.1s	00 1.0s					
≡ Tree	5 UI	ndo 🔿	Redo	<				$\rightarrow$	Prog	ram Nan	ne: Rodi	20				

- Main Program: In this screen, you can input or modify the main program.
- **Sub Program**: In the main program, you can call multiple sub programs for use. Press the **Sub** tab to move to the screen where you can create or edit a sub program. For more details about the sub program, refer to 9.16 Using a Sub Program.
- **Thread Program**: This is a program creation screen that is executed in parallel with the main program.

# Type of commands

You can use the following commands in your programming – Move, If, Loop, Switch, Halt, Wait, Set, Loop, Pattern, Sub Program, and Vision.



		Set the point that the TCP will move to.
	Move	•
•-•-•		For more details, refer to 9.7 Move command.
~~~	TC	Branch the commands based on the conditions.
\ <sub>+</sub>	If	For more details, refer to 9.8 IF Command.
		Repeat a specific command.
S	Loop	For more details, refer to 9.9 LOOP Command.
		·
۲°	Switch	Branch the command for each case of the designated variable.
ىت	Switch	For more details, refer to 9.10 SWITCH Command.
		Tell the robot to wait until the condition entered by the user is
Ċ,	Wait	met. For more details, refer to 9.11 Wait Command.
		Create output signals, variables and TCP profile.
<b>O</b>	Set	For more details, refer to 9.12 Set Command.
ø		For more details, refer to 9.12 Set Command.
Ø	Sub	For more details, refer to 9.12 Set Command. Call a sub program.
<b>Q</b> 		For more details, refer to 9.12 Set Command.
<b>₽</b>	Sub Program	For more details, refer to 9.12 Set Command. Call a sub program. For more details, refer to 9.15 Using a Sub Program.
Q (x) Variables	Sub	For more details, refer to 9.12 Set Command. Call a sub program.
	Sub Program	For more details, refer to 9.12 Set Command. Call a sub program. For more details, refer to 9.15 Using a Sub Program. You can manage the variables required for program creation.
	Sub Program	For more details, refer to 9.12 Set Command. Call a sub program. For more details, refer to 9.15 Using a Sub Program. You can manage the variables required for program creation. Indicates that additional commands can be used in addition to
	Sub Program Variables	For more details, refer to 9.12 Set Command. Call a sub program. For more details, refer to 9.15 Using a Sub Program. You can manage the variables required for program creation.
	Sub Program Variables Commands	For more details, refer to 9.12 Set Command. Call a sub program. For more details, refer to 9.15 Using a Sub Program. You can manage the variables required for program creation. Indicates that additional commands can be used in addition to the basic commands.
	Sub Program Variables	For more details, refer to 9.12 Set Command. Call a sub program. For more details, refer to 9.15 Using a Sub Program. You can manage the variables required for program creation. Indicates that additional commands can be used in addition to

### **Additional Commands**

In addition to the basic commands, the additional commands that appear when the View Command button is clicked are Folder, Message, Halt, Conveyor, Vision, Pattern, Script, and Path.

Additional C	Command	S						×
Basic	move	°℃• if		දූ switch	C) wait	© set	<>> subprogram	
	folder	(c) message	halt	conveyor				
Advanced	(Q) vision	Pattern	{/} script	<b>Path</b>				

	Folder	Groups the created program command icons and bundles the programs into a sub-folder.
$\bigcirc$	Message	Define Message Type.
۲	Halt	Terminate the program.
â	Conveyor	Set the operation to be linked with conveyor's movement
Q	Vision	Use a vision equipment to scan an object. For more details, refer to 9.18 Vision Command.
$\bigcirc$	Pattern	Tell the robot to move according to the predefined pattern. For more details, refer to 9.15 PATTERN Command.
{/}	Script	Provides Editor to edit scripts.
<b>**</b>	Path	Enables the user to directly grasp the robot arm and create motion in order to generate the motion of the robot.

#### **Entering commands**

Each time you press a command, it is inputted in the timeline one by one.

	Thread	• ma		℃ ŕ			<b>ූරී</b> witch	(C) wait	¢ se		<>	•	(x) Variables		mands	۲ Edit
Main Program 24.2(s)	♦	٢	<b>۲</b>	J <b>Q</b>	٥	လာ							20:	R R 0.1s	L. 9	J <b>Q</b> 0.8s
LOOP659077 0(s)	♦					٥	C	L <b>9</b>	LO	ĻQ	10	ĻQ				
i≡ Tree 🔈 Un	ndo [⊂	Redo	<					Prog	ram Nan	ne: Rodi	20					<u>^</u> _
	M		Speed			100 %			Т	empla	ite	Fi	e <sup>+</sup>	Car	ncel	App

- After programming is complete, select the icon 🗾 to repeat the entire program continuously.
- If it overflows to the next screen due to too many commands in the flow line, you can press the up/down and or left/right states buttons to scroll.
- At the start of the program, you can initialize variables, IO, robot posture, etc. using the initialization icon **O**. This initialization icon cannot be deleted.

#### **Check Icon Status**

The status of the icon indicates the status of the newly added command and the modified command.



Command that do not change any parameter after adding new.



- Command which value has been modified.
- When the program is saved, the current icon state is maintained.
- When clicking the Apply button, all icons are changed to normal state.

#### Changing command names

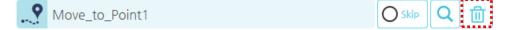
Each command offers an option necessary for execution. The same command yields a different result depending on the option setting, so you can designate a different name for each command.

After entering a command in the timeline, press the command name to modify the name.



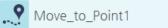
#### **Deleting commands**

- 1. Select a command to delete in the timeline.
- 2. Press the **Delete** button.



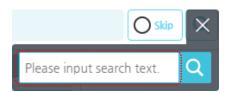
### **Searching Commands**

1. Click the Search button to display the search function on the screen.





2. Enter the name of a command to be searched, and perform a search.



**3.** If there is a searched command, the number of searched commands is displayed, and you can easily find the command by using the left/right navigation button.



### **Skipping Commands**

For each command created in the program, you can skip without executing a specific command during program execution.

1. Check the Skip setting.

MOVE32911

9

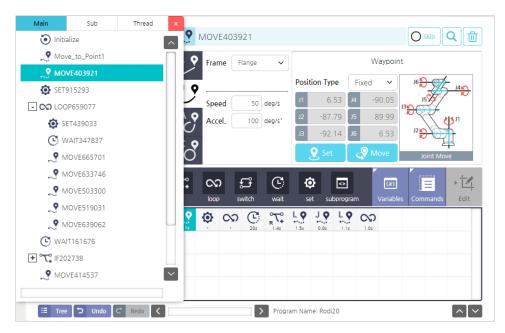


**2.** Commands that have been set to Skip are grayed out, and will not be executed during program execution.

O     S     S     S     S     S     S     S     S     S     S     S     S     S     S     S     S     S     S     S     S     S     S     S     S     S     S     S     S     S     S     S     S     S     S     S     S     S     S     S     S     S     S     S     S     S     S     S     S     S     S     S     S     S     S     S     S     S     S     S     S     S     S     S     S     S     S     S     S     S     S     S     S     S     S     S     S     S     S     S     S     S     S     S     S     S     S     S     S     S     S     S     S     S     S     S     S     S     S     S     S     S     S     S     S     S     S     S     S     S     S     S     S     S     S     S     S     S     S     S     S     S     S     S     S     S     S     S     S     S     S     S     S     S     S     S     S     S     S     S     S     S     S     S     S     S     S     S     S     S     S     S     S     S     S     S     S     S     S     S     S     S     S     S     S     S     S     S     S     S     S     S     S     S     S     S     S     S     S     S     S     S     S     S     S     S     S     S     S     S     S     S     S     S     S     S     S     S     S     S     S     S     S     S     S     S     S     S     S     S     S     S     S     S     S     S     S     S     S     S     S     S     S     S     S     S     S     S     S     S     S     S     S     S     S     S     S     S     S     S     S     S     S     S     S     S     S     S     S     S     S     S     S     S     S     S     S     S     S     S     S     S     S     S     S     S     S     S     S     S     S     S     S     S     S     S     S     S     S     S     S     S     S     S     S     S     S     S     S     S     S     S     S     S     S     S     S     S     S     S     S     S     S     S     S     S     S     S     S     S     S     S     S     S     S     S     S     S     S     S     S     S     S     S     S     S     S     S     S     S     S     S     S     S     S     S     S     S     S     S	)	_									
L S	L • 1.9s	L <b>Q</b> 1.9s	L <b>Q</b> 1.1s	<b>L O</b> 0.9s	L <b>Q</b> 0.9s	L <b>Q</b> 1.9s	L 🛛	L • 1.9s	L <b>Q</b> 1.1s	0.9s	<b>L O</b> .9s

#### Tree

If you click the *Tree*, all the commands programed are displayed in Tree structure. The commands in the Tree and the command icons in the flowchart are displayed in synchronization with selection or program progress.



# 9.2 Setting Variables

You can manage variables such as adding/deleting/modifying variables to be used in the program. Press the variable management menu button at the end of the command list.



When you press the variable management button, a screen for variable management and monitoring is displayed at the top, as shown below.

Val3231/2         number         1837           Val878336         number         10	Ð	Init. value	Type	Name	
	Add	1837	number	Val323172	
De	靣	10	number	Val878336	
Val/04243 number 0	Delete	0	number	Val704243	
cnt number 0		0	number	cnt	

#### **Adding variables**

Press the **Add** button. If you press the **Add** button, the default name and value (0) will be automatically entered.

- Number : Variables to store numbers
- String : Variables to store string
- Boolean : Variables of True or False type
- Position: The Position of TCP
- Joint : The Values of Joints

If you select a variable type, the variable is automatically entered with the default name.

Create Var	iable			×
Туре	number		•	
		ОК		

#### **Modifying variables**

- 1. Press the field if you need to change the variable name or value.
- 2. Change it to the desired name or value and press the **OK** button.
  - The max length of variable is limited to 10 letters.
  - For a variable value, you can only enter a number. The range is from –9999999999 to 999999999.
  - Character variable's maximum length: 20 characters

#### **Deleting variables**

- 1. Check the checkbox for the variable to delete.
- 2. Press the **Delete** button and press the **OK** button.

#### **Variable Monitoring**

You can check the number of currently registered global variables and the real-time values of variables registered in the robot. Numeric variables are displayed with up to four decimal places, rounded to five decimal places.

Variables Mo	nitoring		×
Name	Туре	Value	
g_var_1	number	5	
g_var_2	number	41	
			$\land$

# 9.3 Editing programs

If you want to change the order or structure of commands entered in the timeline, then press the **Edit** menu button at the end of the command list.



**Note** You can also press the command in the timeline for more than three seconds to open the **Edit** menu.

### **Overview of edit menu**

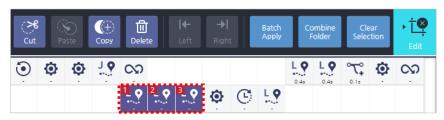


رکھ Cut	Cut	Cut the selected command. You can crop a command to another location.
Paste	Paste	Paste the cropped or copied command to the selected location.
Сору	Сору	Copy the selected command. You can copy a command to another location.
Delete	Delete	Delete the selected command from the program.
<b> ← → </b> Left Right	Left or Right	Move the selected command to the left or right in the timeline.
Batch Apply	Batch Apply	Applies the values of several selected Move commands in batches. It is activated when you select the same move command.
Combine Folder	Combine Folder	Create a folder at the end of the program and move selected icons below.
Clear Selection	Clear Selection	Cancel the selection of the command.
► ÈS Edit	Close	Close the program editing mode and return to the program screen.

#### **Example of program editing**

In this example, you can cut a command entered in the timeline and paste it onto another location.

- 1. Select a program command to be pasted onto another location.
  - The red number marked when a command is selected indicates the order of pasting.



- 2. In the edit menu, press the **Cut** button.
  - After pressing the **Cut** (or **Copy**) button, the **Select Mode** button will be activated, so that you can cancel the edit command and return to the Select Mode again.



- **3.** Select a location to paste it to.
  - Space between commands cannot be selected, so you must select the command right before the location of pasting.
