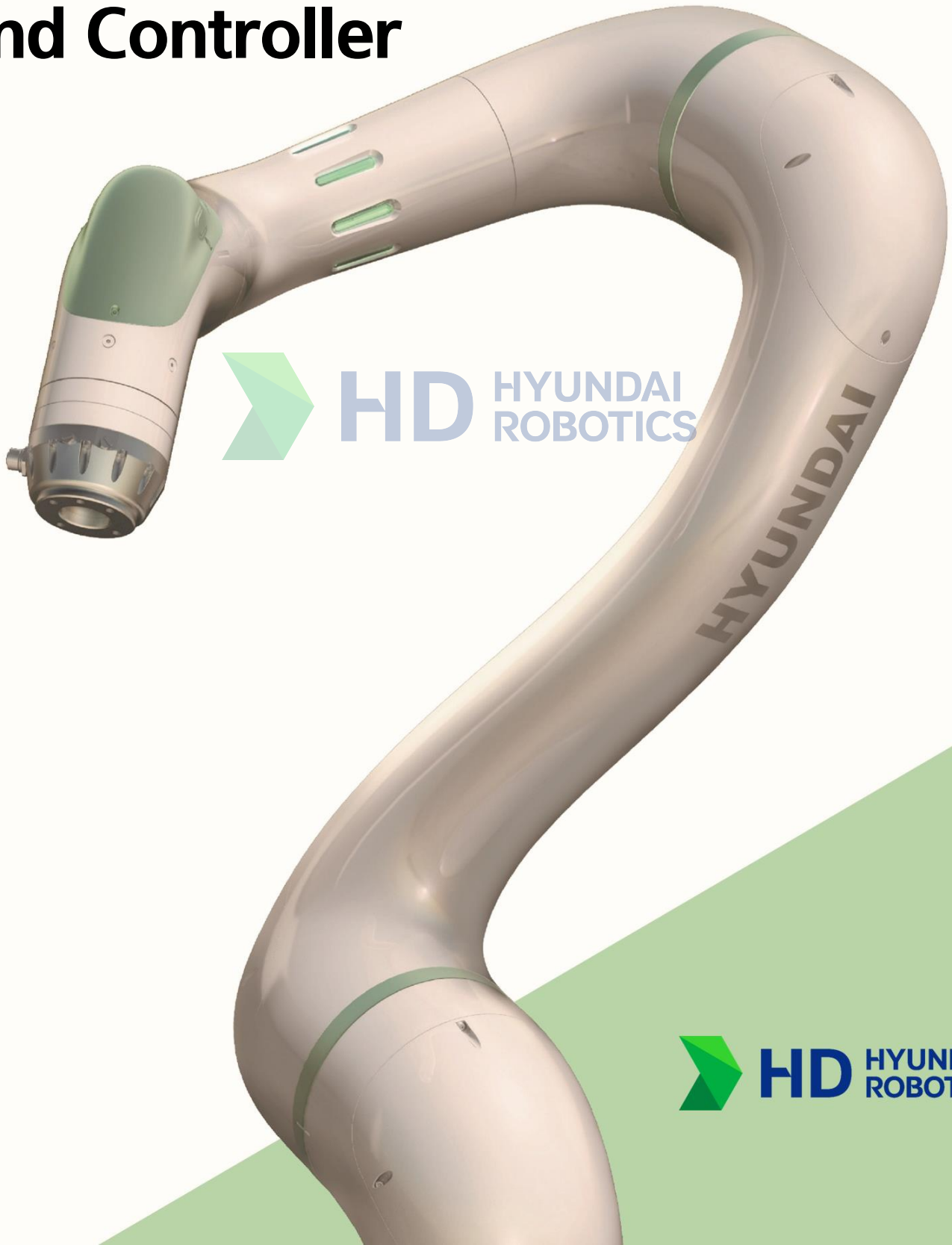
Expanding
Possibility

reddot award 2019
best of the best

Maintenance Manual for Collaborative Robots and Controller



HD HYUNDAI ROBOTICS

HD
HYUNDAI
ROBOTICS

About this manual

This manual describes the safety, installation, use, and maintenance methods of collaborative robots manufactured by Hyundai Robotics.

Before using the product, read and fully understand the contents of this manual. In addition, keep this manual in an accessible place so that it can be read any time when necessary.

This manual may be provided to customers who purchase products of Hyundai Robotics or may be used as material for internal training programs.

As this manual has been prepared based on standard specifications, it may not apply equally to all models. In addition, the details and specifications of this manual are subject to changes for improving product performance without notice, and Hyundai Robotics will not take responsibility for any consequences of incorrect details, typos, or omissions of this manual. For detailed information on revisions, please visit our website (www.hyundai-robotics.com).

Products covered by this manual are :

Division	Name	Version
Manipulator	YL012	0D
	YL015	0A
	YL005	0B
Controller	Hi6-H10	V1.0
Safety control module (SCM)	BD6F1	V1.2
Teach pendant	TP600	V1.0

Copyright

Notation rules

This manual utilizes the following expression rules and safety directions for easy understanding.

■ Description by figures

Figures are used for a better understanding of how to operate the product and for describing screens. When a description is made by a figure, the pertaining part is marked with the figure number that describes the part as shown in the following figure:

GUI (Graphical User Interface)

Regarding GUI, any menu name or button name will be in brackets ([ ]) and in **bold type**. When multiple menus need to be selected in the listed order, the menu names will be separated by the symbol (〉).

- Menu having a title: On the initial screen of the manual or automatic mode, select the **[Menu]** button.
- Multiple menus: In the initial screen of the manual mode, select the **[Set Up]** button 〉 **[5: Reset 〉 7: Unit Setting]** menu.

Manipulation key notation method

Any key to be pressed in the functional manipulation area of the teach pendant will be in angle brackets (〈 〉) and in **bold type**.

- Pressing the **〈Start〉** key will initiate the automatic execution of the sequence programmed into the robot.

Cross-references

This provides the shortcut to the related information in the manual. Cross-references will be in quotation marks and in **bold type**.

- For details of making changes in date and time information, see "**4.5 Date and time setting.**" of "**Operation Manual for Hi6 Controller**"

References

Useful or additional information on using the product will be provided as follows:

Remarks	The blinking of the e icon in the status bar indicates the engineer mode.

Safety precautions

To ensure proper product use and user safety and to prevent property damages, make sure to read and fully understand the following precautions before using the product.

■ Danger

⚠ Danger	Impending risk: If not conformed to, operator deaths or severe injuries may occur.

- Perform a risk assessment on the entire system, not the individual devices. Connecting other devices to the product may increase the risk level of the product or create new risks. If the devices of the integrated robot system have different risk levels, prepare safety devices based on the device with the highest risk level in preparedness for risks.
- In installing the robot product and other devices, make sure to read, fully understand, and conform to the product installation instructions described in the manual.
- In case of any issues of the product, such as faults and damages, stop using the product immediately and contact our Customer Support Team.

■ Warning

⚠ Warning	Potential risk: If not conformed to, operator injuries or property damages, including serious product damages, may occur.

- Take adequate safety measures according to the result of risk assessment, and accurately assign the safe range of robot installation. During the robot operation, product damages or user injuries may occur.
- Persons who manufacture robot application systems or use the robot must read and fully understand the manual and undergo training in robot operation.
- For the safety of operators and users, prepare adequate safety facilities such as safety fences before installing the product.
- Secure sufficient space so that the robot arm can move freely. During the robot operation, product damages or user injuries may occur.
- Fasten locking bolts to the specified torque according to the specification sheet. Loose bolts may lead to damages of the robot because of falling from the installation position.
- Pay attention to the product connections (power and cables) so that no conductive substances, such as liquid, dust, and metal particles, could infiltrate. Do not poke the connection with sharp objects or apply excessive force during cable connection. Corrosion or temporary short circuits of connectors may lead to product explosion or fires.
- Check the wiring specification and connect devices with terminals that are suitable for the device types. Make sure to connect safety devices to dedicated terminals because connecting them to general terminals does not guarantee safety functions.
- Never use damaged cables and do not disconnect cables while the product is in use. Doing so may lead to electric shocks, fires, faults, and injuries.
- Long-time use of the product may lead to overheating and cause injuries such as burns. In the event it is necessary to touch the product, cool down the product sufficiently by powering it off and leaving it for at least one hour.

- Never arbitrarily install, modify, disassemble, or repair the product. This may lead to faults and accidents. Hyundai Robotics will not take responsibility for product damages caused by such arbitrary actions.

■ Caution

⚠ Caution	Minor risk: If not conformed to, minor operator injuries or property damages, including product damages, may occur.

- Do not arbitrarily install, modify, disassemble, or repair the product. It is prohibited for persons other than experts from Hyundai Robotics to modify or attach parts to the product. Product faults caused by it will void free-of-charge services and warranty services.
- In the event it is necessary to install or repair the product, contact our Customer Support Team to consign the work to experts.
- Do not install or use the product at a place filled with dust or dirt. Dust or foreign matters may lead to product faults or malfunctions.
- Do not install or use the product at a place of magnetism, a place which is affected by magnetism, or a place of electromagnetic interferences. Magnetism may lead to product damages or malfunction.
- In operating the product, do not wear loose clothes or accessories. If you have long hair, you should tie it at the back of your head so it will not entangle between joints and the like of the robot.
- While the product is in operation, do not enter its operating range or touch the robot. Doing so may lead to injuries.
- Transport the product as it is packaged to prevent product damages, and store it at a dry and low-humidity place. Storing it at a humid place may lead to product damages or faults caused by moisture infiltration.
- Store the product at a place that is clean, cool, dry, and free from high variation in temperature and humidity.
- The product should be moved by two or more persons, and the correct posture should be maintained. If not, the persons may be subject to physical injuries in the waist, arms, legs, and the like.
- In moving the product using lifting equipment, conform to the local and national safety regulations and the instructions for equipment use.
- Before moving the product, read and conform to the moving instructions specified in the manual. Hyundai Robotics will not take responsibility for product damages caused during transportation by the customer.