  - Once a location is selected, the **Paste** button in the **Edit** menu will be activated.



- ۶Ť₿ (So Paste Batch Apply Clear Selection Combin Folder ල 😧 🔅 🔅 ලා L **Q** 0.4s ℃. ම ගා ĻQ 0.4: 0.1s 🕸 🖸 🐙 1\_ **Q** ۶Ť₿ စ် စံ 😚 လ © L? L? L?
- 4. Press the **Paste** button.

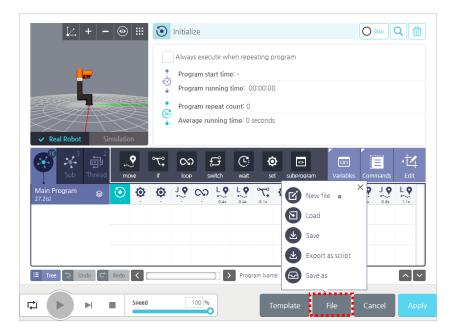
### **Undo Function**

つ Undo	Undo	You can use the edit function to undo edits made to items.
C Redo	Redo	You can redo an edit that has been undone.

Note	. Up to 50 steps are saved.
	. The edit history is initialized when you open a New File, File Open or
	Cancel.

# 9.4 Managing a Program

At the bottom of the programming window, press the **File** button to save, load or delete the program.



#### Saving a program

- 1. To save the completed program, select **File** > **Save** at the bottom of the screen.
- 2. Enter the program name and press the **OK** button.
  - Only if the program is newly saved or saved with a new name, the name input window will appear.

If you want to save the program with a different name, press **Save as** and enter the name and then press the **Save** button.

#### Making a new program

If you want to make a new program, then select **File** > **New** at the bottom of the screen.

**Note** Enter the program name when you apply or save a program.

### Loading a program

- 1. To load the saved program, select File > Load at the bottom of the screen.
- 2. Select a program to load and press the  $\ensuremath{\mathsf{OK}}$  button.

Load							
🖵 C: > Program Files > HCR	Rodi Sim > d	ata > files	Inquiry Keyword Q				
Directory	Ċ	File Name	Edited on 🗸 🗸				
> 📮 HCR Storage		🖫 Rodi20.file	02-Dec-2018 03:08:41				
		SUBPROGRAM433097.file	02-Dec-2018 03:08:40				
		🖫 sub.file	02-Dec-2018 03:08:40				
		SUBPROGRAM497142.file	02-Dec-2018 03:08:40				
File Name: Rodi20.file			OK Cancel Delete				

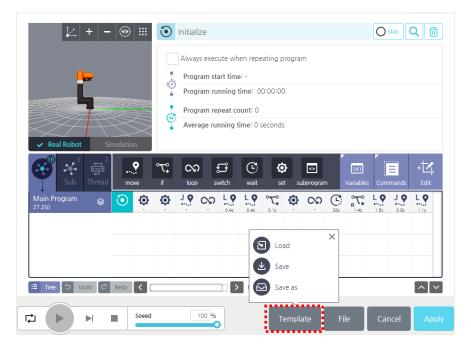
### **Deleting a program**

- 1. To delete the saved program, select File > Load at the bottom of the screen.
- 2. Select a program to delete and press the **Delete** button.

C: > Program Files > HC	Inquiry Keyword O		
Directory	Ċ	File Name	Edited on 🗸 🗸
> 📮 HCR Storage		🖫 Rodi20.file	02-Dec-2018 03:08:41
		SUBPROGRAM433097.file	02-Dec-2018 03:08:40
		🖫 sub.file	02-Dec-2018 03:08:40
		SUBPROGRAM497142.file	02-Dec-2018 03:08:40

# 9.5 Using Templates

You can save the prepared program structure as a template. Only the entire program structure is saved but the option for each command is not saved.



### Saving as a template

To save the completed program as a template, select **Template** > **Save** at the bottom of the screen.

If you want to save the template with a different name, press **Save as** and enter the name and then press the **Save** button.

### Loading a template

- 1. To load the saved template, select **Template** > **Load** at the bottom of the screen.
- 2. Select a template to load and press the **OK** button.

Load Template				×
🖵 C: > Program Files > HCR	≀Rodi Sim > d	ata > templates	Inquiry Keyword	Q
Directory	Ċ	File Name	Edited on	~
HCR Storage		Rodi20.template	05-Dec-2018 12:03:33	
File Name: Rodi20.tem	plate		OK Cancel Del	lete

### **Deleting a template**

- 1. To delete the saved template, select **Template** > **Load** at the bottom of the screen.
- 2. Select a template to delete and press the **Delete** button.

Load Template			×
🖵 C: > Program Files > HCR	Rodi Sim > d	ata > templates	Inquiry Keyword Q
Directory	Ċ	File Name	Edited on 🗸
HCR Storage		Rodi20.template	05-Dec-2018 12:03:33
File Name: Rodi20.tem	olate		OK Cancel Delete

# 9.6 Applying programs

Before applying the program results to the robot or actually using it, it is necessary to do a simulation.



If you want to link the program to an actual robot or check it in previews, press the **Apply** button. To revert it to the previous settings before the changes are made, press the **Cancel** button.



- To check it in preview, select **Simulation**.
- To link it to a real robot, select **Real Robot**.
- The entire program speed can be adjusted by using the **Speed** slide bar.

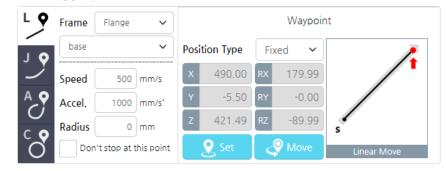
# 9.7 Move command

The command is used to move the robot arm by designating the destination and the movement method.

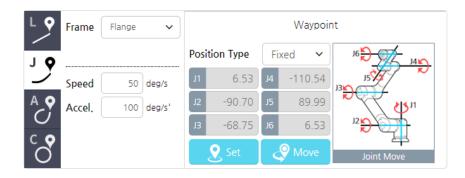
#### **Selecting a movement method**

There are three ways to move as follows and you can set the tool speed and acceleration for each method.

- **Linear**: A tool moves linearly between the starting point and the end point. To make the tool movement path a straight line, each joint tends to move in a more complex way.
  - **Frame**: Select whether to move by TCP or Flange.
  - **Reference coordinate system**: Select the reference coordinate system on which the robot moves when executing the move command.
  - Speed:  $0.1 \text{ mm/s} \sim 1000 \text{ mm/s}$
  - Accel. (Acceleration):  $0.1 \text{ mm/s}^2 \sim 2500 \text{ mm/s}^2$
  - Don't stop at this point: This is a setting that allows you to move at a constant speed without stopping operation between move commands. For details, refer to Move without stopping.



- **Joint**: The tool movement path between the starting point and the end point is ignored but the movement of joint is minimized, instead.
  - **Speed**: 0.1 deg/s ~ 180 deg/s
  - Accel. (Acceleration): 0.1 deg/s<sup>2</sup>  $\sim$  360 deg/s<sup>2</sup>

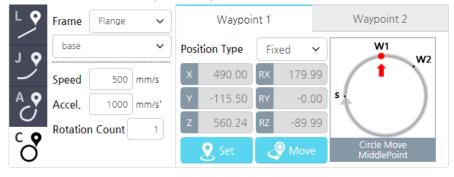


- **Arc**: A tool moves along the circumscribed circle whose center is the circumcenter of a triangle formed by the starting point(S) and the two points (W<sub>1</sub>, W<sub>2</sub>).
  - **Speed:** 0.1 mm/s ~ 1000 mm/s
  - Accel. (Acceleration):  $0.1 \text{ mm/s}^2 \sim 2500 \text{ mm/s}^2$



**Note** The TCP coordinates of the last position held by the robot are the coordinates of the starting point.

- **Circle**: The tool moves along the circle formed by the start point (S) and the two waypoints (W<sub>1</sub>, W<sub>2</sub>).
  - **Speed:**  $0.1 \text{ mm/s} \sim 1000 \text{ mm/s}$
  - Accel. (Acceleration):  $0.1 \text{ mm/s}^2 \sim 2500 \text{ mm/s}^2$
  - **Rotation Count**:  $1 \sim 50$  (Default 1)



**Note** The starting point is the TCP coordinates of the robot's last posture.

#### **Radius of Linear**

If you use the radius in Linear movement and the next command is Linear movement, it moves the curve without stopping when moving between commands.

LQ	Frame	Flange	~				Waypoir	nt
7 O	base		~	Posit	ion Type	Fi	xed 🗸	
2	Speed	19.685	in/s	x	19.29	RX	179.99	
AQ	Accel.	39.370	in/s*	Υ	-4.54	RY	-0.00	
	Radius	50	in	Z	17.38	RZ	-89.99	s
Õ					Set 🤇		Move 🖓	Linear Move

- The minimum radius is zero. If you set the radius to zero, then its path is not a curve.
- The maximum radius is the minimum of the distance,  $SP_1$  and the distance,  $P_1P_2$ .

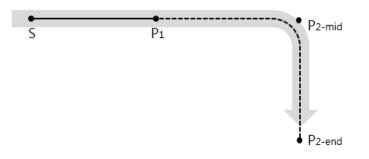
#### Don't stop at this point

This is a setting that allows the robot to move at a given speed without stopping operation between motions. If the currently set move command is Move Linear and the next move command is the same straight line motion, the robot will move without stopping.



- If P1 and P2 are linear motion and the radius is 0, the move commands of P1 and P2 should be on the same straight line with respect to the start position (S), as above.
- Even if P2 is a moving motion with a radius, the motion must be programmed so that the start of P2 motion and the end position of P1 are on the same straight line.

However, if the set travel command does not reach the set speed or if the next move command is not on the straight line, an error may occur and the robot program may malfunction or not perform.



#### Setting the coordinates for movement

LQ	Frame	ТСР	~				Waypoir	nt
7 O	base		~	Posit	ion Type	Fix	(ed 🗸	1
	Speed	19.685	in/s	X	19.29	RX	179.99	
AQ	Accel.	78.740	in/s'	Y	-6.71	RY	-0.00	
	Radius	0	in	z	13.44	RZ	-89.99	s
Õ	Don	't stop at t	his point		🥑 Set	٩	Move 🖓	Linear Move

To set the movement coordinates, you can either use an absolute value that is fixed in the space or a relative value that is relative to the previous location.

- **Fixed Point**: The 3D coordinate is received from the robot's coordinate system and used as the movement coordinate.
  - Press the Set button to launch the Manual Move screen. For more details about the Manual Move screen, refer to 5.3 Manual Move Screen.
- **Relative**: You can set the movement coordinate with respect to the previous location.
- **Variables**: You can set the position variable specified as a local variable.

**Note** The inputted coordinate is examined in the control software whether it indicates an area where the robot can move to. Even if you entered an input within the range, an error can occur when the area is prohibited by the safety setting or physical restrictions.

After setting the coordinates, press the **Move** button to move the robot arm to the coordinate where a tool is set.

#### **Displaying as groups**

If the move commands are repeated two or more times, then you can use one icon to indicate them all.



In the flow chart, press the group button, then they will be grouped as one. The number of commands in a group will be indicated by a number at the right top of the group icon.



# 9.8 IF Command

Use the command to initiate different commands depending on the condition.

•-• IF	cnt > 10	Θ	•
Le Else IF	cnt > 5		Else IF
L₀ Else IF	cnt > 3	3	<ul><li>団</li><li>삭제</li></ul>
∟₀ Else IF	cnt > 1	9	
	8		[^[~]

Enter the condition in an IF statement.

● ● IF
--------

- Press the text box to launch the formula keypad. For more details about the formula keypad, refer to 5.4 Virtual Keypad.
- If you use an IF command, an if statement will be created below the main flow.
- Select the **Use Else** checkbox to create an else statement below the if statement.

Main Flow 1.3(s)	۲	0.1s	•••••• 1.1s	0.1s
lf 0.1(s)				0.1s
Else 0.1(s)				0.1s

- Add Else IF to add another condition under the if statement.
  - To add Else IF under IF, then press the **+ Else IF** button.
  - To delete the Else IF statement you added, select the checkbox for the Else IF statement, and press the **Delete** button.
- If you select the icon on the right side of the conditional statement as shown below, you can program to check the conditions of the conditional statement in real time.
  - Even if the IF condition is judged to be true, the condition is checked in real time while executing the program. If the condition is False, the execution of the program command is stopped and the upper or lower conditional statement is executed.
  - When If is executed

: If Else is present, execute the program command with the Else condition. If Else is not present, execute the next program command of If.

#### When ElseIf is executed

\_

: If ElseIf is present in the child, execute the ElseIf program command that meets the current condition.

If Else is present in the child, execute the Else program command.

•-• IF	cnt > 10	€	•
L₀ Else IF	cnt > 5	$\odot$	Else IF
L₀ Else IF	cnt > 3		- 団 - 삭제
L₀ Else IF	cnt > 1		
L <sub>e</sub> Else 사용	8		^ <b>_</b> ~

# 9.9 LOOP Command

Use the command to repeatedly execute a series of commands.

Disabled	
Always apply	
O Loop input times:	
C Execute loop based on input expression	
	Ŀ

- **Disabled**: Do not use a LOOP command.
- **Always**: Repeat execution.
- **Loop input times**: Repeat as many times as the entered number.
  - By default, it is set to one.
  - Max: 1,000,000
- **Execute loop based on input**: Repeat execution until the condition entered by the user is met.
- Real-time condition check

Loop condition is judged to be true, and the program corresponding to the condition is executed. When the condition is checked in real time and it becomes False, the executing command is stopped, the Loop command is stopped, and the next program command is executed.

Disabled	
Always apply	
O Loop input times:	
Execute loop based on input expression	
D_GEN_IN_0 == 1	•

# 9.10 SWITCH Command

Use the command to execute a different command depending on each specific case. An IF command is executed after assessing all the conditions branching to Else IF, but a SWITCH command is executed immediately by finding the corresponding case, thus it is much faster than execution of an IF command.

⊷ Switch	Val759212 ~	Ð
L <sub>e</sub> Case		Case
L₀ Case		Delete
L <sub>•</sub> Case		
L₀ Use Def	ault	^ [ ~ ]

1. Using the drop-down menu next to **Switch**, select a variable.

For more details about the variable setting, refer to 9.2 Setting Variables.

← → Switch	Selected 🗸
------------	------------

2. Enter a value corresponding to each case.

|--|--|--|

- To add a Case, press the **+ Case** button.
- To delete the Case you added, select the checkbox for the Case and then press the **Delete** button.

# 9.11 WAIT Command

Instruct the robot to wait for a certain period.

O Disabled				
• Waiting time		20 (s	)	
	Select		✓ Low	~
Analog	Select	~		
O Input Expression				

- **Disabled:** Do not use a Wait command.
- Waiting time: Enter the duration of waiting time.
- **Digital**: Wait until a digital signal is inputted to a specific digital input terminal.
  - For a digital signal, you can choose either of low or high.
- **Analog:** Waits until the condition of the value set to a specific analog input terminal is met. On analog setting, whether to use the current (A) or the voltage (V) is determined by the unit set under the Monitoring menu.
- **Input expression**: Wait until the conditional expression set by the user is met. You can enter the conditional expression indicating the waiting condition on your own.

# 9.12 SET Command

You can set a digital or analog output value or assign a specific value to a variable or even change the TCP profile currently in use.

10					
/0 &	Oigital	D_CONF_OUT_0	✓ High	~	
Var	Analog	Select	~		
고 TCP	O Tool Power	• OV • 12V (	24V		

- **Disabled:** Do not use a SET command.
- **Digital**: Set a specific digital output value.
- **Analog:** Set a specific analog output value. The output unit is based on the analog unit that you set in the Monitoring menu.
- **Tool Power**: Set the voltage of Tool IO Power.
- **Test** : Test defined output before running program.

🔵 Disabl	ed			Test
।/O ्रि	Variable	g_var_1	✓ = Assignment	~
Var	Message			
Σ	21			
тср				

• **Variable**: Assigns a specific value to a variable added to the variable list and to a register item set in the MODBUS TCP menu. Press the text box next to the variable selection menu to launch the expression keypad. For more details about the expression keypad, refer to 5.4 Virtual Keypad.

O Disabled		Test
I/O Set TCP	Select 🗸	
Var Set the payload	0 lb	
TCP Use active	TCP as center of gravity	

- **TCP**: Switch to another TCP profile.
- **Payload**: Change the payload of current TCP.

# 9.13 Folder

Program command icons can be grouped into folders.

### **Change Programed Icons into Folder**



- 1. Click the Edit icon.
- 2. Select icons that you want to group into folder.
- 3. Click the Combine Folder icon.

### **Create New Folder**

Sub	2 میں Thread	• ma		°℃‡ if			<b>H</b> witch	C) wait	© set
Main Program <sub>0(s)</sub>		١	10		10	10	ĻQ	10	
FOLDER404183 0(s)				1 <b>9</b>					

- 1. In the Commands view, click the Folder icon to create a folder.
- 2. Add icons to be programmed under the created folder.

# 9.14 Message

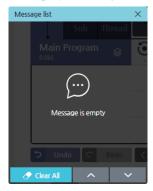
Displays a user-defined statement or variable in a pop-up or console window.

The command can be added from the Command Extension tab.

Message Type	Pop-up Message	~
	None	~
Message Output Type		
🖲 User Message		
🔿 Variable Output	Select	~

### **Output format**

- Pop-up: Displays a pop-up window with messages.
- List: Displays messages in the lower left console window.



#### **Message operation**

If you set the message format as pop-up, you can specify the operation accordingly. None / Suspend / Stop

If pause is set, you can select whether to continue the program from the popup message.



#### Message format

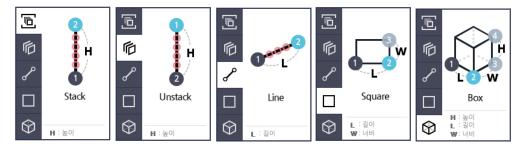
- User message: Outputs the message the user has entered.
- Variable output: Selects the variable to which to output the value.

# 9.15 **PATTERN Command**

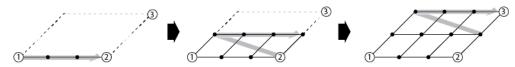
If the robot repeatedly executes the same task along the same path, you can define it as a pattern by using this command.

#### **Pattern types**

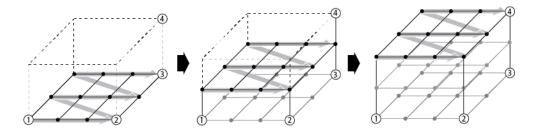
There exist the following five types of patterns.



- Stack pattern: In this pattern, the robot stacks objects while vertically moving with certain intervals.
- Unstack pattern: In this pattern, the robot unstacks objects while vertically moving with certain intervals.
- Line pattern: In this pattern, the robot repeats the same task while moving along the straight line with certain intervals.
- Square pattern: In this pattern, the robot repeats the same task while moving along the straight line and in the direction perpendicular to it.

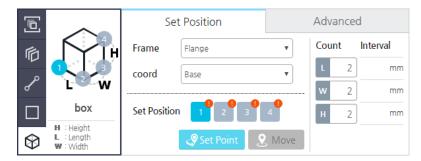


• Box pattern: In this pattern, the robot also repeats the same task vertically which it performs in a square pattern.



#### Setting the pattern coordinates

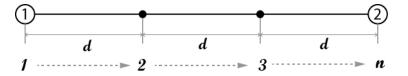
After selecting a pattern to use, set the coordinates that determine the type of pattern. The following image illustrates a box pattern.



- 1. Select the coordinates to set by starting with number 1.
  - Select the number for the sample image or press the list of the pattern location coordinates.
- 2. Press the Set Point button.
  - Press the **Set Point** button to launch the **Manual Move** screen. For more details about the **Manual Move** screen, refer to Manual Move Screen
  - On the Manual Move screen, enter the final coordinate values.
- 3. Proceed with point setting until you reach the last number.

#### Setting repeat counts

For every pattern, you need to set repeat counts between the starting point and the end point on each side.



**Count** (n): the number of repeated movements on a side

**Interval** (d): the distance that the robot moved each time

Note	•	If you do not enter the coordinates, the repeat count or the interval will not be displayed.
	•	When the repeat counts are set, the intervals are automatically calculated and displayed. The intervals are not editable.

#### **Advanced commands for patterns**

Sets the display of the currently executing index of the pattern, the moving index using the variable, and the starting position.

Ē	2	Set Position	Advanced
卮	<b>H</b>	Start at this position	н
r			2 Check location
	stack	Select a variable for monitoring     variables	н
$\bigcirc$	H : Height	Use the position to move as the se	etting for the variable

- Start at this position: If 'Start at this position' is checked, the start position is set at the initial position of the pattern.
- Check Location: While pressing this button, move to the position you entered.
- Select a variable for monitoring: If you want to know the current running index of the pattern, you can use a numeric variable to monitor for the current moving index.
  - Starting index: 0 Base
  - After executing the pattern, the monitoring variable is automatically increased by 1.
- Use the position to move as the setting for the variable

: Used to move to a specific position using a variable.

Variables are used together with monitoring variables.

If starting position and variable movement are used together, starting position is given priority.

#### **Setting pattern points**

If you enter a pattern command in the timeline, then the line to set the pattern point and the  $\overline{\mathbf{M}}$  icon will be added. When each pattern repeats, if you immediately move to the

next destination, then you can get interfered by an obstacle. So, by using the pattern point setting, you can avoid collisions with them and smoothly continue with the next pattern task by selecting a desirable tool path.

Main Program	8	0.0s	L Q 0.05	<b>~~</b> 0.0s	0.05	0.0s	<b>Č</b>	0.0s
PatternPoint 0.0(s)								

Press the pattern point II icon to launch the following setting screen.

Pattern Po	int			2	Set	\$	Move
Speed	19.685 in/s	x	19.29	Y	-4.54	z	10.46
Accel.	39.370 in/s <sup>2</sup>	RX	179.99	RY	-0.00	RZ	-89.99
				relat	ively based	on pa	ittern

The options for the pattern point settings are the same as the linear movement options in the move command section, and additionally you can insert move commands before and after the pattern point to adjust the tool path.

**Note** Only a linear type of move command can be used before and after a pattern point.

# 9.16 Using a Sub Program

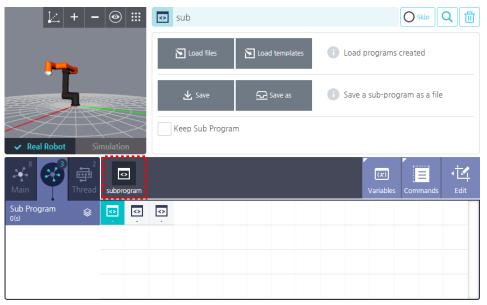
In the main program, you can call multiple sub programs for use.

#### **Making a sub program**

1. In the flow chart, press the **Sub** tab.



- 2. Press the **subprogram** button in the command menu of the **Sub** tab.
  - Once the **subprogram** button is pressed, a new sub program will be created.
  - The name of the sub program is automatically generated.
  - To delete the sub program, press the **Delete** button at the top or press the **Edit** > **Delete** button.



- **3.** After pressing the sub program, create a program that will be used as a sub program.
  - Once the sub program is pressed, available commands will appear in the command menu and a time line will be created, so that you can prepare a program.

Main 8	2 مت Thread	• mo	ove	°℃₊ if	loop		<b>G</b> witch	C wait	© set	
Sub Program <sup>0(s)</sup>	\$	\$				<	<>			
sub o(s)	\$	1 <b>O</b>	10	1 Q	1 <b>O</b>					

#### Saving and loading a sub program

After creating a sub program in the **Sub** tab, you can save it as a file or load the sub program or template.

🔁 Load files	Eoad templates	1 Load programs created
<b>⊥</b> Save	Save as	i Save a sub-program as a file
Keep Sub Program	m	

• **Keep Sub Program**: Even if the original subprogram is changed, the contents of the program at the time of loading can be preserved, and even if modified by another program that shares the subprogram, the operation at the time of loading the subprogram can be preserved without being affected.