Contents

1. Safety

1.1 Safety requirements

1.1.1 Applicable standards

This product has been designed and manufactured in compliance with ISO 10218-1, a safety standard of industrial robots, and ISO/TS 15066, a standard specifying safety requirements for collaborative operation. The safety standards applicable to this product are as follows:

- ISO 10218-1:2011 Robots and robotic devices - Safety requirements for industrial robots - Part 1: Robots
- ISO 10218-2:2011 Robots and robotic devices - Safety requirements for industrial robots - Part 2: Robot systems and integration
- ISO/TS 15066:2016 Robots and robotic devices - Safety requirements - Industrial collaborative workspace
- IEC 61508-1:2010 Functional safety of electrical/electronic/programmable electronic safety-related systems - Part 1: General requirements
- IEC 61508-2:2010 Functional safety of electrical/electronic/programmable electronic safety-related systems - Part 2: Requirements for electrical/electronic/programmable electronic safety-related systems
- IEC 61508-3:2010 Functional safety of electrical/electronic/programmable electronic safety-related systems - Part 3: Software requirements
- IEC 61508-4:2010 Functional safety of electrical/electronic/programmable electronic safety-related systems - Part 4: Definitions and abbreviations
- IEC 61508-5:2010 Functional safety of electrical/electronic/programmable electronic safety-related systems - Part 5: Examples of methods for the determination of safety integrity levels
- IEC 61508-6:2010 Functional safety of electrical/electronic/programmable electronic safety-related systems - Part 6: Guidelines on the application of IEC 61508-2 and IEC 61508-3
- IEC 61508-7:2010 Functional safety of electrical/electronic/programmable electronic safety-related systems - Part 7: Overview of techniques and measures
- IEC 61800-5-1:2007/A1:2017 Adjustable speed electrical power drive systems - Part 5-1: Safety requirements - Electrical, thermal, and energy
- IEC 61800-5-2:2015 Adjustable speed electrical power drive systems - Part 2: General requirements - Rating specifications for low voltage adjustable speed AC power drive systems
- ISO 13849-1:2015 Safety of machinery - Safety-related parts of control systems - Part 1: General principles for design
- ISO 13849-2:2012 Safety of machinery - Safety-related parts of control systems - Part 2: Validation
- IEC 62061:2005/A2:2015 Safety of machinery. Functional safety of safety-related electrical, electronic, and programmable electronic control systems
- IEC 61784-3:2016 Industrial communication networks - Profiles - Part 3: Functional safety field buses - General rules and profile definitions
- IEC 61800-3:2017 Adjustable speed electrical power drive systems - Part 3: EMC requirements and specific test methods

- IEC 61000-6-7:2014 Electromagnetic compatibility (EMC) - Parts 6-7: Generic standards - Immunity requirements for equipment intended to perform functions in a safety-related system (functional safety) in industrial locations
- IEC 61326-3-1:2017 Electrical equipment for measurement, control, and laboratory use. EMC requirements. Part 3-1: Immunity requirements for safety-related systems and for equipment intended to perform safety-related functions (functional safety) - General industrial applications

1.1.2 Safety performance

The safety performance of the collaborative robot is as follows:

Item	Safety performance	Application standards
HFT	1	IEC 61508/62061/61800-5-2
SIL (Safety Integrity Level)	2	
Category	3	ISO 13849-1
PL (Performance Level)	d	

1.2 Safety measures

This section describes the safety functions embedded into the product and the measures for ensuring the safety of users and operators.

1.2.1 Safety functions

The collaborative robot is intended to carry out collaborative tasks based on the following safety functions. For the details of the safety functions, see the "**Safety Function Manual for Collaborative Robots**."

- STO: Safe Torque Off
- SS1: Safe Stop 1
- SS2: Safe Stop 2
- EM (Emergency) Stop
- Protective Stop
- SBC: Safe Brake Control
- Safety Outputs
- Safety Inputs
- SOS: Safe Operating Stop
- Joint-SLP, Joint Angle Monitoring
- Joint-SLS, Joint Angular Speed Monitoring
- Joint- SLT, Joint Torque Monitoring
- Collision Detection
- TCP-SLP, TCP Position Monitoring
- TCP Orientation Monitoring
- TCP-SLS, TCP Speed Monitoring
- TCP Force Monitoring
- Momentum Monitoring
- Power Monitoring

1.2.2 Safety training

To effectively use the product functions, the user must read and fully understand the manual, and install, use, and maintain the product properly. The product user will be responsible for having the full knowledge of and conforming to the robot-related safety regulations of the locality in which the robot is installed and used, and for the proper designing, installation, and operation of the safety devices that can guarantee the safety of the workers of the robot system.

- All workers who install, use, and maintain the robot system must read and fully understand the manual. They must be fully knowledgeable of the safety precautions (⚠).
- Hyundai Robotics establishes and implements plans to provide training in product installation, use, and maintenance. Product operators and workers must undergo the relevant training programs before handling the product.
- Workers who are responsible for the robot's teaching and checkups must undergo a training program in robot use and safety before handling the robot. The safety training program covers the following topics:
  - The concept of safety and the purposes and functions of the safety devices
  - The procedures for handling the robot safely
  - The performance and potential risks of the robot and robot system
  - The materials relating to the application of specific robots

1.2.3 Safety labels

On the inside and outside of the controller, nameplates, warning signs, safety symbols, and the like are attached. Check the labels to ensure safety.

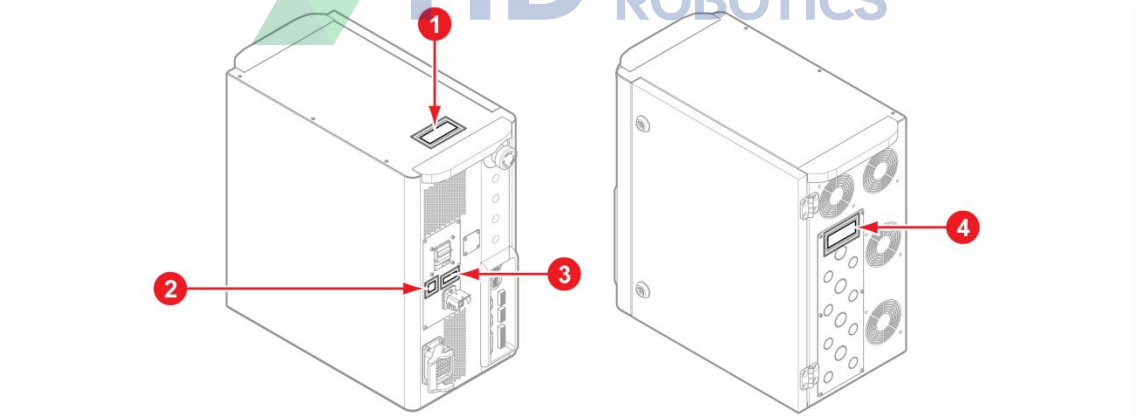


Figure 1 Safety label attachment points: front and top (left) / rear (right)

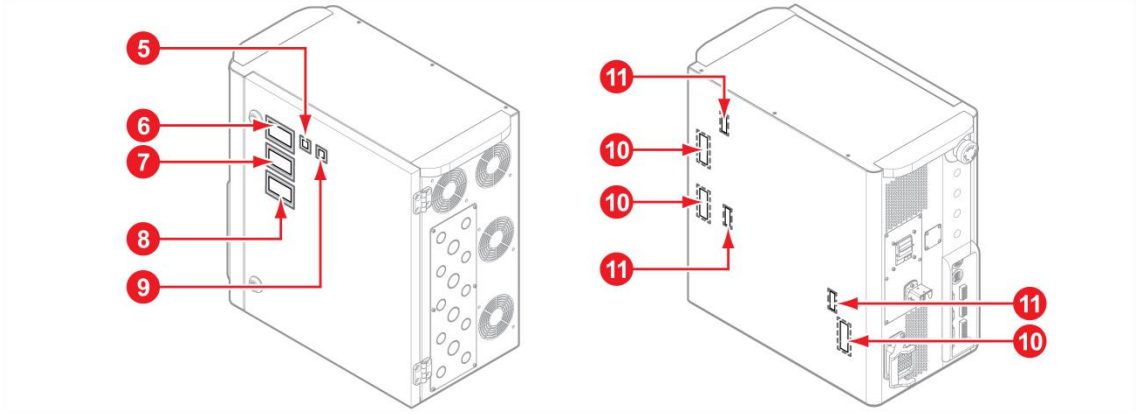
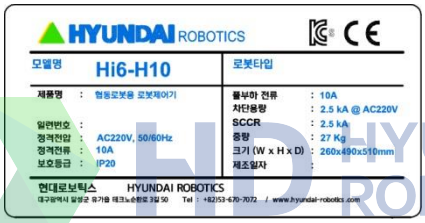
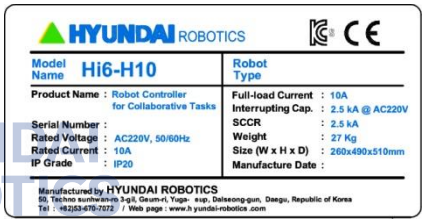


Figure 2 Safety label attachment points: side (left) / inner side (right)

No.	Item	Korean	English
1	Caution for Power and Grounding	**주 의** - 전원선을 결선하기 전에 공급되는 전원이 적절한지 확인해 주십시오. - 접지는 단독 3종접지(100Ω 이하)하십시오. - 1차 전원 연결 AWG16	**CAUTION** - Check appropriate supplied voltage before connection. - Make grounding which is 100Ω resistance or less for the robot independently. - Main Power Connection AWG16
2	High voltage Indication		
3	Input power Indication	AC220V	AC220V
4	Air irculation of ventiduct precautions	**주 의** 공기 순환용 흡/배기구를 막지 마십시오. 제어기에 손상을 입힐 수 있습니다.	**CAUTION** Ensure no interference for air circulation of ventiduct. Interference may cause controller damage.
5	NRTL Certification mark		
6	Nameplate		
7	high voltage Warning	**경 고** **고전압 ! 충전 에너지!** - 고전압에 의해 중대한 인명사고가 일어날 수 있으므로 다음을 준수해 주십시오. - 제어기 뚜껑을 열 때는 반드시 전원을 OFF해 주십시오. - DC48V의 충전된 에너지가 존재합니다. 완전히 방전시키기 위해 전원 OFF후 3분 이상 기다리십시오.	**WARNING** **High Voltage ! Stored Energy!** - High voltage can cause injury or death. - Control cabinet must be turned to "OFF" before opening cabinet cover. - The Robot System must be switched off before any maintenance, exchange, repair. - Be careful of stored energy of DC 48V. Wait more than 3 minutes for deenergizing after power off.
8	Installation precautions	**주 의** - 설치작업전에 조작설명서 및 안전지침서를 주의깊게 읽어주십시오. - 조작중에는 로봇 작업영역내로 들어가지 마십시오. - 케이블을 연결하기 전에 로봇 본체와 제어기의 일련번호가 동일한지 확인하여 주십시오. 일련번호가 다를 경우, 비정상적인 동작을 일으킬 수 있습니다.	**CAUTION** - Carefully read the operation manual and the safety manual before installation and using application. - Do not enter the working range of the robot system under operation. - Before cables connecting, check that the S/N is identical on the controller and on the manipulator. If the S/N is different, robot may be operated abnormally.
9	Functional safety Certification mark		
10	Ground wire connection precautions	**주 의** 구리, 구리도금 알루미늄, 알루미늄 재질의 도체를 사용하여 연결하십시오.	CAUTION **Use copper, copper clad aluminum, or aluminum conductors.**
11	Ground mark		

⚠ Warning	Never engage in behaviors that damage safety labels, such as moving the position of the nameplate, warning signs, safety symbols, nomenclature markings, cable markings, and the like attached to the controller. In addition, do not hide these labels by putting paint or covers.

⚠ Caution	Indicate the robot installation areas and hazard areas with distinct shapes, colors, or styles so that they are clearly distinguished from other facilities and equipment.

1.2.4 Emergency stop

The emergency stop function is actuated in an emergency where a worker or object enters a hazard area. All the emergency stop switches are installed at places easily accessible from outside the safety areas.

When the emergency stop function is actuated, the robot will immediately stop moving in any case.

- The servo system power of the robot will be cut off, and the motor brake will be actuated.
- On the teach pendant screen, an emergency stop message will appear.

1.2.4.1 Emergency stop switches

emergency stop switches are installed at the controller and the teach pendant. In case of an emergency, press the emergency stop switch.