#### Entering a sub program

After creating and saving a sub program in the **Sub** tab, proceed as follows to use it in the main program.

1. Enter the **subprogram** command in the main program.

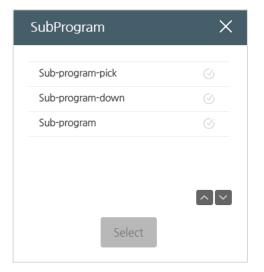


#### 2. Press the Sub-program button.

• After selecting a sub program, the sub program name will be displayed on the button.

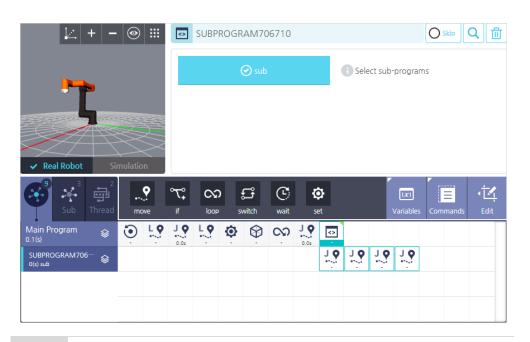
Select sub-programs	Select sub-programs
---------------------	---------------------

3. Select a sub program for use and press the **Select** button.



Once a sub program is selected, the **subprogram** command will be added to the timeline as shown below, and a sub program line will be added at the bottom to indicate the content of the sub program.

In the main program, you can also modify the content of the sub program. Since the sub programs in the main and sub tabs are linked to each other, modification made in one of them will be also reflected in the other.



**Note** In the main program, you can modify the content of sub program but you cannot save it. If you want to save modifications made for the sub program in the main program, you must save it in the Sub tab.

## 9.17 Conveyor

Executes operations linked with conveyor movement.

## **Conveyor Setting**

Conveyor Settin	g			
Direction	Direction	~	Position offset	0 in
Conveyor Speed	Direct Input	~		0 in/s

- Direction : Set the conveying direction information of the conveyor. Select the line coordinates created from the coordinate settings.
- Position offset: Set the distance to delay tracking start.
- Conveyor Speed: Set the conveying speed of the conveyor. Select the Number variable or type the value directly.

### **Conveyor Start Options**

If the I/O set in the trigger satisfies the condition, it starts tracking the conveyor.

Conveyor Start	Options			
Trigger	Select	~ =	Select	~

• Trigger : Set the I/O and condition that trigger the start of conveyor tracking. Only Digital Input is available.

### **Setting Conveyor Command**

Set the actions to be executed during conveyor tracking.



- During conveyor tracking, the robot moves to the Move position specified by the conveyor moving direction. Only Linear Move can be set in the conveyor.
- The real-time monitoring function of If and Loop can not be set for operation during conveyor tracking.
- Conveyor tracking is finished when all work in the conveyor tracking is complete.

## 9.18 VISION Command

You can communicate with a vision equipment by using the vision data configured in the **Device Setting** menu.

#### **Setting basic options**

Press the drop-down menu to select a desired vision equipment and set the waiting time and the data receiving option.

Set visions		
Vision	vision1	~
Workspace	cognex	~
	Move So	an Position

#### Setting the movement speed

Once you have entered the **vision** command, a vision capture point  $\mathfrak{S}$  and a moving point will be created below the vision command.

Main Program	\$ 0.1s	Ļ	L • 1.45	L Q 0.1s	L Q 0.1s	L <b>Q</b> 0.1s	0.0s		<> 0.3s	Ģ
Vision 0.0(s)	\$						0.0s	L <b>Q</b> 0.0s		

You can set the vision capture point  $\mathfrak{O}$  on the following screen.

Move Speed	
Speed         50 deg/s           accel.         100 deg/s'	Select a result variable of capture job Variables Selected
Options for receiving vision data Input number of requests 1 times Waiting time(sec) 3 s	

You can set the movement speed/acceleration for a vision camera attached in the robot to move to the recording location.

- The same input range of speed/acceleration is used as in linear movement.
- Variable setting: If there is a variable registered by the user, it can be used to store whether to recognize the vision. If you select a variable, it stores the success or failure during program execution, and you can program it using the corresponding variable in the next program. Conversely, if you do not select a variable, when the vision fails, the program will not proceed any further.
- Since the scan position is configured in the **Device Setting** menu, you do not need to set it in the vision command again.
- **Wait time(s)**: After a vision equipment moves to the recording location, it may require some waiting time until the robot arm's position is stabilized. (No waiting time is required depending on the robot speed.) Set the waiting time for responses after requesting data from a vision equipment.
  - Default: 3 sec
  - Input range:  $1 \sim 10$
- **Read and Fail Options**: You can set the number of data requests in case data receiving is unstable.
  - **Request count:** The input range is  $2 \sim 10$ .

#### **Setting the movement location**

After a vision equipment arrives at the location, you can use an additional Move command to adjust the Z-axis for the TCP. You can use a Move command under a Vision command as follows.

Move S	speed	Set Move Point(Z)		
Speed accel,	50 mm/s 100 mm/s'	441.50	mm	Set Point

- The same input range of speed/acceleration is used as in linear movement.
- The X, Y coordinates and the RX, RY, RZ coordinates used are received from a vision equipment and only the Z coordinate can be set to user's preference.

**Note** If you want to use a tool such as a griper, you will need to input the **set** command additionally.

### 9.19 **Thread**

When a robot program is executed, it is possible to execute parallel programs that require IO and other controls in parallel with the Main program. However, Move-related commands cannot be used.

### **Thread Tab**

Select the Thread tab to create a thread. Click the drop-down menu to select the vision device you want to use, and set the wait time and data reception options.

<u> </u>   +   -		THREAD654839			<b>۱</b>
••		read's Properties Setting			
✓ Real Robot Sim	Internet	erval	50 ms		
Main Sub	thread event			(x) Variable	ن <mark>ان</mark> Edit
Thread Program 3(s)	ð Is				
-					_
-					

- **Repeat:** Selects whether to repeat the program. If it is not checked, thread will be executed just once.
- **Interval:** Set the execution interval.

#### **Thread Creation**

Multiple threads can be created. Like a sub-program, each Thread is clicked on as an icon and added to the timeline in the lower layer.

Main Sub		o- i	<b>ג</b> ₁		<b>ස්</b> switch	C: wait	© set	
Thread Program	י ≨	<b>ن</b> ۱:						
THREAD654839 1(s)	\$	°T°	C S S	Ċ	۲			

**Note** Commands to control the motion of the robot cannot be used.

### **Event Tab**

Create Thread which has condition. Select the Event tab to create a Event.

<u> </u>   + -		EVENT65	0036			O Skip	<b>ک</b> 🗇
		⊷ • Event	D_GEN_IN_1=	:= 1			
F							
✓ Real Robot Sir	mulation						
Main Sub	🕉 🧭 thread ever				(x) Variabl	es Commands	Edit
Thread Program 😝	1: 2:						

It's same with Thread except using condition.

## 9.20 **Script**

Provides the function to edit the robot script and set it as a robot command.

#### **Script Viewer**

Displays a created script. While the program is running, a line currently proceeding in real time is displayed on the screen.



• **EDIT**: You can edit the edit window by opening it.

Javascript ECMA 5													
													∢©≫ Manual Control
													$f_{(x)}$
													Functions
													Var
													Variables
RESULT													
	Co	ору		Cut		Paste							
	• Co	opy	2	Cut 3	4	Paste	6	7	8	9	0	×	
							6 U	7 i	8	9 p	0	× )	
	·	1	2	3	4	5							
	• q	1 w	2 e	3 r	4 t	5 y	u	i	0	p	(		
	、 q a z	1 w s	2 e d c	3 r f	4 t g	5 y h	u j	i k	0 	р ;	( -	) ₩	

- Click the Validation Check button to check the integrity of the created script.
- Manual Control: Operate the robot manually and get the coordinates of TCP, Flange, and Joints.
- Functions : Available functions can be added to Script by clicking on them.
- Variables: Available variables can be viewed and used.

Note For script commands, refer to the separate manual.

#### 9.21 **Path Command**

You can create a motion by holding the robot arm directly.

#### **Record Start** Play Path Speed 1 x PATH255384.raw 💽 Import Export O Deduplicate path at the ends The path of the Path is not displayed in 3D.

**Recording Paths** 

#### 1. Starting to record

Click the button and move the robot arm along the path you want to record.

During recording, the recording status is displayed in a pop-up window, and can be canceled or stopped.

During recording, you cannot move to another screen or perform other operations.

If an already created path is found, it will be deleted and a new one created.

	RATH80351.ray	•	
	Recordin	g motions.	
<b>ک</b> ا	00	S C	ø
	Cancel	ОК	set :

#### 2. Path Playback

If there is a recorded path, it will perform its motion.

- S: Move to the beginning of the path.
- E: Move to the end of the path.

#### 3. Apply

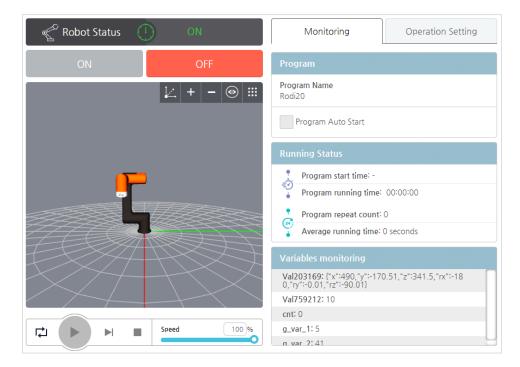
Once you have confirmed the motion, click the Apply button to save it as a file.

- Speed: Sets the execution speed of the recorded motion.
- Import: Imports an already recorded motion.
- Export: Saves the recorded motion separately.
- Deduplicate path at the ends: If there are the same postures at the start and end points in the motion recording process, they are deleted.

Note To execute the recorded motion, the Move coordinates immediately before the Path command and the start coordinates of the Path must match. Press the S button to move to the start position, and match it with the coordinates of the previous Move command.

## Chapter 10 Starting the Robot

Starting the robot means that you are powering up the servo motor and get ready for its operation.

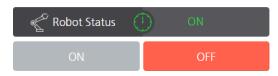


#### Select **M** Robot Operation in the main menu.

Note	If your robot is already registered, then it will appear in the initial screen
	after booting up the system.

#### **Turning ON/OFF the robot**

You can check the start/end status of your robot at present, and turn on or off the robot.



- **ON:** Power up the motor for the robot joints and get ready for robot operation. If the robot status is **ON**, then the **OFF** button will be activated and the **ON** button will be deactivated.
- **OFF:** Power off the motor for the robot joints and enable robot operation. If the robot status is **OFF**, then the **ON** button will be activated and the **OFF** button will be deactivated.

#### Monitoring

Program
Program Name Rodi20
Program Auto Start
Running Status
Program start time: -
Program running time: 00:00:00
Program repeat count: 0
Average running time: 0 seconds
Variables monitoring
Val203169: {"x":490, "y":-170.51, "z":341.5, "rx":-18 0, "ry":-0.01, "rz":-90.01}
Val759212: 10
cnt: 0
g_var_1:5
g var 2:41

- Program Name: Indicate the name of current program loaded.
- Program Auto Start: It is activated when setting the program auto start condition at system startup Managing the Robot System Configuration. For details on the settings, refer to 16.5 Managing the Robot System.
- Variable Monitoring: Displays the name and current value of the variable being used.

#### Checking and setting the robot operation data

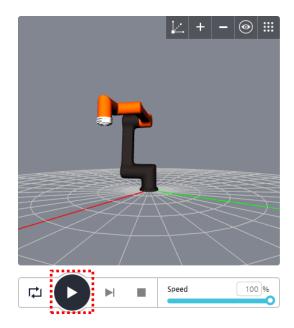
You can check the effective weight applied to the currently selected robot and quickly retrieve the saved robot settings and program and apply them to the system.

Reset	✓ Use safety limit check
Active TCP	
X 0 RX	0.00 CX 0
Y 0 RY	0.00 CY 0
Z O RZ	0.00 CZ 0 Payload 0 lb
Load Robot Config	juration
Please select a settin	ng file.
Tool Power (Voltag	ge)
0 V 0 12 V	○ 24 V
Please select a prog	gram file.
Rodi20.file	<ul> <li>✓ Apply</li> </ul>

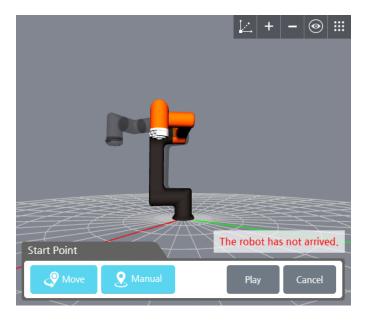
- **Reset:** If the robot is malfunctioning or uncontrollable temporarily then initialize the controller.
- Use safety limit check : Enables/disables menu's safety settings.
- Active TCP: Indicates currently set TCP information.
- Load Robot Configuration: A user can load a robot configuration file exported to a local storage. For more details about how to export robot settings, refer to 16.5
   Managing the Robot System Configuration.
- Tool Power(Voltage): Set the Power of Tool IO.
- **Select Program File**: You can select one of the program files stored in a local storage and quickly apply it to the system.

#### **Operating the robot**

If you want to operate your robot according to the program selected in the operation setting, then press the ▶ button in the preview window. For more details about the preview screen, refer to 5.2 3D Preview Screen.



If the current coordinates of the robot are different with the start coordinates of the program, a pop-up window will be displayed for confirmation.

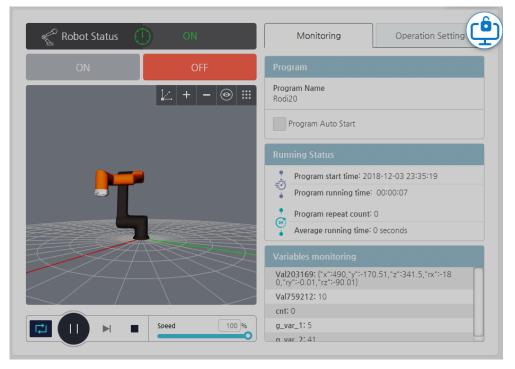


If there is an obstacle at the start of the current coordinate and there is a possibility of a cllision, you can check it and move the robot to the safety position and start.

- **Move**: Move robot to start position.
- **Manual**: Manually move robot through the manual contro.
- **Play**: Start program from current position. If the robot is not at the start position of the program, it moves to the start position and the program starts.
- **Cancel :** Cancel Playing program.

### **Locking Screen**

Restricts the operation of the screen during program execution. All operations except screen lock button are restricted.



# Chapter 11 Monitoring

You can check the selected robot's position/status and I/O status in real time.

## 11.1 Monitoring the Robot

You can check the robot's position and status in real time.

Select 🖭 Monitoring > Robot Status in the main menu.

#### **Monitoring the robot positions**

In the robot position tab, you can check the position of the selected robot (joint angle and speed) and see how it is moving in real time in 3D preview.

Robot Pose		Robot	Health	
<u> </u> ∠  +   −  ⊚  :::		<mark>IIII</mark> t Range (°)	Joint S "/si	peed
	Joint1	30.96	Joint1	0.00
	Joint2	-122.19	Joint2	0.00
	Joint3	-41.23	Joint3	0.00
	Joint4	-106.58	Joint4	0.00
	Joint5	90.00	Joint5	0.00
	Joint6	30.96	Joint6	0.00

#### **Checking the robot status**

In the robot status tab, you can check the selected robot's power consumption, voltage or current.



**Note** The monitoring values are displayed when the robot is running normally.

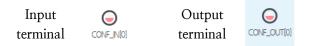
## 11.2 Monitoring Inputs/Outputs

You can check and set the real time I/O status of robot.

In the main menu, select 💻 Monitoring > I/O Status.

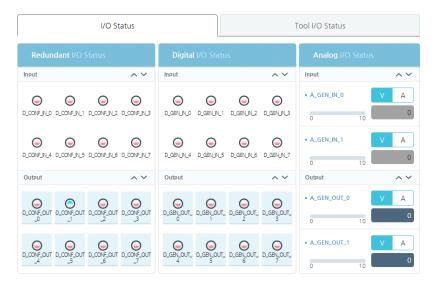
**Note** The monitoring period is 10 Hz.

- You can check the status of digital I/O by examining the following icons.
  - Oigital signal high
  - Oigital signal low
  - No signal
- The input terminals that users cannot adjust the values for and the output terminals that users can adjust the values for are marked as follows.



#### Monitoring controller inputs/outputs

In the **I/O Status** tab, the status of signals transmitted to and received from the I/O terminal of the controller are displayed in real time.



- You can press the I/O status icons to switch digital outputs to high and low. For example, if you press O(High) then it switches to O(Low).
- For analog outputs, you can press the icon to enter values.
  - Voltage range:  $0 \sim 10.00 \text{ V}$
  - Current range:  $0.004 \sim 0.02$  A
- You can select either voltage or current as the analog I/O unit.
  - V A: Voltage(V) is used.
  - V A : Current(A) is used.
- If you change the unit of analog output, the output is changed to a minimum.

Note	•	The number of terminals may vary depending on the controller specifications.
	•	If not all the terminals are displayed on the screen, press the $\sim \sim$ up/down scroll button to scroll them.

## Monitoring tool inputs/outputs

In the **Tool I/O Status** tab, the status of signals transmitted to and received from the I/O terminal of the tool flange are displayed in real time.

I/O Status	Tool I/O Status
Digital Input	Analog Input
	A_TOOLINL0     V A     0     0     A_TOOLINL1     V A     0     0
Digital Output	Tool Power
	Voltage           0 v         12 v         24 v           Current         0 A

- A tool's digital inputs/outputs and analog inputs are set and displayed in the same way those of the controller are set and displayed.
- If you can set the output voltage to a tool, then you can select one from 0 V, 12 V, or 24 V.

Note	•	The value of the tool's current cannot be configured by the user.
	•	If the robot status is servo-off or the emergency stop button is pressed
		to stop the robot, the monitoring screen may display abnormal information.

## Chapter 12 Report

You can check the robot's system operation time, servo start, and the program operation time information.



Select Report > Utilization in the main menu.

• **Cumulative system operation time**: Total cumulative system operation time from production time to present

**Note** The basic unit for collecting the operation time is every hour; as such, there may be error of up to one hour.

## Chapter 13 Linking with External Equipment

You can link your robot to an external equipment such as a vision equipment (object detection camera), and conveyor system.

**Note** Different external equipment is supported depending on the SW version.

## 13.1 Using a Vision System

You can register the vision to be linked to the robot and configure necessary settings.

In the main menu, press **Device Setting** > Vision System.

	Name			Model Select type
vision1 Model:BAUMER_VISION	Vision Type	Embedded S	tand Alone	
	Connection Infe	o TCP/IP Address 12	7.0.0.1	Port Number 9875 Connection Te:
vision2 Model : OMRON_VISION				
				Cancel Save
	• Vision Wo	rkSpace	0	Scan Position
	• Vision Wo	rkSpace Name	+ 🗊 Edit	
	• Vision Wo		+ 🗃 Edit	Scan Position
	• Vision Wo	Name		Scan Position Robot position for vision scan (based on flange
	•	Name	-	Scan Position      Robot position for vision scan (based on flange     X 0.00 Y 0.00 Z 0.00

To interwork with the vision, the following two steps are required.

#### Vision System Setting

- Communication Setting: To send and receive data to and from the vision system, data is exchanged via TCP/IP communication. The vision system should be set up to use TCP/IP communication.
- Exchange Data Format (Protocol) Setting: To exchange data with the robot system, the type and format of the data sent from the vision system should be set as follows.

#### Data Communication Protocol

The data format consists of a string, which is set up to be transmitted by the

TJG	,	х	,	Y	,	TH	CR	LF
-----	---	---	---	---	---	----	----	----

vision system in the following conventions.

TJG: Result value from object recognition in the vision. 1(Success) or 0(Fail) X: X coordinate value of object recognized by the vision

- Y: Y coordinate value of object recognized by the vision
- TH: Rotation theta value of object recognized by the vision

CR, LF: Separator for the end of data

Comma(,): Separator for each item

#### Robot System Setting

- Interworking vision setting: Sets the model and communication connection information of the vision to be interworked.
- Vision workspace setting: One vision camera can have a number of vision work areas, and by using the information set by the 'Vision workspace setting,' the vision coordinates recognized by the vision are converted into the robot coordinates to move the robot.

## 13.2 Adding and setting vision equipment

#### Adding a vision equipment

Press the **Add** button. They will be added under names such as Vision1, Vision2 to the list and they become configurable.

#### **Setting a vision equipment**

- **Name**: Enter the equipment name. (The length of name is limited to 15 letters and special characters cannot be used.)
- Model: Select the manufacturer for your vision equipment.
- Omron vision
- Cognex vision
- Hostar vision
- Keyence vision
- Baumer vision

**Note** Different vision equipment is supported depending on the software version.

- **Connection info**: Enter the TCP/IP address and the port number necessary for communication between a vision equipment and the robot.
  - Range of port number:  $0 \sim 65535$
  - Press the **Connection Test** button to check the status of connection with a vision equipment by using the connection data.

**Note** To perform the connection test correctly, the vision system and our system must be connected to a single network before the test.

- **Vision Type**: Select a type of vision installation.
- **Embedded**: Attached to the robot arm.
- Stand Alone: Fixed to another location and detached from the robot arm.

## 13.3 Setting Vision Workspace

Vision workspace setting sets information to change the vision coordinate recognized by the vision to the robot coordinates. Up to 5 workspaces can be set for one vision.

#### Adding Vision Workspace

- To add a vision workspace, select the vision already added from the vision list.
- When you click the **Add vision workspace**<sup>①</sup> button, the following workspace setting screen appears.

Name	Vision Scan Coc	ordinates		Set	Point	Move	2	Rotat	ion Offse	et	
cognex	X 592.49 Y	-57.42 Z	483.99 RX	179.99 RY	-0.00 RZ	Z -89	9.99		0.	Set	Offset
						Point	1		Set Poin	t	Move
P1				P2		Х	253.74	Y	-258.05	Z	142.7
					Í	RX	179.99	RY	0	RZ	-89.9
2000		00	00	00		Vision Coordir	ates	x	100	Y	10
		00	00			Point	2		Set Poin	t	Move
		00	00			х	592.49	Y	-258.05	Z	142.7
Vision test						RX	179.99	RY	0	RZ	-89.9
Robot X 0 Y						Vision Coordir	ates	X	10	Y	1
Vision						Point	3		Set Poin	t	
X 0 Y						х	592.49	Y	127.57	z	142.7
R O					$\leq$	RX	179.99	RY	0	RZ	-89.9
Test				P3		Vision Coordir	ates	x	120	Y	12

- **Name** : Enter a name for the vision workspace. The input range is up to 15 characters, and no special characters are allowed. (Exclude '-' and '\_'.)
- Vision Scan Coordinates: If the vision type is **Embedded**, the setting is necessary for moving the robot arm to the scanning location.
- Press the **Move** button to move the robot arm to desired location and view it there.
- Press the **Set Point** button to launch the manual control screen. For more details about the manual control screen, refer to 5.3 Manual Move Screen.
- **Rotation Offset:** If the vision type is **Stand Alone**, you can set the angle between the robot's location and the scanning location, so that the rotational angle for an object necessary for a gripper to hold it. Press the **Set Offset** button to automatically set the rotation offset. For more details, refer to the next page.

- Vision Test: Test vision with the set values.
- Set Points: It matches the number of guide image and is activated by clicking the number. The initial value is '0'. At each number, enter the robot coordinate values and the coordinates of the vision system at that point. Range :

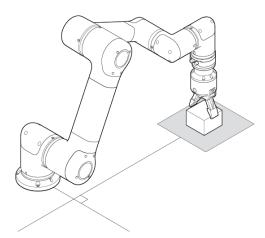
   -10000~10000(Pixel)
- **Rotation Direction Setting**: Sets the rotation direction of the object recognized by the vision.