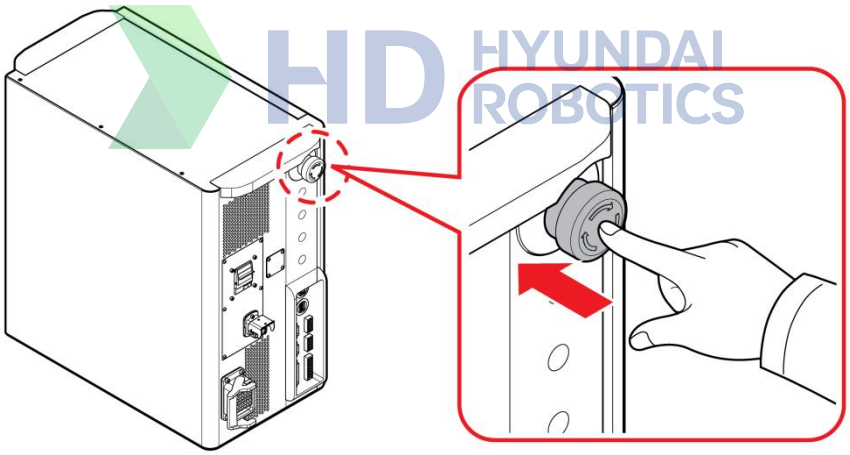


Figure 3 Emergency stop switchesof controller

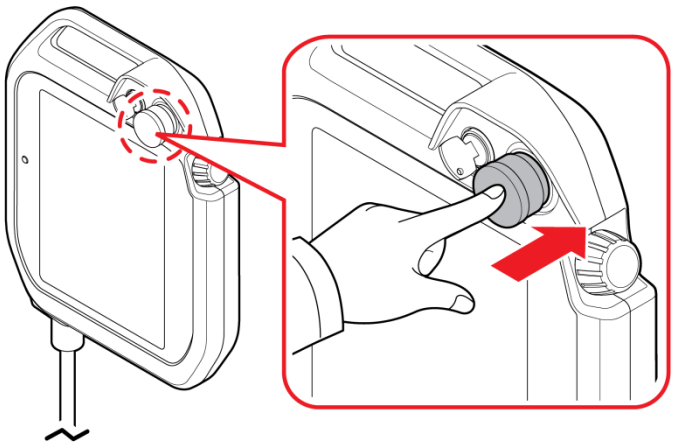


Figure 4 Emergency stop switches of teach pendant

1.2.4.2 Connecting to emergency stop devices of external systems

In addition to the emergency stop switches installed by default, it is possible to add external emergency stop XL devices according to site conditions and applications. For more details, see "**3.3.2.4 D-SUB 5 connector(SDIO): General purpose safety I/O signals and 4.3.2 Safety control module.**."

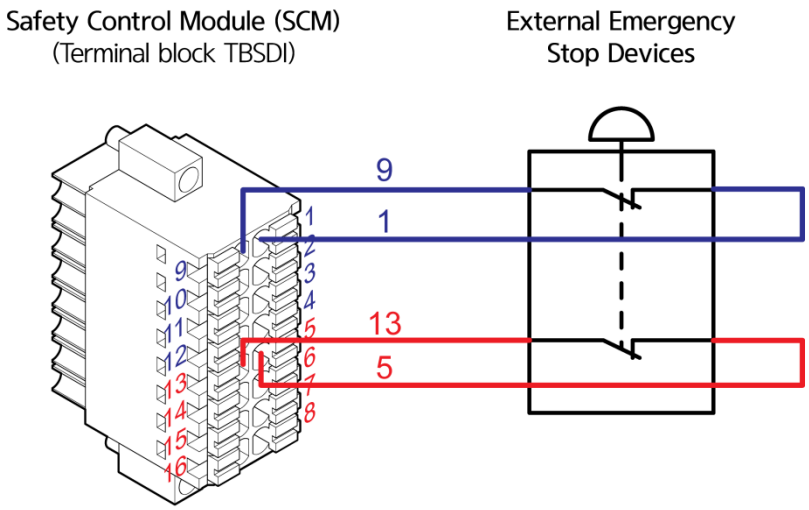


Figure 5 Connecting the emergency stop device of a safety control module (SCM)

1.3 Risk assessment

In a system integration including robots, risk assessment is of great importance that most countries specify it as a statutory requirement. Because safety assessments of robot installation vary depending on methods for integrating robots into systems, the risks of robot integrated systems cannot be assessed only by robots alone.

System administrators should carry out a risk assessment on the robot system according to the instructions specified in ISO 12100 and ISO 10218-2. The technical specifications ISO/TS 15066 may also be referred to.

Perform risk assessment in consideration of the entire processes of the integrated system including robots. The major objectives of risk assessment are as follows:

- Basic setting of robot use and robot teaching
- Problem diagnosis and maintenance
- Normal operation of installed robots

After installing robots and composing the system, a risk assessment must be performed. In risk assessment, the major points to be determined include the adequacy of the safety devices of integrated robot systems and the necessity for additional emergency stop devices or other safety devices.

It is very important to compose robot integrated systems based on the identification of adequate safety devices. Compose robot integrated systems referring to the relevant details of the manual.

For collaborative robots, it is possible to set tool center point (TCP) speed, pressure, power, momentum, collision detection, limit values of reduction ratio, and limit values of joint-specific angles, speeds, and torques. In addition, safety functions can be set by using safety-related inputs/outputs (I/Os). For more details for the composition of safety functions, see the "**Safety Function Manual for Collaborative Robots**."

In the **[Safety functions]** menu, the safety-related functions of the collaborative robot can be set, including the following:

- Force and power limiting: Limit the force and pressure at which the robot should stop in case of collision between the robot and an operator.
- Momentum limiting: Limit energy and impact load by decreasing the robot's motion speed in case of collision between the robot and an operator.
- Joint and TCP position limiting: Limit the robot's motion so that it does not move to body parts such as the user's neck or head.
- TCP and tool posture limiting: Limit motion to reduce risks relating to specific sections or characteristics of tools and operating parts (e.g., sharp points of tools or objects under operation).
- Speed limiting: Limit the speed of the robot to a low speed so that an operator can escape collision with the robot.

In addition, safety-related functions can be composed by installing the robot at a specific location or using safety I/Os.

The major categories of the risk assessment of robot integrated systems include the following:

- Collision severity of robots
- Collision probability of robots
- Collision avoidance probability of robots

In integrating robot systems, if risk factors (e.g., use of tools unintended for collaborative robots) are not sufficiently removed by the robot's safety functions, additional protective devices shall be installed according to the risk assessment.

HD
HYUNDAI
ROBOTICS

1.4 Potential risks

In the risk assessment of an integrated robot system, if the assessment result indicates that risk factors are not sufficiently removed only by the robot's safety functions, additional protective measures must be established.

In establishing additional protective measures, the following should be considered:

- Finger pinching (entanglement) between the robot base and the installation support during installation
- Injuries (such as poking and piercing) caused by sharp edges or protruding parts of obstacles or tools in the operating area
- Injuries caused by collision with the robot (such as bruises, falling, and bone fractures)
- Injuries caused by obstacles around the robot (such as poking, piercing, and bone fractures)
- Injuries caused by loose connections
- Injuries caused by toxic or hazardous substances under work (such as skin damage and breathing disorders)
- Displacement of objects under work caused by abrupt power shutoffs
- Erroneous activation of emergency stop switches caused by confusion with those of other equipment
- Errors caused by arbitrary modification of the Set up of safety functions

Because the types of potential risks vary depending on system compositions, a risk assessment must be carried out before using an integrated robot system.

1.5 Validity and responsibilities

The user should conform to the safety requirements specified in the safety laws and regulations of the country and locality in which the robot is installed and used. Responsibilities of suppliers and users of integrated robot systems include but are not limited to the following:

- Risk assessment of robot integrated systems
- Addition or removal of safety devices according to the result of risk assessment
- Checking that robot integrated systems are properly composed, installed, and set
- Establishment of the methods and instructions for using robot integrated systems and provision of user training
- Management of safety devices (prohibition of users from arbitrary modification and manipulation of safety devices)
- Provision of important pieces of information, contact addresses, and others relating to product use and safety
- Provision of all types of technical documents including manuals

The safety-related content of this manual does not cover all the risk factors and situations that may occur during product use.

2. Introduction to the product

This product, which is an industrial collaborative robot that can be used for moving objects or assembling parts using various tools, may be used only in environments that meet the requirements specified in this manual. This product, which is manufactured for collaborative tasks with persons, has safety functions that enable collaborative operation without physical protective devices.

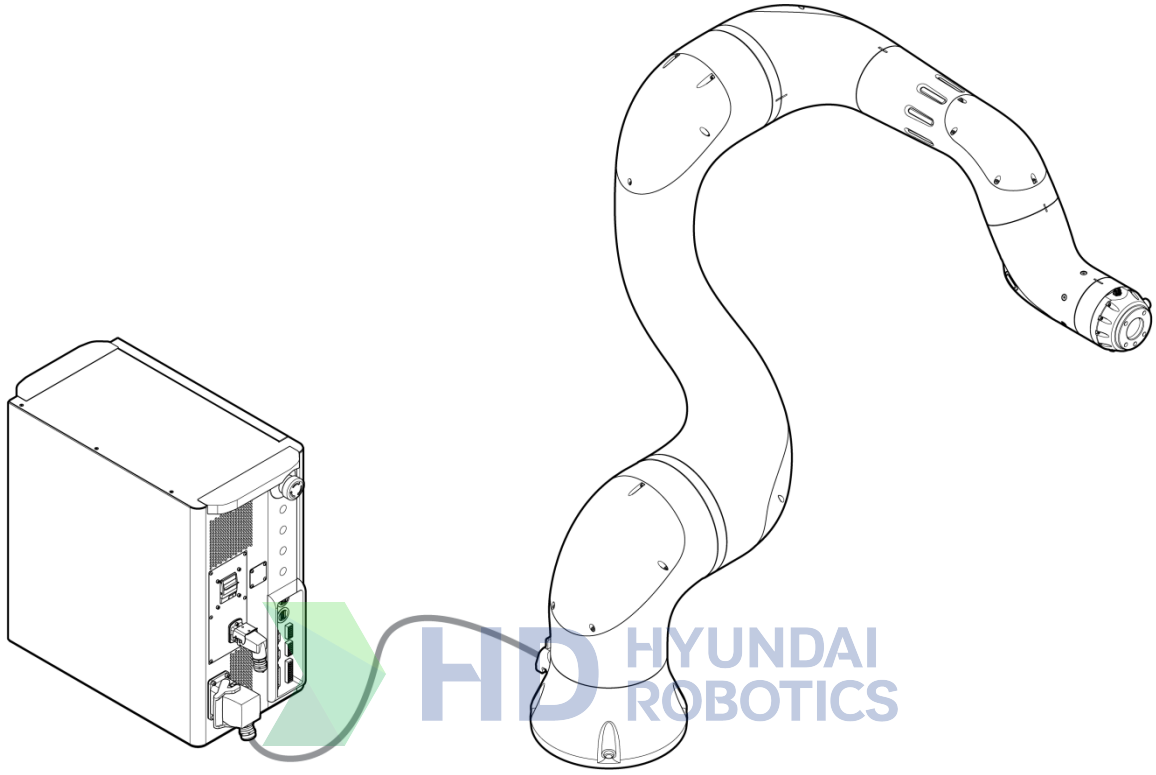


Figure 6 Collaborative robot and controller

⚠ Caution	In devising a system linked with tools, objects under work, and other additional equipment, a final risk assessment must be carried out to verify the safety of the system before using it.