Note When attaching the vision to the robot arm, attach the upper left / upper right / lower right directions shown on the setup screen so that they match the directions shown in the vision software.

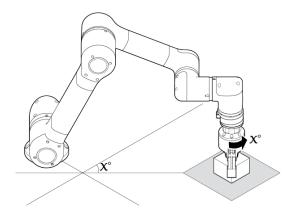
#### **Understanding rotation offsets**

When a vision equipment scans an object, the angle of shifted position for an object is used the reference for a vision equipment. Thus, the angle data of object that a vision equipment sends to the robot is obtained from the perspectives of vision equipment. Now, if the robot does not know the angle between the scanning location and the its position (rotation offset), then the robot will assess the scanned angle data from its own perspectives and use a gripper accordingly, thus making it hard to pick up an object accurately.

As shown below, if the scanning location is same as the basic TCP location of robot (A) all it has to do is to rotate the gripper angle by as much as the angle of scanned object. However, if the scanning location is shifted by X degrees from the robot base, then when an object is scanned, although a vision equipment detects the angle of object as same as from the location (A), its gripper will have to rotate by X degrees to pick it up. In other words, from the robot's perspectives, it is same as if an object is shifted by X degrees, so, a rotation offset is required to compensate for the angle of object sent from a vision equipment.



A. When the scanning location and the robot's location are on the same line



B. When the scanning location and the robot's location are shifted by  $X^{\boldsymbol{\circ}}$ 

## Chapter 14 Environment Setting

## 14.1 General Setting

You can select the desired UI language and unit also set the time/date.

In the main menu, press	SW Configuration	• General.
-------------------------	------------------	------------

.....

Language Selection	English	~			
Unit Selection	Imperial System	~			
					Reset Apply
Date	& time settings				
Set Date	2018-12-03		() Set Time	23 : Hours	43   18     Image: Winutes   Seconds
					Reset Apply

- Language Selection: You can select a language for the UI.
- Units Selection: You can select units of weight.
- Date & time settings: You can set the system date/time.
- **Calibrate Touch Screen:** If it is hard to touch a desired location on the screen, then you can correct the touch locations.

**Note** The language and unit settings are immediately applied to the system without restarting it, but the time/date are applied to the system after restarting it.

## 14.2 Network setting

You can configure the network settings for Ethernet communication of your operation software.

In the main menu, press **SW Configuration** > **Network**.

192 . 168 . 100 . 45
255 . 255 . 255 . 0
· · ·
er address
192 . 168 . 100 . 231

- **DHCP**: IP address is automatically assigned.
- **Static IP:** Fixed IP address is used.
- Obtain DNS server address automatically: DNS address is automatically received.
- **Use following DNS server address**: Use the DNS server designated by the user.
- **Do not use**: Do not connect to the network. Use it as standalone.

**Note** For more details about network settings, consult with your system network administrator.

## Chapter 15 Turning Off the System

## 15.1 Shutting Down the Operation Software

To shut down the operation software, proceed as follows.

- 1. Select 🔀 SW Configuration > Shutdown in the main menu.
- 2. Press the **OK** button.

Note	•	You can	press the	power	button	of the	teaching	pendant to	shut it
		down.							

• If the operation software does not shut down properly, press and hold the power button of the teaching pendant for 5 to 10 seconds.

## 1 Caution

Shutting down the system improperly may cause problems for the software. If the software has a problem after abnormal system termination due to the reason that the system is forcefully turned off by the power switch or the Power button of TP, or the power is out, contact local distributor.

## 15.2 **Turning Off Controllers**

After shutting down the operation software, press the power switch to turn off the controller.

## Chapter 16 Maintenance

## 16.1 Inspection Items and Periods

Periodic inspections are required to maintain the robot in the best condition for a long period of time. An inspector should prepare and execute an inspection plan.

The following items require periodic inspections. If you found some problems during inspections, and you can resolve them on your own, contact Hanwha Precision Machinery Co.

Inspection item		What to inspect	Periods
	All	Check if the robot moves to the desired destination according to the program.	Daily
-	All	Remove stains, dusts and pollutants.	3 months
Robot arm	All	Check if the robot arm or tool sags when you turn on/off the servo power.	Daily
	Main bolts	Check if the bolts exposed to the outside of the robot is loose.	3 months
	Motor	Check for abnormal heat generation or noises.	Daily
	Cable	Check the cable connections.	
Controller	Internal	Remove dusts from the inside.	6 months
	Filter	Remove dusts from the filter.	-

## 16.2 Checking the Robot Arm

#### **Inspection period**

Inspect at least once every year. The inspection period may vary depending on the inspection area.

#### Checking and cleaning the robot arm

- 1. Move the robot arm to home.
- 2. Turn on the controller.
- 3. Check the followings.
  - Check the cable connecting the controller and the robot arm.
  - Check if the screws exposed outside is loose or unfastened.
  - Check for defects in the motor, the brake and the decelerator.
- 4. Remove stains, dusts and pollutants.

### 16.3 Checking the Controller

If dusts accumulate inside the controller, electrostatics or overheating can cause product malfunctions. Periodically check the inside of the controller and clean off dusts and check if the internal cables are connected properly.

#### **Inspection period**

Inspect at least once every six months.

**Note** The inspection periods may vary depending on the installation environment.

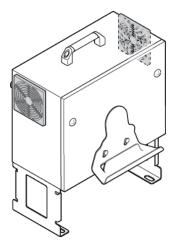
#### **Checking and cleaning the controller**

- 1. Turn off the power for the controller.
- 2. Open the cover for the controller.
- 3. Check if there are dusts inside the controller.

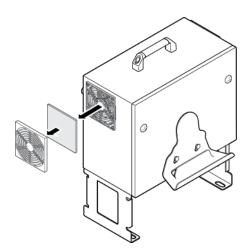
- 4. If there are dusts, then use a vacuum cleaner to carefully remove dusts.
- 5. Check if the connector cables are connected properly.

### **Cleaning and replacing the filter**

The controller has an air suction hole and an air discharge hole, which have dust filter mounted in them.



Separate the filter from the controller and use a vacuum cleaner or air compressor to remove dusts.



## 16.4 Viewing and Managing Logs

You can view and manage the logs for the operation system.

		1	•	
Select Management >	Log 1	n the	main	menu
		in the	TTTCCTTT	monter.

Devic	e Log 🗸 🗸	All	♥ 2018-12-03	2018-12-03     Inquiry Keyword	
Type	Controller	Robot Name	Date/Time	Log Description	
=	controller	[ HCR5 ]	2018-12-03 23:37:20:301	[event] programEvent : program_stop	
=	controller	[ HCR5 ]	2018-12-03 23:35:20:475	[event] programEvent : program_toolChange	
	controller	[ HCR5 ]	2018-12-03 23:35:20:189	[event] programEvent : program_toolChange	
=	controller	[ HCR5 ]	2018-12-03 23:35:19:836	[event] programEvent : program_start	
=	controller	[ HCR5 ]	2018-12-03 23:35:14:482	[event] programEvent : program_end	
=	controller	[ HCR5 ]	2018-12-03 23:35:04:608	[event] programEvent : program_toolChange	
=	controller	[ HCR5 ]	2018-12-03 23:35:04:330	[event] programEvent : program_toolChange	
=	controller	[ HCR5 ]	2018-12-03 23:35:03:916	[event] programEvent : program_start	
=	controller	[ HCR5 ]	2018-12-03 23:26:53:607	[event] programEvent : program_end	
=	controller	[ HCR5 ]	2018-12-03 23:26:44:139	[event] programEvent : program_toolChange	
Total Cou	unt: 29 Case		1 2	3 >	Error

## **Deleting Logs**

Press the **Delete** button and the log data found will be deleted.

### **Exporting Logs**

- 1. Press the **Export** button.
- 2. Select the location to export the logs into and press the **OK** button.

#hanwha#tgos#let-it-bot#exportLog				
Directory	Ç	File Name Date		
> 📮 HTW Storage		2017-03-22_09h_47m_24s	22-Mar-2017 9:47 AM	
		2017-03-22_09h_47m_53s	22-Mar-2017 9:47 AM	
		OK Cancel		

When export is finished, a folder in the form of 'date-time' is created at the selected location, and the log data are saved in the folder along with the robot configuration and program files.

## 16.5 Managing the Robot System Configuration

You can save the robot configuration in a local or external storage device or retrieve the saved robot configuration from them.

In the main menu, select M Management > Setting Management.

Robot Name: HCR5	🖶 Packing P	ose	C Factory Reset
Use Default Program Rodi20 file	Auto Start Program on System Startup	× = High	~
Initial Setup File	D_GEN_IN_0 (Unassigned) Auto Servo On	✓ = High	
Please select a setting file.	D_GEN_IN_1 (Unassigned)	✓ = High	✓ Apply
File Directory	File Nan	ne	Date / Time
🛱 HCR Storage 🧭	cfg.robotConfig		November 30, 2018
C	₩Program Files₩HCR Rodi Sim₩data₩con	figs	
	ile Name	Export	Delete Import

#### **Packaging posture**

- Arrange the posture of the robot in a position that allows it to be placed in the delivery box.
- The robot only operates while the button is pressed.
- The posture depends on the model of the target robot.

```
[J1:0, J2:-90, J3:-160, J4:-90, J5:180, J6:0]
```

#### **Factory reset**

- Initializes the system to its factory settings.
- A warning message is displayed twice before the reset is performed. When the factory reset is complete, the system restarts.

**Note** If you perform a factory reset, all information including the robot information will be deleted. Please back up the necessary information before you perform a reset.

### **Use Default Program**

Set the program and configuration file to load automatically when the robot is booted. It provides Servo On and program start function automatically after booting.

- Check Use Default Program to activate it.
- Select the program to be loaded among the stored programs.
- Set the condition of Auto Start Program on System Startup.
- Select **Initial Setup File** to use among the saved configuration files.
- Set the condition of **Auto Servo**.

**Note** The available inputs are Digital Input or Digital Input of Modbus TCP.

#### **Exporting the configurations**

You can save the following settings by exporting them.

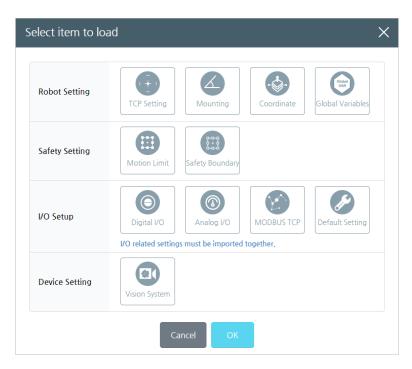
TCP Setup
Mounting
Motion Limit
Safety Boundary
Digital I/O
Analog I/O

- 1. Select the file path to export.
  - Press the refresh  $\circlearrowright$  button to update the storage list and the file list.
- 2. Press the filename input field and enter the filename.
  - Filename is limited to 25 letters, and empty character is not allowed.
- 3. Press the **Export** button.
- 4. When the confirmation window appears, press **YES**.

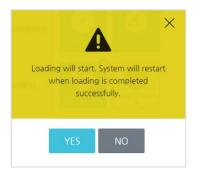


#### Importing the configurations

- 1. Select the file path for importing.
  - Press the refresh  $\circlearrowright$  button to update the storage list and the file list.
- 2. Press the **Import** button.
- 3. Select the configuration items to import and press the **OK** button.
  - You can select multiple items.
  - If you want to deselect it, press it again.



4. When the confirmation window appears, press **YES**.



## 16.6 Software Update

You can update the operation software and the controller software.

In the main menu, press 🖾 SW Configuration > SW Update.

• Rodi Software	P Rodi Software					
Current Version Ver. 2.000.001.002						
Update					Import	Update
Controller Softwa	Controller Software					
Current Version	Current Version Ver. 1.006.000(4294967295)					
Update					Import	Update
Safety Module Ve	rsion					
Current Version	Current Version Ver. N/A					
Tool I/O Version Ir	nfo					
Current Version	Ver. N/A					
Servo Driver Version						
Joint 1 1.0.0		Joint 2	1.0.0	Joint 3	1.0.0	
Joint 4 1.0.0		Joint 5	1.0.0	Joint 6	1.0.0	

### **Cautions during update**

- Update can be performed using the external storage device only.