2.1 Intended uses of the product

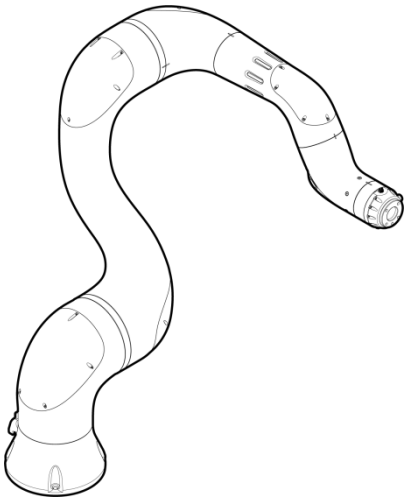
This product may be used only for the specified intended uses. The use of this product for other purposes than the intended uses will be considered inappropriate behavior. Hyundai Robotics will not take responsibility for injuries or property losses, including product damages and faults caused by unintended uses of this product. Examples of improper uses of this product include the following:

- Using the product as a means of stepping on
- Using the product for moving persons or animals
- Using the product in areas relating to health care and human lives
- Using the product in environments of explosion hazards
- Using the product without carrying out a risk assessment
- Using the product in conditions where the requirements for the performance of safety functions are not met
- Using the product at places where the performance and environmental requirements are not met

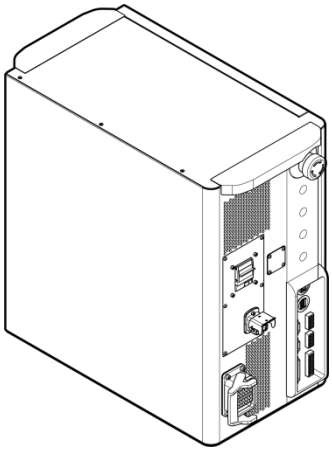
- Using the product (e.g., for welding) at places where electromagnetic waves higher than those specified in the international standard (IEC) is radiated

2.2 Product components

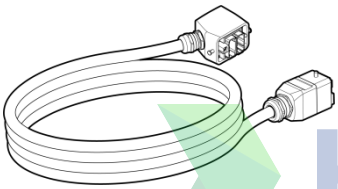
Upon purchasing the product, make sure to check that it includes all the components, as stated in this manual. If it does not include any components, contact our Customer Support Team or make a query on our website (www.hyundai-robotics.com).



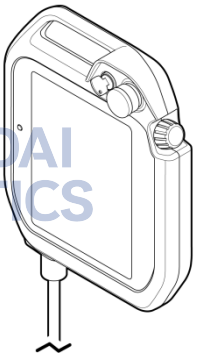
Collaborative robot



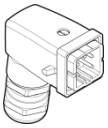
Controller



Robot connection cable



Teach pendant



Power connector

User manual

Notes	• The available collaborative robot models are YL005, YL012, and YL015. This maintenance manual describes the methods for assembling, installing, using, and maintaining them based on the YL012 model. • Partial details, including components, product parts, and methods of use, may be different depending on collaborative robot models. • If the packaging materials of the product are retained, they may later be used for transporting and storing the product.

2.3 Part names

Identifying the part names of the product is useful for learning how to install and use the product.

2.3.1 Manipulator

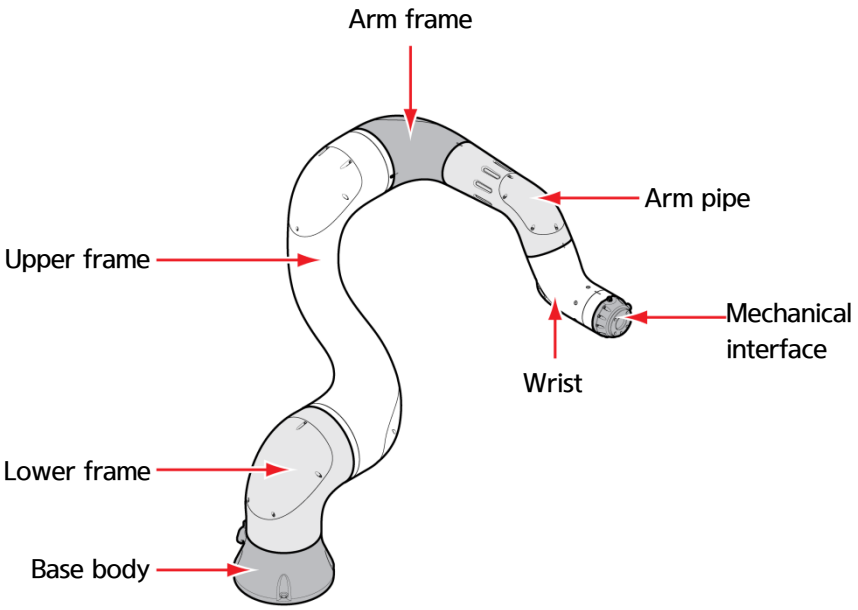


Figure 7 Layout of the manipulator

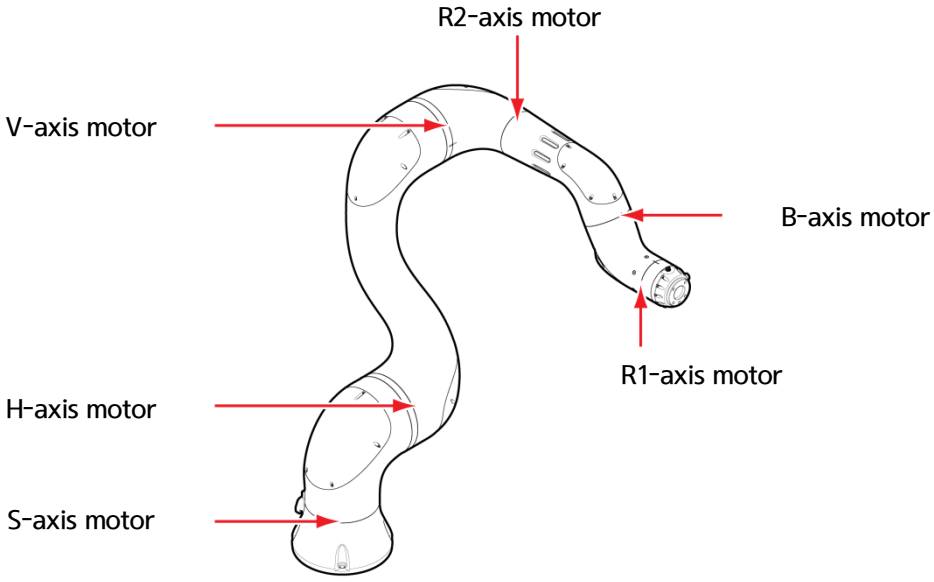


Figure 8 Major parts of the manipulator

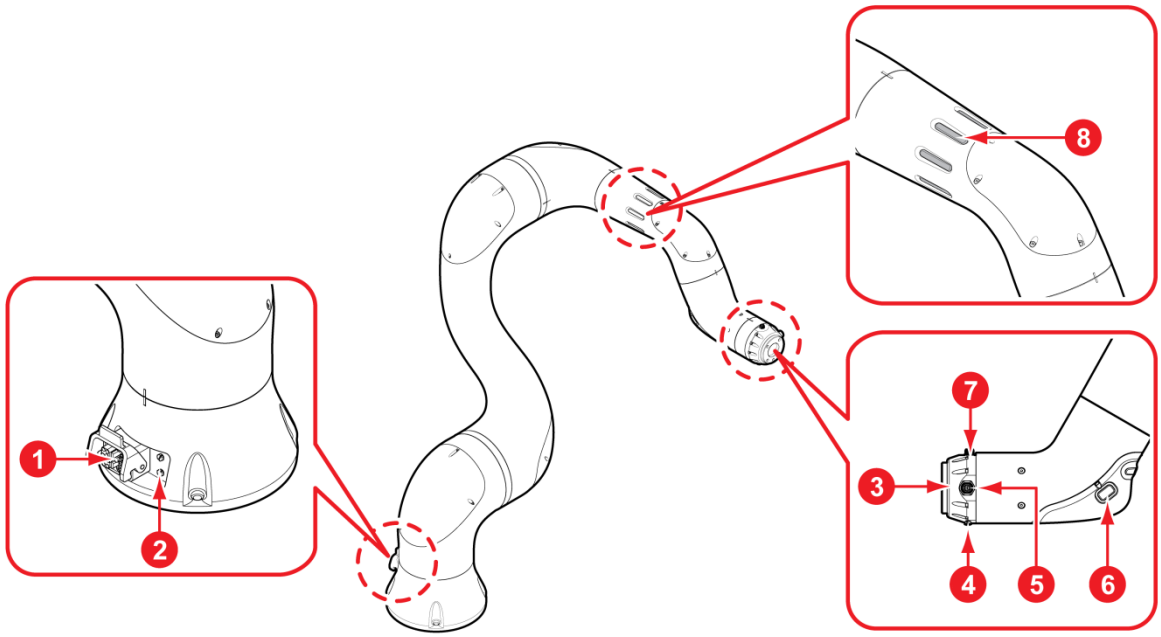


Figure 9 Manipulator connection and display device (YL012)

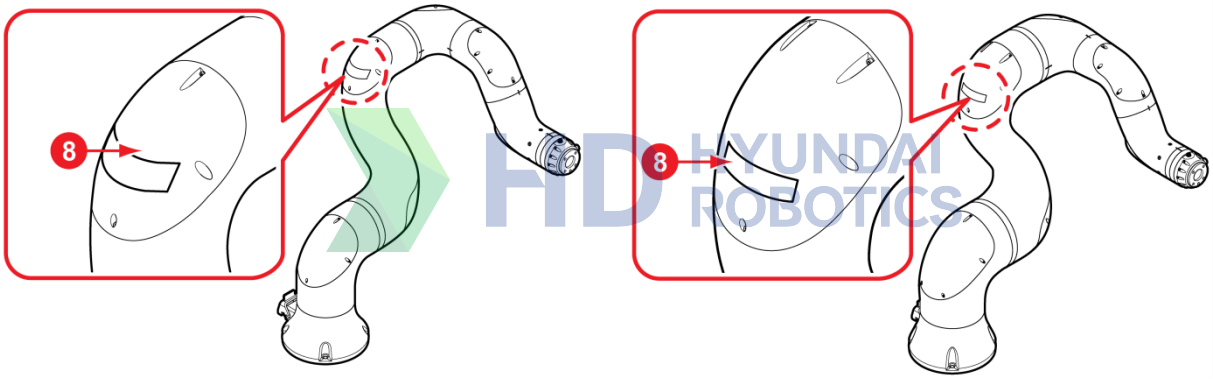


Figure 10 Manipulator LED lamp (Left : YL005 / Right : YL015)

No.	Name	Description
1	Power and Communication connectors	These supply power to and communicate with the robot, respectively.
2	Air inlet	This supplies pneumatic pressure through the pneumatic hose.
3	Tool flange	This mounts tools to the robot.
4	Air outlets	(YL012, YL015) These are used for moving various tools by connecting pneumatic hoses (ø 3.2, two pieces).
5	Tool I/O connectors	These control the motion of tools. For more details of the tool I/O, see "**3.3.1 Tool flange connection point.**"
6	Handgrip module	This is used for direct teaching.
7	EtherCAT connector	This establishes communication with tools through EtherCAT-based terminals. For more details of EtherCAT, see "**3.3.1 Tool flange connection point.**"

No.	Name	Description

8	LED lamp	This indicates the operating states of the robot.
		• OFF: The power of the robot system is off.
		• ON: The power of the robot system is on. Different colors of the LED lamp indicate the following states of the robot:
		  • White: The servo motor is waiting for actuation (the power is on or the brake is on) or is in the normal stop state.
		  • Green: The servo motor is actuated (the power is on or the brake is off). At this state, jog operation, step forward/backward motion, and playback are possible.
		  • Blue: The servo motor is actuated in the direct teaching mode. In this state, only direct teaching is possible.
		  • Red: The robot stopped operating because of an error. Resolve the error and try to actuate the servo motor.

Notes	
	• Air outlets are available only for the YL012 and the YL015 models. • The LED lamp position varies depending on the models. In the cases of the YL005 and the YL015 models, the LED lamp is on the upper frame cover. • For Ethernet options, and Ethernet connector is installed instead of Air.

2.3.2 Controller

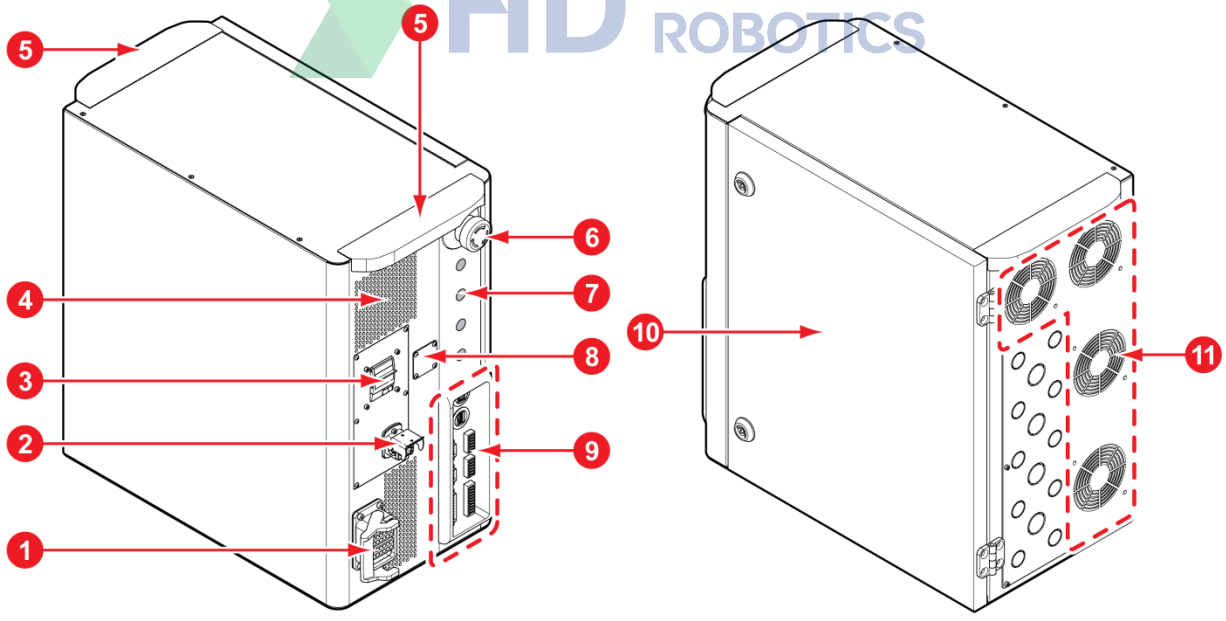


Figure 11 Controller front side (left) / rear side (right)

No.	Name	Description
1	Robot cable connector	This contains the power cable and the communication cable and connects the controller with the device.
2	Power connector	This connector supplies power to the controller.
3	Power breaker	This turns the main power of the controller on or off using the power switch.

No.	Name	Description
4	Ventilation hole	This is the airflow path for cooling the controller.
5	Handles	These are mounted on the front and the rear of the controller and are used for moving the controller.
6	Emergency stop switch	This button is pressed to stop the motion of the robot in case of an emergency.
7	Application device connection hole	This is the path used for passing cables connecting application devices with the internal modules.
8	Teach pendant Connection hole	This is the path used for connecting a teach pendant of the direct-connection type.
9	I/O connection block	This connects peripheral devices to the controller.
10	Door	This door is used for opening a side of the controller.
11	Cooling fan	This forcibly vents out the heated air inside the controller.

2.3.3 Teach pendant

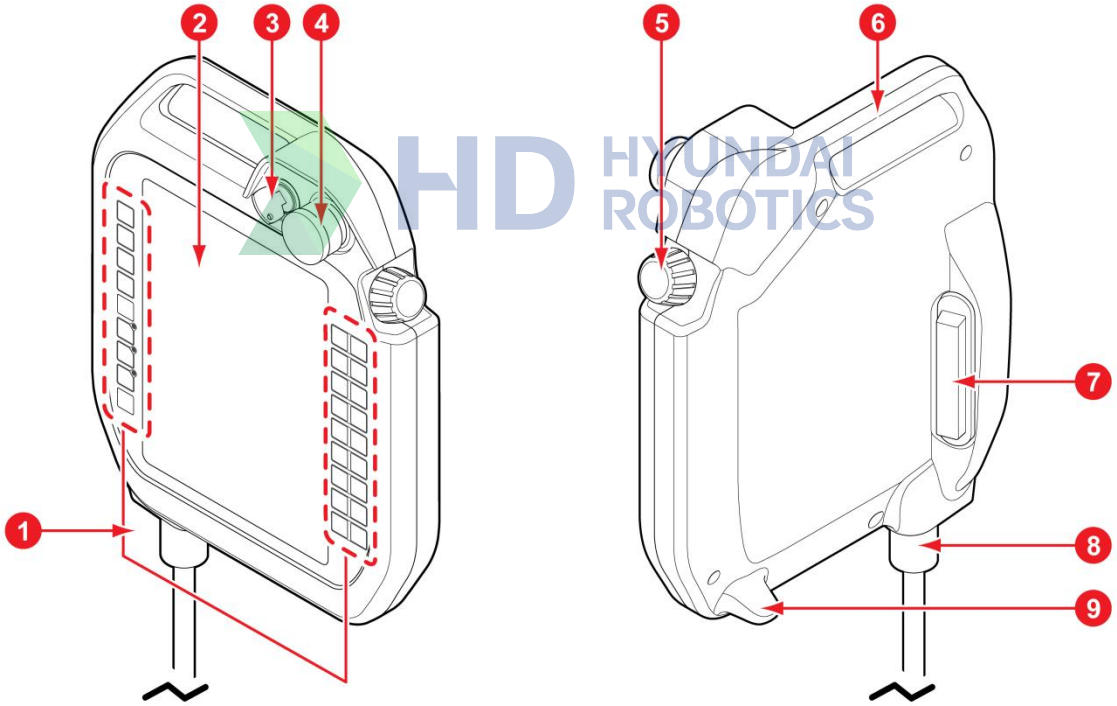


Figure 12 Teach pendant front side (left) / rear side (right)

No.	Name	Description
1	Operating keys	These are used for controlling the robot motion, entering commands, and selecting and setting menus.
2	Display	This displays and allows modification of the robot's motion states and setting information.
3	Mode switch	This can be rotated for selecting operating modes (automatic, manual, and remote).
4	Emergency stop	This button is pressed to stop the motion of the robot in case of an emergency.

No.	Name	Description
	switch	
5	Jog dial	This can be rotated for selecting menus.
6	Mounting bracket	This is used for keeping the teach pendant suspended or hung.
7	Enabling switch	This is used as a safety switch when the robot is operated by the teach pendant in manual mode. • Position 1, Position 3: At these positions, the robot operation is stopped. At position 3, it returns to position 1 without going through position2. • position 2: At this position, the robot can be operated.
8	Cable connector	This connects cables with the controller.
9	USB port	This is for connecting USB devices such as portable storage media.

2.4 Nameplate

The nameplate attached to the product contains information, such as robot type, manufacture number, and manufacture date. Compare this with the specifications of the purchased product to ensure they are consistent with each other.

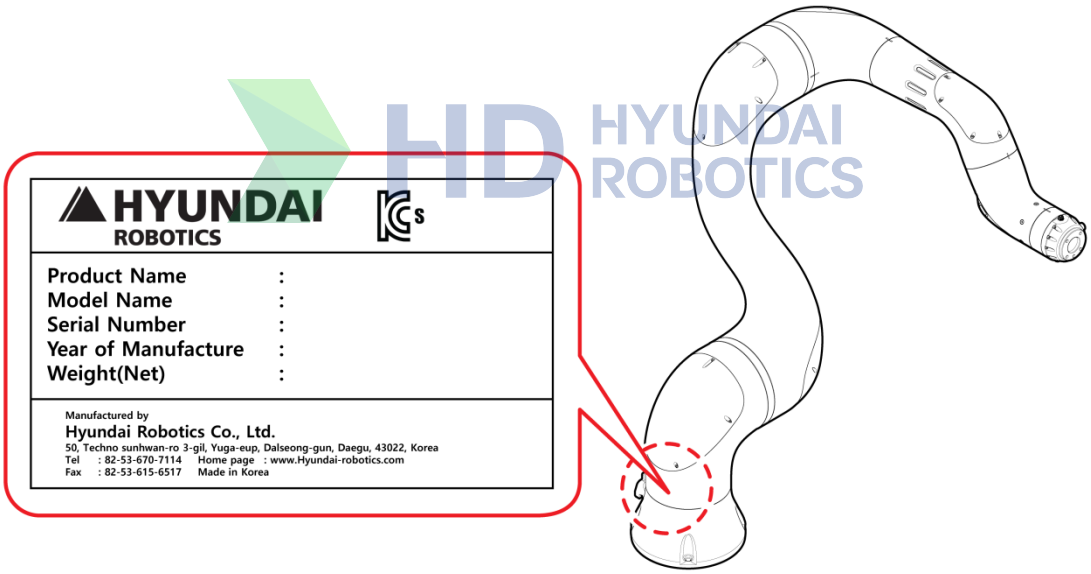


Figure 13 Nameplate of the manipulator

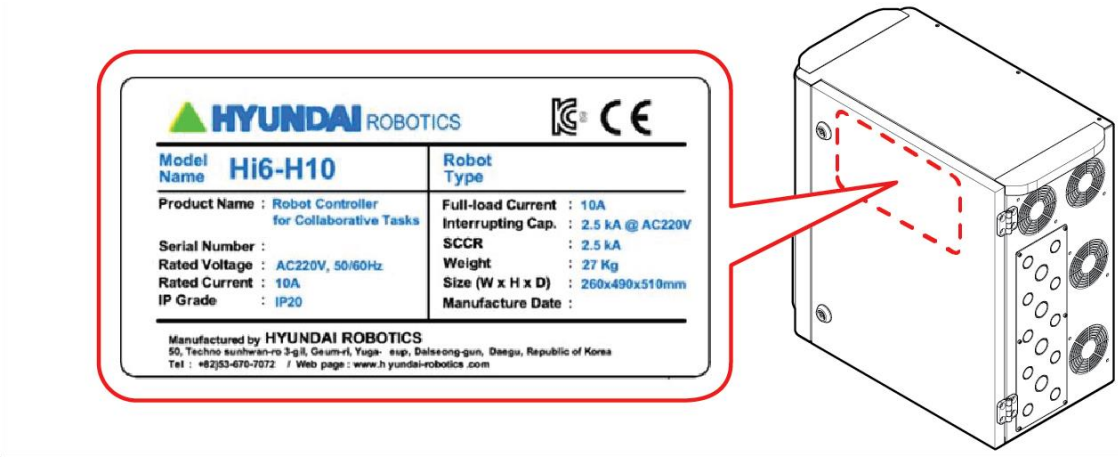


Figure 14 Nameplate of the controller

The model names of Hyundai Robotics collaborative robots and controllers are denoted as follows:

Division		Information		
Manipulator	YL□□□□-□□	①	Robot code	YL: Collaborative robot
		②	Payload	005: 5 kg / 012: 12 kg / 015: 15 kg
		③	Material	- : Standard material
		④	Specification number	
Controller	Hi6-□□□	①	Platform	Hi6: Hi6 platform
		②	Controller code	H: for collaborative robots
		③	Material	• 00: Plastic case • 10: Metallic case

3. Product installation

Installing the product properly in consideration of installation location, orientation, and adjacent space can increase the product's service life and prevent performance degradation. The installation sequence of the collaborative robot is as follows:

1. Check the environments of installation and use.
2. Check the operating area of the robot.
3. Check the allowable limit of the wrist axis load and the payload of the robot.
4. Compose the robot system and install devices.
5. Connect a tool.
6. Connect external devices and safety devices.
7. Set the operating area of the robot, such as the function for using the safety-rated soft axis and space limiting function, stopping time and distance, etc.
8. Set safety functions.
9. Verify the robot movement: Check that the setting and the safety functions run normally.