- If you connect a USB drive to TP, as there is a lot of data, the operating software may not be updated normally. Be sure to connect directly to the controller.
- Update files may be composed of multiple files instead of a single file. For proper update of files, do not modify the name or path of an update file package arbitrarily.
- It is recommended to update the operating software and the control software at the same time in the versions compatible with each other. If versions incompatible with each other are installed as a result of not checking compatibility, the robot may not work normally.
- The update function is not available for general users but for the user with a certain authority. If you need an update, contact Hanwha Precision Machinery or a local service center.

### Updating the operation software

Check the version of the operation software and proceed as follows:

- 1. Connect the external storage device (such as the USB memory) where the update files are stored to the USB port of the teaching pendant or the controller.
- 2. In the software update screen, press the **Import** button.

Operation Software		
Current Version	Ver. 2.11.170317	
Update		Import Update

- 3. Select an update file in the correct location and press the **OK** button.
  - The extension of the update file is "tgos", and the update file name contains its version. The file selection window displays applicable files only.

Please select f	ile		×
H:₩Release₩2017-03-184	₩v2.11.170317	.tgos	
Directory	Ç	File Name	Date
<ul> <li>→ H:</li> <li>&gt; → HCR5</li> <li>→ ■ Release</li> <li>&gt; ■ 2017</li> <li>&gt; ■ Log</li> </ul>	03-18		18-Mar-2017 1:36 PM
		OK Cancel	

4. From the software update window, press the **Update** button.

Operation Software			
Current Version	Ver. 2.11.170317		
Update	H:₩Release₩2017-03-18₩v2.11.170317.tgos	Import	Update

When the operation software is updated, a window appears to ask whether to update the controller software additionally. If no additional update is available, the system restarts.

#### Updating the controller software

Check the version of the controller software and proceed as follows:

- 1. Connect the external storage device (such as the USB memory) where the update files are stored to the USB port of the teaching pendant or the controller.
- 2. In the software update screen, press the **Import** button.

Control Software	
Current Version	Ver. 1.0.0.0
Update	Import Update

- 3. Select an update file in the correct location and press the **OK** button.
  - The extension of the update file is "run". The file selection window displays applicable files only.

Please select f	ile		×		
H:₩Release₩Controller_Update₩hcr5_makeself.run					
Directory	Ç	File Name	Date		
<ul> <li>→ H:</li> <li>&gt; → HCR5</li> <li>→ ■ Release</li> <li>&gt; = 2017</li> <li>■ Contr</li> <li>&gt; ■ Log</li> </ul>	03-18 oller_Update	√ hcr5_makeself.run	17-Mar2017 2:29 PM		
		OK Cancel			

4. From the software update window, press the **Update** button.

Γ	<ul> <li>Control Software</li> </ul>			
	Current Version	Ver. 1.0.0.0		
	Update	H:₩Release₩Controller_Update₩hcr5_makeself.run	Import	Update

When the controller software is updated, a window appears to ask whether to update the operation software additionally. If no additional update is available, the system restarts.

## Appendix A Warranty

Refer to the contract between the sales team and you.

### Warranty

Our company guarantees specifications, quality and reliability that our customer demands during the warranty period.

### Warranty period

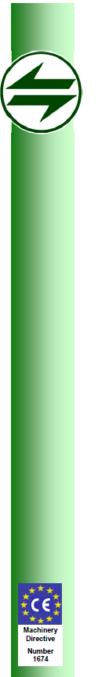
One year since the date of equipment purchase (varies depending on the contract between our company and you.)

### **Limitation of Liability**

- If a problem occurs after the customer mounts an unauthentic part in our product, our company will not be responsible for it.
- If your product has a fault deemed as our company's responsibility, we will immediately repair it or replace the product with a good one.

## Appendix B Certification

### Safety



## Safenet Limited

Denford Garage, Denford, Kettering, Northants., NN14 4EQ, U.K.

Tel: +44 1832 732174 E-mail: office@safenet.co.uk

European Notified Body 1674

#### EN ISO 13849-1:2015 Compliance Certificate

This is to certify that

#### Hanwha Techwin Co., Ltd.

1204, Changwon-daero, Seongsan-gu, Chang-won-si, Gyeongsangnam-do, Korea

Has had a Safety Module for HCR examined to the International and European Standard BS EN ISO 13849-1:2015.

The following safety functions have been identified and their achieved performance level is listed below:

Safety Function	PL
<ol> <li>Stop Monitoring</li> </ol>	d
<ol><li>Joint Position Monitoring</li></ol>	d
<ol><li>Joint Velocity Monitoring</li></ol>	d
<ol><li>Joint Position Limit Monitoring</li></ol>	d
5) Joint Velocity Limit Monitoring	d
<ol><li>Joint Torque Limit Monitoring</li></ol>	d
<ol><li>TCP Position Monitoring</li></ol>	d
<ol><li>Collision Detection</li></ol>	d
<ol><li>Brake Monitoring</li></ol>	d
10) Emergency Switch Monitoring	d
11) H/W Monitoring	d

The technical documentation supplied contains all the information to include the following models in the certification; HSM-V1. All the safety functions above have been realised using an architecture that exhibits Category 3 behaviour, as defined in BS EN ISO 13849-1:2015.

Certificate Number:

6760020517 version 2

Date:

19/05/2017

Signed for Safenet Limited

7. min

Peter McNicol Technical Manager This Document remains the property of Safenet Ltd and w

This Document remains the property of Safenet Ltd and will be returned to them if so requested. Safenet will review the continued compliance of the machinery on a 5 yearly cycle to check for changes in the state of the art.

#### **MD(Machinery Directive)**



Any other holder of this document is advised that information contained hereon reflects the Company's findings at the time of its intervention only and within the limits of Clients instructions, if any. The Company's sole responsibility is to its Client and this document does not exconerate parties to a transaction from exercising all their rights and obligations under the transaction documents.

SGSPAPER 19022834

#### LVD(Low Voltage Directive)

Reference: 20299C



## **CERTIFICATE OF CONFORMITY**

#### Product:

Industrial robot controller

Tested by request of Hanwha Techwin Co., Ltd. 1204, Changwon-daero, Seongsan-gu, Changwon-si, Gyeongsangnam-do, 51542, Republic of Korea

Manufactured at (name and place)

Hanwha Techwin Co., Ltd. 1204, Changwon-daero, Seongsan-gu, Changwon-si, Gyeongsangnam-do, 51542, Republic of Korea

Trade mark (if any):

Hanwha Techwin

100 - 240 V~, 50 - 60 Hz, 1 kW

Model/Type Ref:

HCR-5

Ratings and principal characteristics:

Additional information (if any)

A sample of the product has been tested and found to be in conformity with :

EN 61010-1:2010, EN 61010-2-201:2013

as shown in the test report(s) F690501/RF-SAF009051

This Certificate of Conformity is the result of testing a sample of the product submitted, in accordance with the provisions of the relevant specific standard. It does not imply an assessment of the whole production. Conformity of the produced products with the specimen tested remains on the full responsibility of the manufacturer.

Brussels, 21/04/2017

Yuta Kim, 200 Certification Manager.



### **EMC (Electro Magnetic Compatibility)**

Reference: EMC/COC/B54/2017



## **CERTIFICATE OF CONFORMITY**

Produc	<u>:</u> :
Tested	by request of

Collaborative Robot

Hanwha Techwin Co., Ltd.

Hanwha Techwin Co., Ltd. 1204, Changwon-daero, Seongsan-gu, Changwon-si, Gyeongsangnam-do, Korea (Republic)

1204, Changwon-daero, Seongsan-gu, Changwon-si,

Manufactured at (name and place)

Trade mark (if any):

Gyeongsangnam-do, Korea (Republic)

Model/Type Ref:

HCR-5 100 ~ 240 Vac, 47 ~ 60 Hz

Ratings and principal characteristics:

Additional information (if any) :

A sample of the product has been tested and found to be in conformity with :

EN 61000-6-2 : 2005, EN 61000-6-4 : 2007/A1:2011

as shown in the test report(s) F690501/RF-IMS005255

This Certificate of Conformity is the result of testing a sample of the product submitted, in accordance with the provisions of the relevant specific standard. It does not imply an assessment of the whole production. Conformity of the produced products with the specimen tested remains on the full responsibility of the manufacturer.

Brussels, 18/05/2017

Forest Lee. Certification Manager.



SGS Belgium NV – Division SGS CEBEC Riverside Business Park Bld. Internationalelaan, 55 Build. D BE-1070 Brussels Tel. +32 2 556 00 20 Fax +32 2 556 00 36

SG

### **Cleanroom-Body**



## CERTIFICATE

TÜV SÜD Industrie Service GmbH hereby confirms the Company Hanwha Precision Machinery Co.,Ltd. 6, Pangyo-ro 319beon-gil, Bundang-gu, Seongnam-si, Gyeonggi-do, 13488, Korea, that the product:

#### ROBOT MODEL: HANWHA COLLABORATIVE ROBOT (HCR-5)

the cleanroom compatibility of the equipment for the ISO Class 2 according ISO 14644-1.

The certificate is limited to the particulate cleanliness. The product was tested according to VDI 2083 Part 9.1 in January 2018.

The implementation of the testing and certification is carried out by TÜV SÜD Industrie Service GmbH.

Certificate-no.: 2820932-01 Report-no.: 203772 Valid till: February 2020

Dipl.-Ing. Walter Ritz Berlin, 19. February 2018 TÜV SÜD Industrie Service GmbH Wittestraße 30, Haus L, 13509 Berlin

CERTIFICAT ٠ CERTIFICADO ٠ CERTIFICATE ٠ ZERTIFIKAT

#### **Cleanroom-Controller**



## CERTIFICATE

TÜV SÜD Industrie Service GmbH hereby confirms the Company Hanwha Precision Machinery Co.,Ltd. 6, Pangyo-ro 319beon-gil, Bundang-gu, Seongnam-si, Gyeonggi-do, 13488, Korea, that the product:

#### CONTROLLER MODEL CONTROLLER FOR HANWHA COLLABORATIVE ROBOT (HCR-5)

the cleanroom compatibility of the equipment for the ISO Class 5 according ISO 14644-1.

The certificate is limited to the particulate cleanliness. The product was tested according to VDI 2083 Part 9.1 in January 2018.

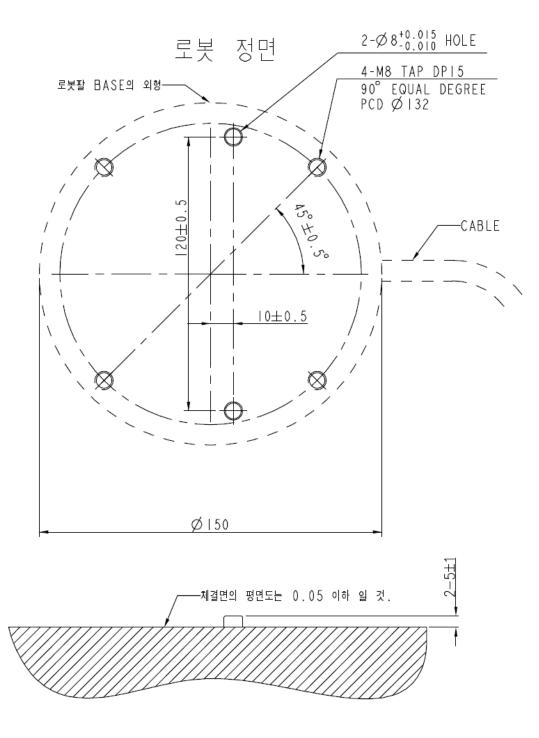
The implementation of the testing and certification is carried out by  $T\ddot{U}V$  SÜD Industrie Service GmbH.