⚠ Caution	• Before installing the product, make sure to carry out sufficient risk assessment and set the safety functions based on the result of the assessment. • For more details of the safety functions, see the "**Safety Function Manual for Collaborative Robots**."

3.1 Environment of installation and preparation

3.1.1 Environments of installation and use

Install the product at an adequate place in consideration of the requirements for the environments of installation and use.

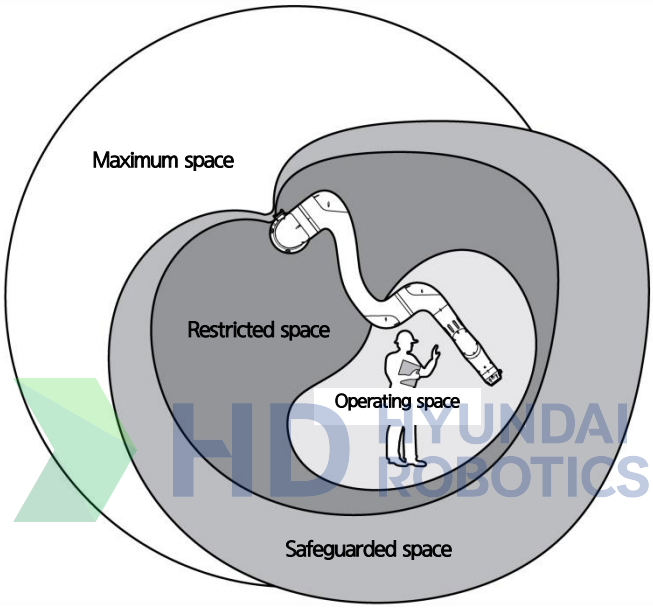
- The adequate temperature of use for the product is 0° C–45° C, and the adequate storage humidity is 20%–85% RH.
- In moving or using the product, avoid causing high-impact contact, for example, by dropping it.
- Based on the weight of the product, move and install it using the correct method, while paying attention to safety.
- Install and use the product on a hard, flat, and no-vibration surface where the product cannot easily tumble.
- Do not install and use the product at a place with plenty of water, moisture, gas, dust, or dirt.
- Do not install and use the product at a place with flammable or corrosive materials/gases, high heat, or flames.
- Do not install and use the product at a place with sources of strong electric noises or a place subject to the influence of such sources.

⚠ Caution	Installing the product at an inadvisable place may lead to a decrease in product performance and service life. Conform to the recommendations in installing and using the product.

3.1.2 Spaces of the robot system

Check the following information, and arrange the space adequately to meet the operating purpose and the maximum operating space of the model.

In collaborative operation in which the operator is allowed to contact the robot system, the operator should work within the operating space. On the contrary, in collaborative operation in which the operator is not allowed to contact the robot system, the operator should work only in the safeguarded space. In the general operation of industrial robots, the operator should work outside of the safeguarded space.

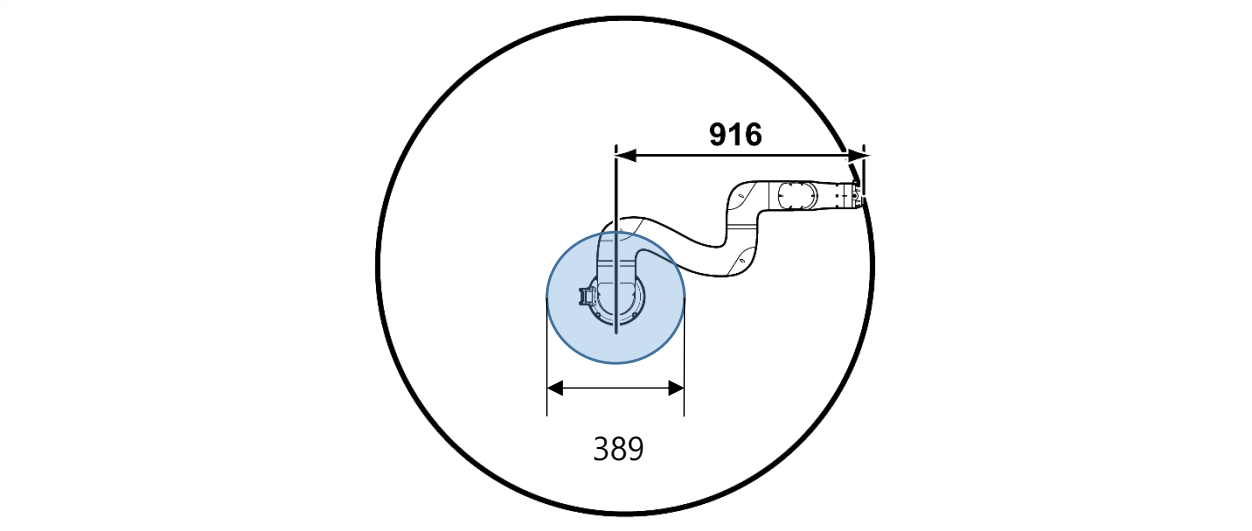


- Operating space: A part of the restricted space that is used while the robot moves according to the operating program
- Restricted space: A part of the maximum space that is restricted by restricting devices
- Safeguarded space: A space for which safeguarding devices run
- Maximum space: A space in which the robot can move to the maximum extent

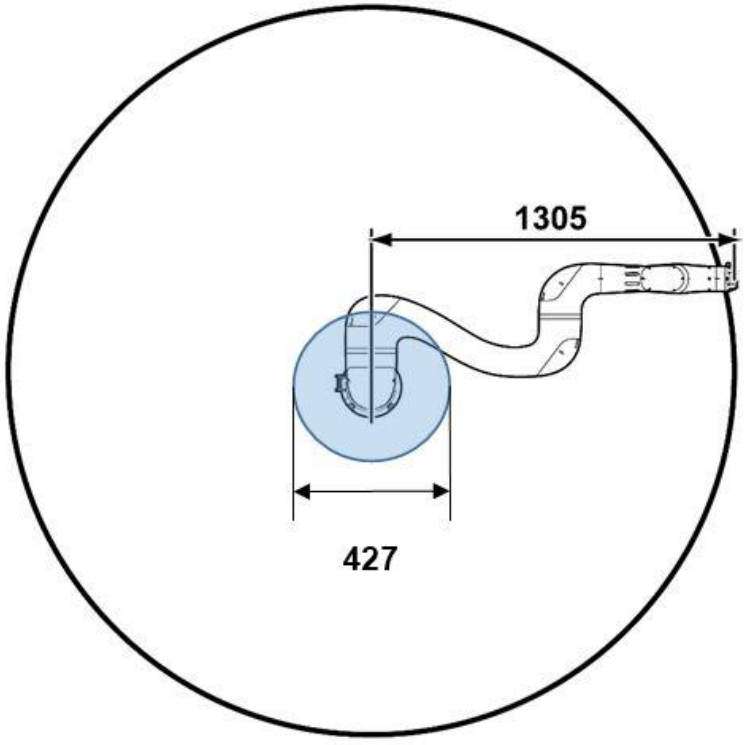
The maximum working spaces of collaborative robots vary depending on models. The maximum working spaces of models are as follows:

Notes	• Not all postures are possible even within the working area, so it is recommended to check through HRSpace

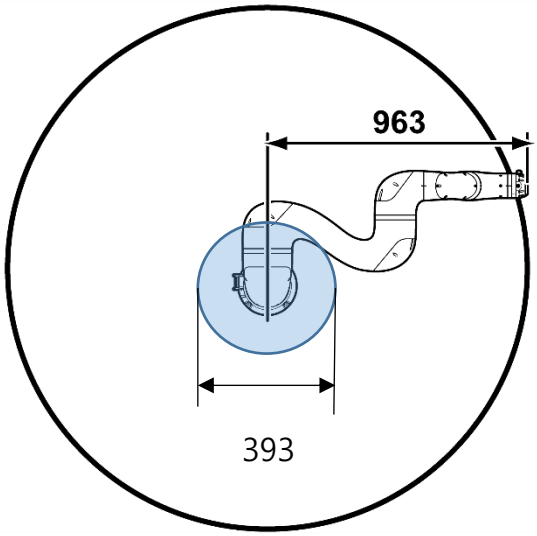
- YL005: 916 mm



- YL012: 1,305 mm



- YL015: 963 mm



Notes	• In the above cylindrical space passing through the S-axis, even if the tool flange moves slowly, other joints move quickly, possibly causing inefficient operation and damage to the robot. Therefore, it is not recommended to perform any operation in this space.

3.1.3 Allowable limit of wrist axis load

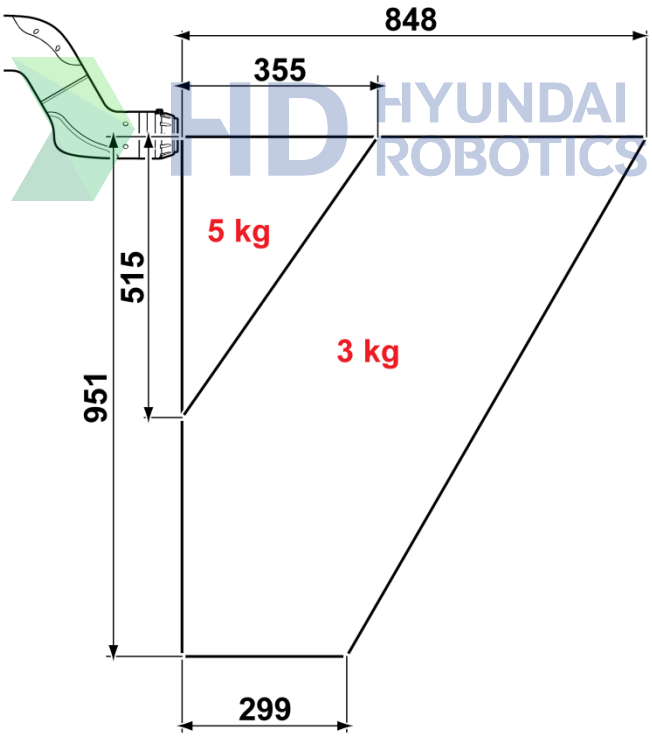
The load to be applied to the tip of the wrist axis of a collaborative robot is regulated by the allowable weight, load torque, and moment of inertia. The allowable limits of wrist axis load of the models are as follows:

Division		YL005	YL012	YL015
Weight		49 N (5 kgf) maximum	117.6 N (12 kgf) maximum	147 N (15 kgf) maximum
Load torque	R2-axis rotation	Rating: 48 Nm (4.9 kgf/m)	Rating: 49 Nm (5.0 kgf/m)	Rating: 49 Nm (5.0 kgf/m)
	B-axis rotation	Rating: 26.5 Nm (2.7 kgf/m)	Rating: 54.9 Nm (5.6 kgf/m)	Rating: 54.9 Nm (5.6 kgf/m)
	R1-axis rotation	Rating: 27.4 Nm (2.8 kgf/m)	Rating: 27.4 Nm (2.8 kgf/m)	Rating: 27.4 Nm (2.8 kgf/m)

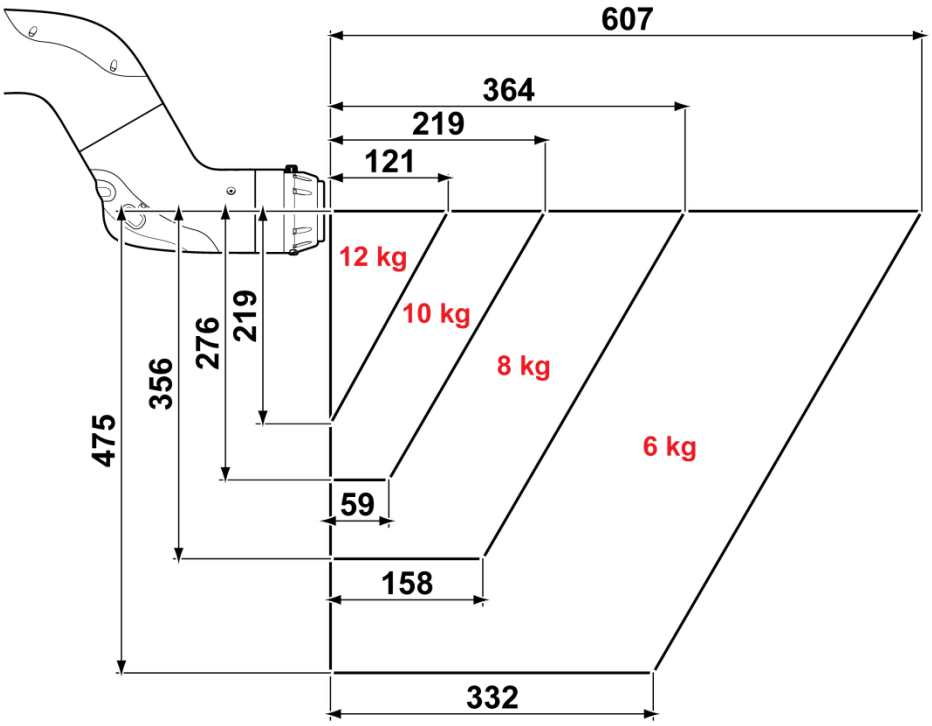
3.1.4 Payload

The maximum payloads of collaborative robots vary depending on distances to the center of gravity. The maximum payloads of the models are as follows.

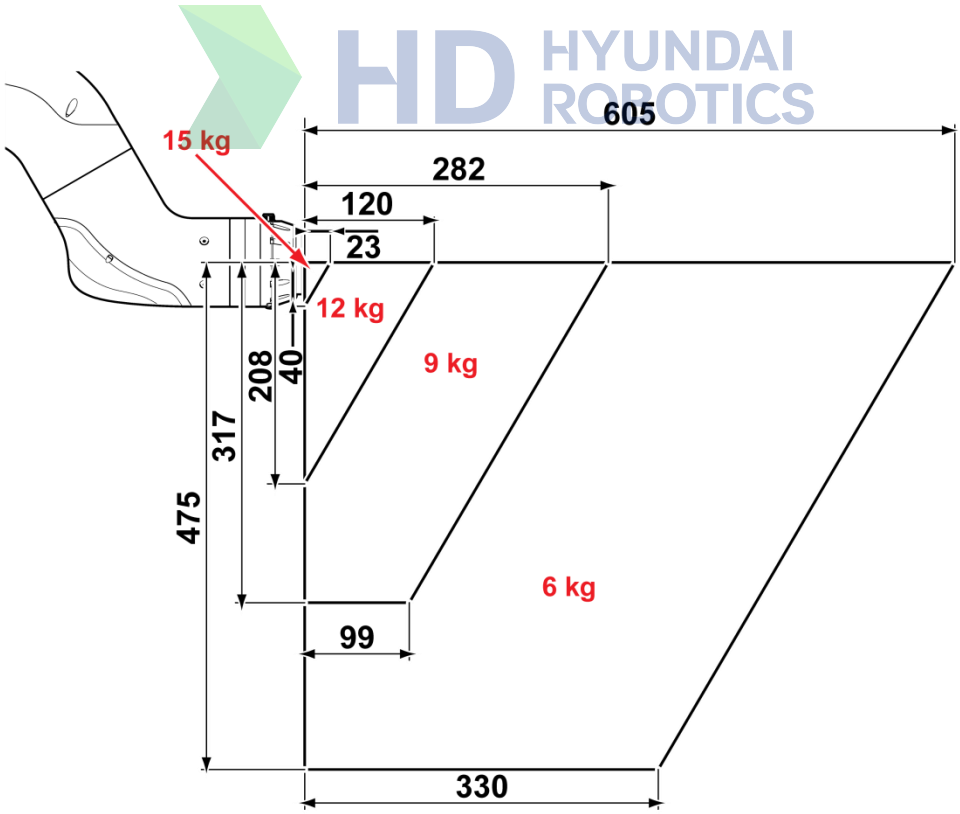
- YL005



- YL012


607
364
219
121
12 kg
10 kg
8 kg
6 kg
475
356
276
219
59
158
332

- YL015


15 kg
605
282
120
23
12 kg
9 kg
208
40
317
475
6 kg
99
330

3.2 Product installation

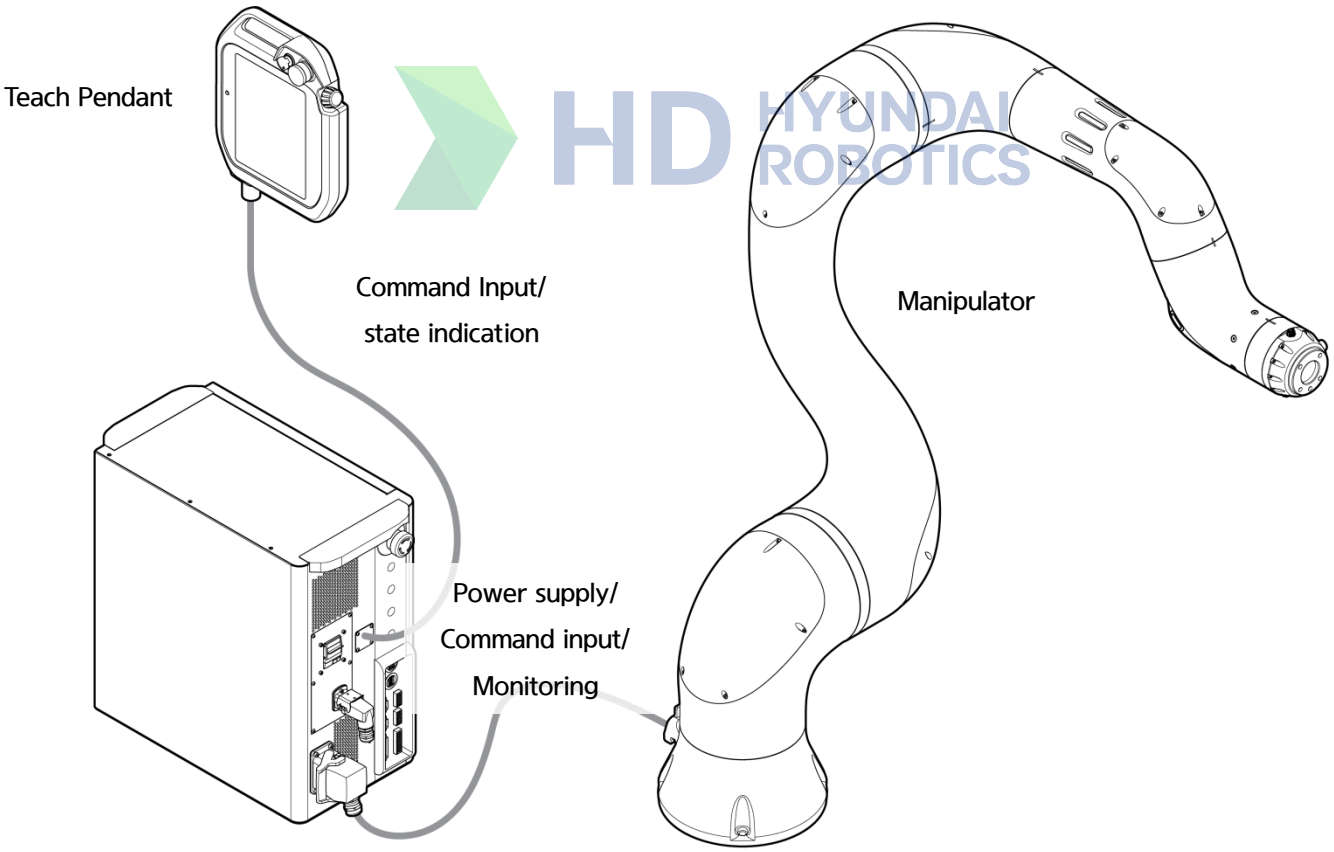
The product should be installed by qualified experts in compliance with the applicable laws and regulations of the pertaining country and locality.

- Upon unpacking the product, check that the product was not damaged during transportation and unpacking.
- After unpacking and before installing the product, make sure to check the safety regulations and instructions, as well as the requirements for the installation and use of the product. Make sure to be fully knowledgeable of the installation method.

⚠ Caution	• The robot should be installed and operated according to the guidelines specified in ISO 10218-2 and in compliance with the requirements specified in the applicable international standards, such as ISO/TS 15066 and national statutes. • Hyundai Robotics (or manufacturer) will not take responsibility for accidents caused by noncompliance with the applicable international standards and national statutes or non-review of "**Risk assessment**."

3.2.1 Composition of robot systems

A collaborative robot system, as an integrated system interfaced with peripheral devices, should be composed and connected with a selection of adequate peripheral devices.

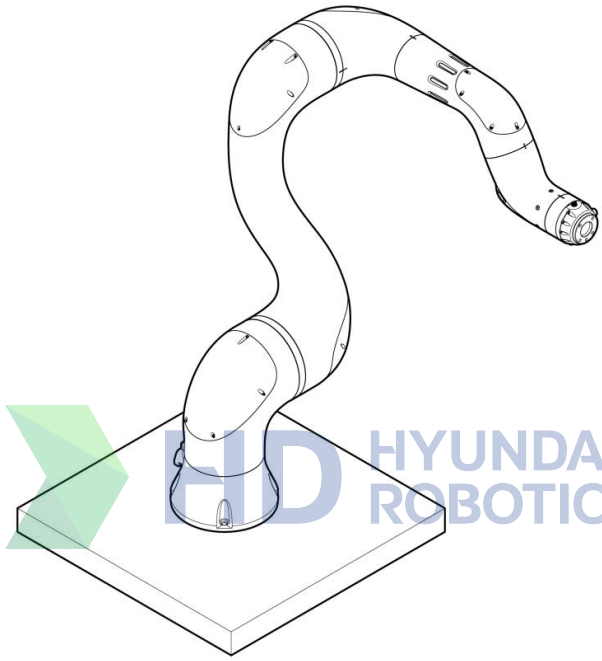


- **Teach pendant** : This is the I/O device that enables command input and state view for controlling the entire robot system. It can teach specific postures to the robot or set/control the program.
- **Controller** : This controls the motion of the robot according to the setting values of the program configured by the teach pendant. Using the I/O ports of the controller, you can compose a system interfaced with various external equipment or devices.