Certificate-no.: 2820932-02 Report-no.: 203772 Valid till: February 2020

Dipl.-Ing. Walter Ritz Berlin, 19. February 2018 TÜV SÜD Industrie Service GmbH Wittestraße 30, Haus L, 13509 Berlin

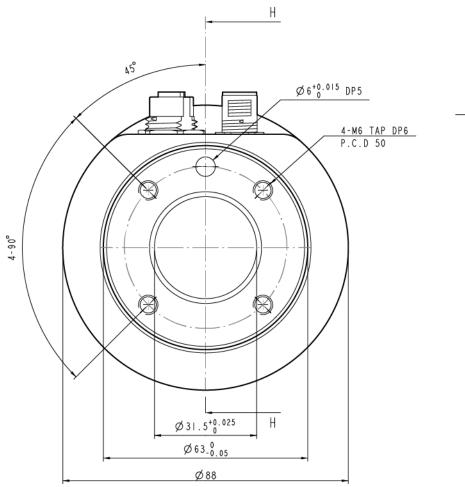


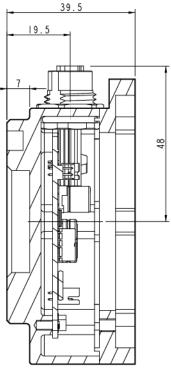
## Appendix C Dimensions for Installation



## Appendix D Tool Flange Cross Section

The tool flange is designed suitable for ISO9409-1-50-4-M6.





Section H - H

## Appendix E Port Pin Map

Ports in the tool flange have the following specifications.

- Tool I/O: SACC-DSI-M12FS-12CON-M16/2,0 1458790
- EtherCAT: SACC-DSI-MSD-4CON-M12/0,5 SCO 1551901

Port	Layout	Pin number	Signal	Color
		1	0/12/24 Vdc	Brown
		2	Ground	Blue
		3	Digital Output Ch 0	White
		4	Digital Output Ch 1	Green
	10 2 3 11	5	Digital Output Ch 2	Pink
Teel I/O	1 0 0 4	6	Digital Output Ch 3	Yellow
Tool I/O	9 0 0 5	7	Digital Input Ch 0	Black
	8 7 6	8	Digital Input Ch 1	Gray
		9	Digital Input Ch 2	Red
		10	Digital Input Ch 3	Violet
		11	Analog Input Ch 0	Gray/Pink
		12	Analog Input Ch 1	Red/Blue
		1	TX+	Red
EtherCAT		2	TX-	Yellow
EUIEFCAI		3	RX+	Green
		4	RX-	Blue

## **Appendix F** System Specifications

Degree of freedom	6
Base weight	5 kg
Working radius	915 mm
Joint rage	±360° (J3: ±165°)
Repeatability	±0.1 mm
Weight	20 kg
Bottom area size	Ø 150 mm
Temperature	$0 - 50^{\circ}$
IP class	IP54 (Robot Arm) / IP20 (Robot Controller)
Power supply	100 – 240 VAC, 50 – 60 Hz

		Controller	Tool connector
I/O port	Digital input	16	4
	Digital output	16	4
	Analog input	2	2
	Analog output	2	_
	EtherCAT	_	1
I/O power supply	Controller: 24 V 2 A		
	Tool connector: 12 V or 24 V	V 1.6 A	
External communication	TCP/IP, Modbus TCP,		
	CC-link / Profinet / Etherne	t / IP (optional)	
Cable length	Robot arm to controller conr	nection cable: 6 m	
	Teaching pendant to controll	er connection cable: 5	m

## Appendix G Stopping Time and Distance

### Stopping time and distance for stop category 1

The robot configuration to measure the stopping time and the stopping distance for the stop category 1 is as follows:

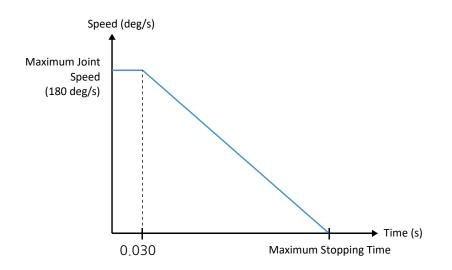
- Position: Maximum load position (the position of the robot arm fully stretched horizontally to make the maximum load)
- Speed: Maximum joint speed (maximum speed of 180°/sec which can be generated at the robot joint)
- Payload: Maximum load possible to be installed on the TCP (5 kg)

The behavior to measure the stopping distance for the joint J1 was driven in parallel to the ground and joints J2 and J3 were driven perpendicular to the ground. The stop category 0 was performed when each joint reached its maximum speed.

It takes 0.03 sec for the brake to be engaged for deceleration after the stop signal is

	Stopping Distance (deg.)	Stopping Time (sec.)
Joint J1	34.67	0.61
Joint J2	31.60	0.55
Joint J3	29.08	0.51

detected.



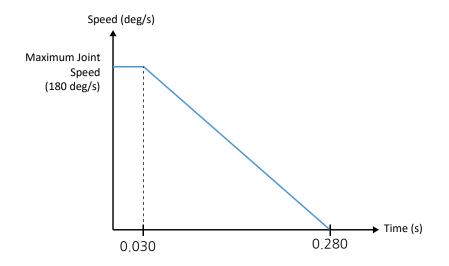
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## **Stopping time for stop category 1**

The robot configuration to measure the stopping time for the stop category 1 is as follows:

- Position: Maximum load position (the position of the robot arm fully stretched horizontally to make the maximum load)
- Speed: Maximum joint speed (maximum speed of 180°/sec which can be generated at the robot joint)
- Payload: Maximum load possible to be installed on the TCP (5 kg)

Create a behavior to stop regardless of the speed and the payload so that it comes to a full stop after a certain period (0.250sec).



# Appendix H Error Codes

Code	Cause	Actions
10001	The operation software has a server connection error.	Restart the system or ask the administrator.
10002	An error occurs while the operation software communicates with the server.	Restart the system or ask the administrator.
10005	A DB connection error.	Restart the system or ask the administrator.
10006	Controller update server connection error.	Check the EPC and controller board connection cable or check the access information. If the same problem persists, then ask the administrator.
10007	A data tx/rx error occurs while the operation software communicates with the controller.	Check the EPC and controller board connection cable or check the access information. If the same problem persists, then ask the administrator.
10008	A communication error (heartbeat) occurs between the operation software and the controller.	Check the EPC and controller board connection cable or check the access information. If the same problem persists, then ask the administrator.
20001	A system initialization error.	Restart the system or ask the administrator.
20006	Vision equipment fails to detect an object.	Check the recording setting for the vision camera and check if it detects objects properly.
20007	An error occurs while receiving data from the vision equipment.	Check the vision equipment connection information and the cables.
30002	The operation software does not support the feature currently.	Check the software version installed in the system and ask the administrator.
30005	A pattern initialization error occurs while running the program.	After checking the pattern settings, try again.

Code	Cause	Actions
30008	An error occurs while retrieving the file.	If the file is retrieved from an external storage device, then check the connection to it.
30010	An error occurs while exporting the file.	If the file is retrieved from an external storage device, then check the connection to it.
40001	Infinite loop is found while running the program.	After checking the program logics, make sure to avoid an infinite loop.
100002	The robot cannot be paused (without motion operation), and you cannot execute a pause command.	If the program is in the pause state with the robot operation already stopped, send the program stop command and continue the next operation.
100008	An error occurs while calculating the time for inputted motion.	Check the motion's input value and try again.
100017	A communication error occurs while sending the program's command data (motion).	Check the network cable and restart the system.
100018	A communication error occurs while sending the program's command data (stopped).	Check the network cable and restart the system.
100019	A communication error occurs while sending the program's command data (I/O).	Check the network cable and restart the system.
100020	A communication error occurs while sending the program's command data.	Check the network cable and restart the system.
100021	A communication error occurs while sending the robot data.	Check the network cable and restart the system.
100022	An error occurs while establishing communication between the controller and the EPC.	Check the network cable and restart the system.
100037	The robot cannot move to the destination indicated by the transmitted command.	Check the command input and try again.

Code	Cause	Actions
100047	You cannot execute the current jog command because the robot is still operating.	Check that the robot operation is fully stopped and retry it.
100048	At present, the robot is violating the safety settings (border, joint range).	Disable the safety setting in the operation menu and use manual control to move the robot into the working range that complies with the safety settings. For normal operation, check the Enable Safety Setting item before use.
100051	The speed input for the currently transmitted command exceeds the max speed limit.	Check the input for the command and try again.
100052	The speed input for the currently transmitted command is zero.	Check the command input and try again.
100053	The currently set speed limit is zero, so the robot may not move.	Check the safety speed limit.
100057	An error occurs while using the inputted point data to calculate the TCP.	Reset the point for TCP calculations.
100059	A speed input error.	Check the speed input range $(0 \sim 1.0 (100\%))$ .
100061	Cannot execute the currently inputted motion command.	Reset the current motion settings such as location and speed.
100075	The currently inputted motion's joint speed is zero.	Enter the joint speed greater than zero.
100076	The currently inputted joint speed violates the max speed limit.	Reset the joint speed input.
100077	The currently inputted joint speed violates the speed limit.	Reset the motion's joint speed or speed limit.
100078	Jog control speed violates the limit.	Check the speed limit settings.
100079	Jog control speed violates the limit for the robot.	Check the speed limit settings.

Code	Cause	Actions
100080	The joint speed limit is set to zero.	Reset the joint speed limit input.
100100	An error occurs while calculating the inputted motion (circular).	For circular motion setting, check the start/mid/end location inputs.
100101	An error occurs in the radius value while calculating the inputted motion (circular).	For circular motion setting, check the radius input value.
100102	An error occurs while calculating the inputted motion (circular).	For circular motion setting, check the radius and input values.
100103	An error occurs while calculating the inputted motion (circular).	For circular motion setting, check the radius and input values.
203100	The operating robot's joint exceeds the range of safety operation.	Press the reset button in the operation menu and move the robot into the permitted working range. For normal operation, check the Enable Safety Setting option before use.
203101	The joint's safety speed exceeds the limit.	Reset the safety speed in the safety setting menu or adjust each motion speed in the program to meet the speed limit. (The problem may occur while moving even if the speed and acceleration of each motion are entered within the allowed ranges. You must find the speed and acceleration of the motion normally operating.) For items related to safety setting, ask the administrator with the Admin authority to login as the Admin and set them.

Code	Cause	Actions
203102	The joint's safety acceleration exceeds the limit.	If the servo is off due to an error, then turn on the servo in the operation menu and adjust each motion's acceleration in the program to meet the safety setting. (The problem may occur while moving even if the speed and acceleration of each motion are entered within the allowed ranges. You must find the speed and acceleration of the motion normally operating.)
203103	This is a one-time error that can occur when excessive torque is applied to the joint drive.	You can ignore a one-time error. If the same error persists, then you need further analyze the robot's drive and motor conditions and take additional actions.
203104	This is a one-time error that can occur when excessive torque is applied to the joint drive.	Press the reset button in the operation menu and try again. If the same error persists, ask the administrator.
203105	Out of the range of safety border.	If the servo is off due to an error, then turn on the servo in the operation menu, (if the servo is still off. then disable 'safety limit' and try to turn on the servo again) and use manual control to move the robot into the permitted working range. For items related to safety setting, ask the administrator with the Admin authority to login as the Admin and set them.
203106	Cannot move the robot to the destination that is inputted.	Check the position, speed and pose of the motion
280000	The operation or control software is down or a communication error occurs due to a cut in the cable.	Check the network cable connection. Restart the operation software. If the operation software malfunctions, then force it to stop and restart it.

Code	Cause	Actions
280001	A communication error between the controller board and the robot (EtherCAT).	Press the reset button in the operation menu and press the start button after several seconds to turn on the servo motor. If the problem persists, then press and release the emergency stop button for the TP, press the reset button and check if the Start button is activated in the Operation menu after several seconds and check operation of the controller.
		If the system does not operate normally despite of actions taken as above, restart the system.
280002	Drive error	Use the device log in the Log Inquiry screen to inquire about the axial number that is causing errors. Press the reset button in the operation menu and see if the start button is activated after several seconds. If not activated, press and release the emergency stop button for the TP, press the reset button and check if the Start button is activated in the Operation menu after several seconds and check operation of the controller. If the system does not operate normally despite
		If the system does not operate normally despite of actions taken as above, restart the system.



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