- **Manipulator** : This is a robot intended for attaching various tools and making collaborative operation for moving objects or assembling parts.

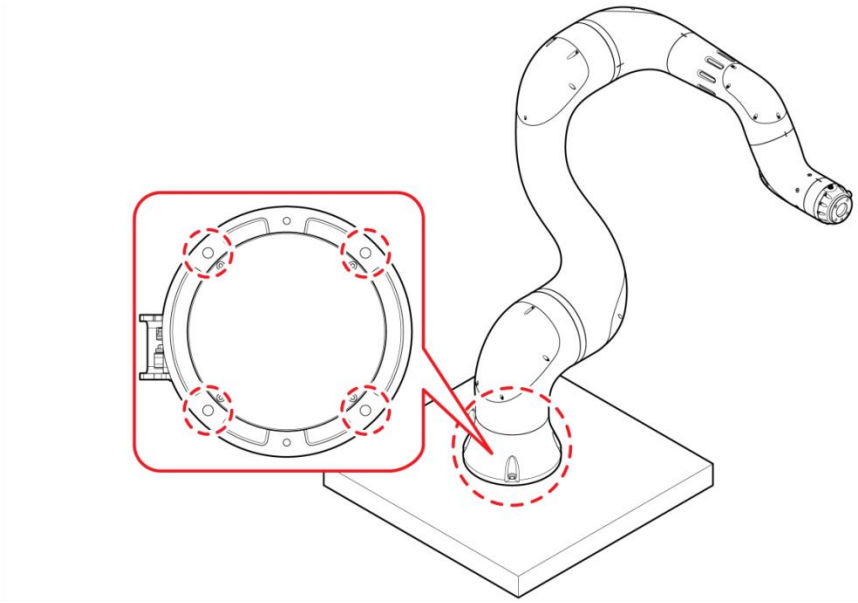
3.2.2 Robot and controller installation

1. Check the concrete thickness of the surface on which the collaborative robot will be installed. Follow the procedure below according to the concrete thickness.
   - If it is ≥200 mm, fixate the mounting plate at the robot installation point, referring to "**3.2.2.1 Mounting plate installation**."
   - If it is ≤200 mm, consult with our Customer Support Team and carry out additional foundation work.
2. Put the Manipulator on the installation point.



⚠ Warning	Because the manipulator cannot stand by itself, the installation requires two or more workers. While one worker holds the robot, the other worker(s) should fixate it.

3. Using hex wrench bolts (M8 (12.9), four pieces), fixate the manipulator.



- The proper tightening torque of the bolts is 340 kgf/cm.
- If positioning pins are used (Φ6, two pieces), installing the manipulator will be accurate at a desired specific point.
- Connecting an earth cable will prevent electrostatic discharge.
- The information on the installation positions of YL005 and YL015 is the same as that of YL012.

⚠ Warning	Tighten the bolts firmly so that they do not become loose during robot operation.

4. Ensure that the robot base is in full contact with the installation surface.
5. Check the installation space of the manipulator, and place the robot controller at a proper point.

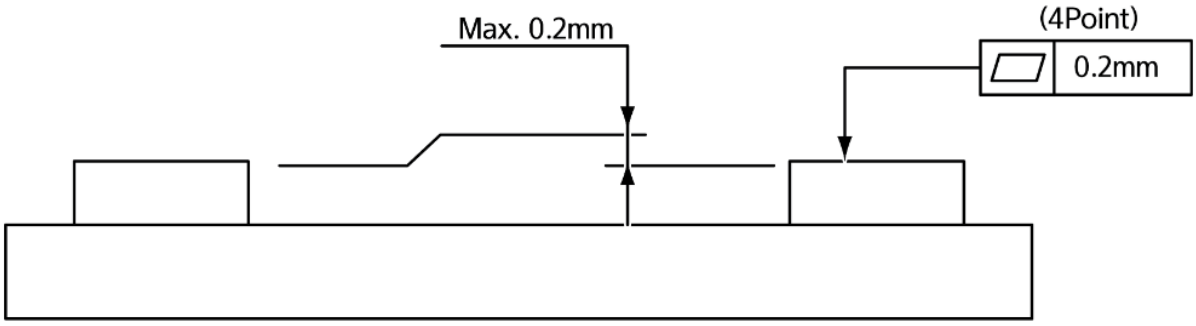
⚠ Caution	• Place the controller at a cool and dry place, and keep it away from moisture or water. • Allow sufficient buffer space around the controller for air circulation. Ensure that no obstacles block the vent hole and the cooling fan on the front and the rear of the controller.

3.2.2.1 Mounting plate installation

The firmness of the floor on which the manipulator will be installed should be designed to minimize the dynamic impact of the robot. If the firmness of the installation surface is not sufficient for supporting the robot arm, a mounting plate for the product installation may be used.

⚠ Warning	The robot installation surface should be firm enough to bear both the weight of the robot and the load that occurs during robot operation.

1. Check the installation surface of the collaborative robot, and remove any uneven points, cracks, and others.
2. Place the mounting plate on the surface on which the manipulator will be installed.
3. Pass the anchor bolts (M20) through the bolt holes of the top contacting surface of the mounting plate, and fixate them by fastening to an adequate torque or by hammering them. The anchor bolts should not protrude from the contacting surface of the mounting plate by no more than 0.2 mm (±0.1 mm).

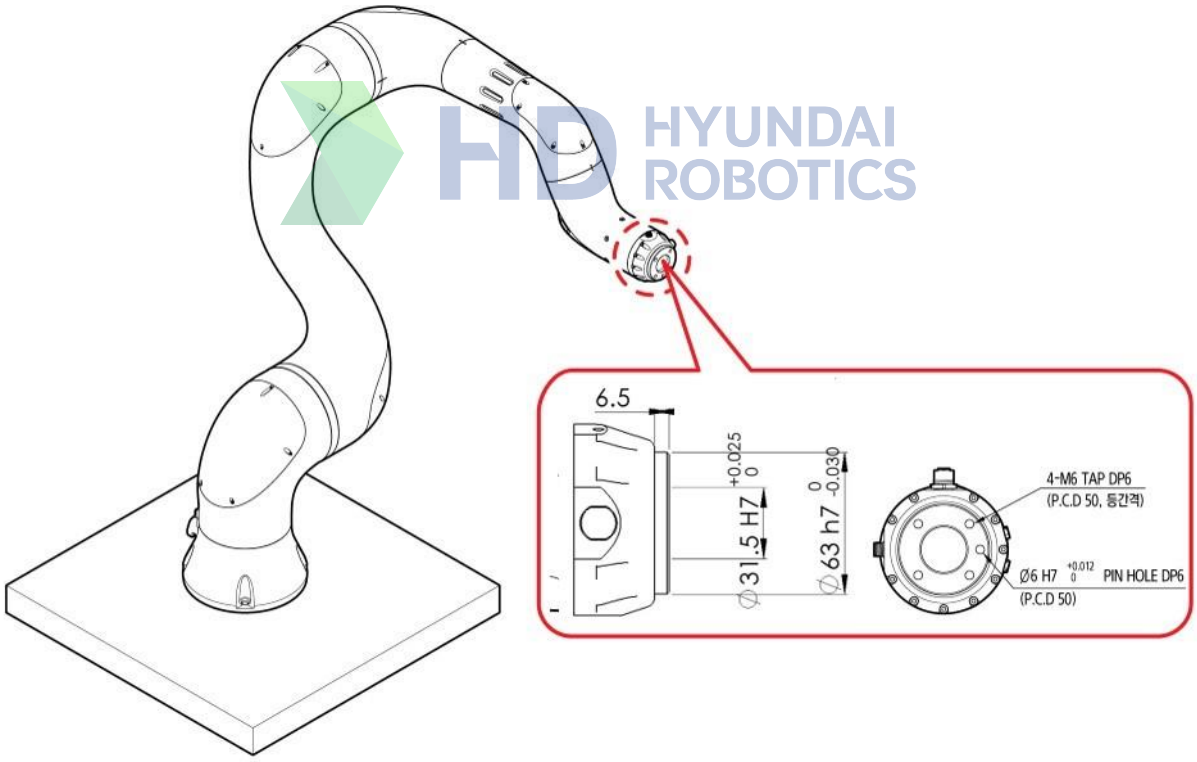


- The flatness of the other areas should be no more than ±0.2 mm.
- The flatness of the four sheets of the mounting plates should be no more than 0.2 mm.
- The flatness of the four contacting surfaces of the mounting plates should be no more than 0.2 mm (±0.1 mm).
- Fill any gaps with shims when necessary.

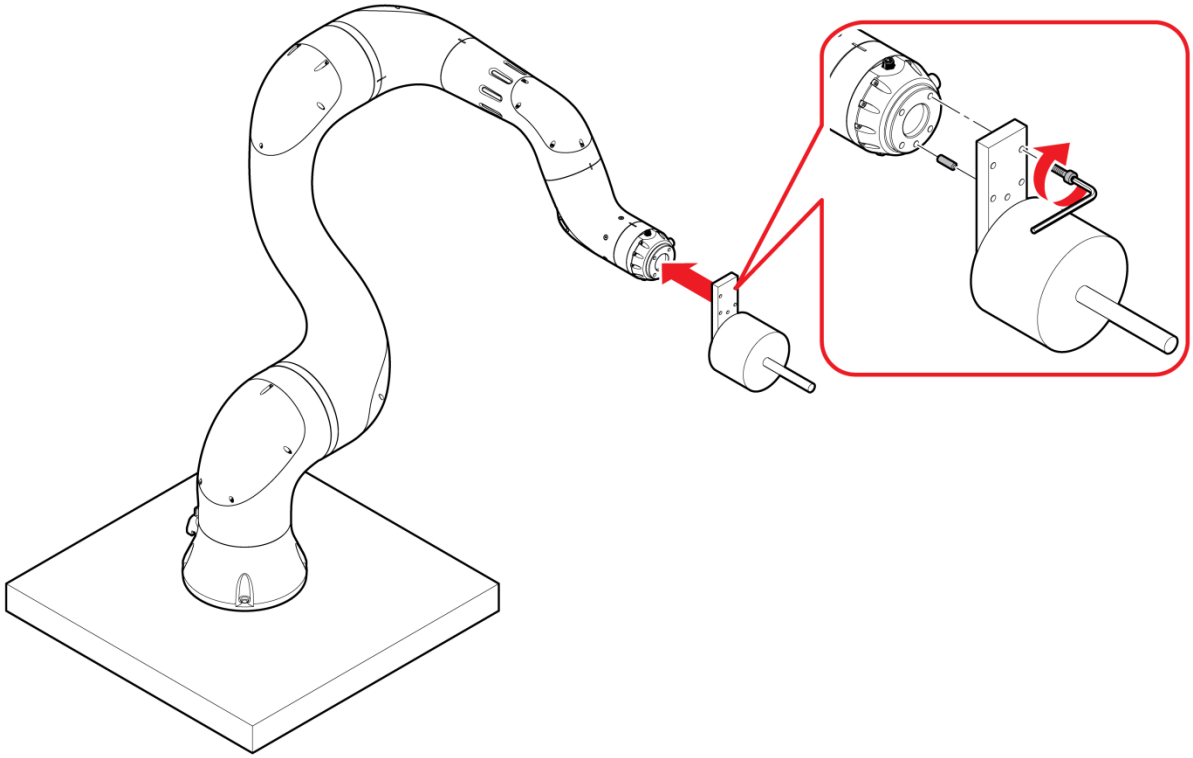
3.2.3 Tool connection

Connect a necessary tool to the manipulator.

1. Check the connection port of the tool flange of manipulator.

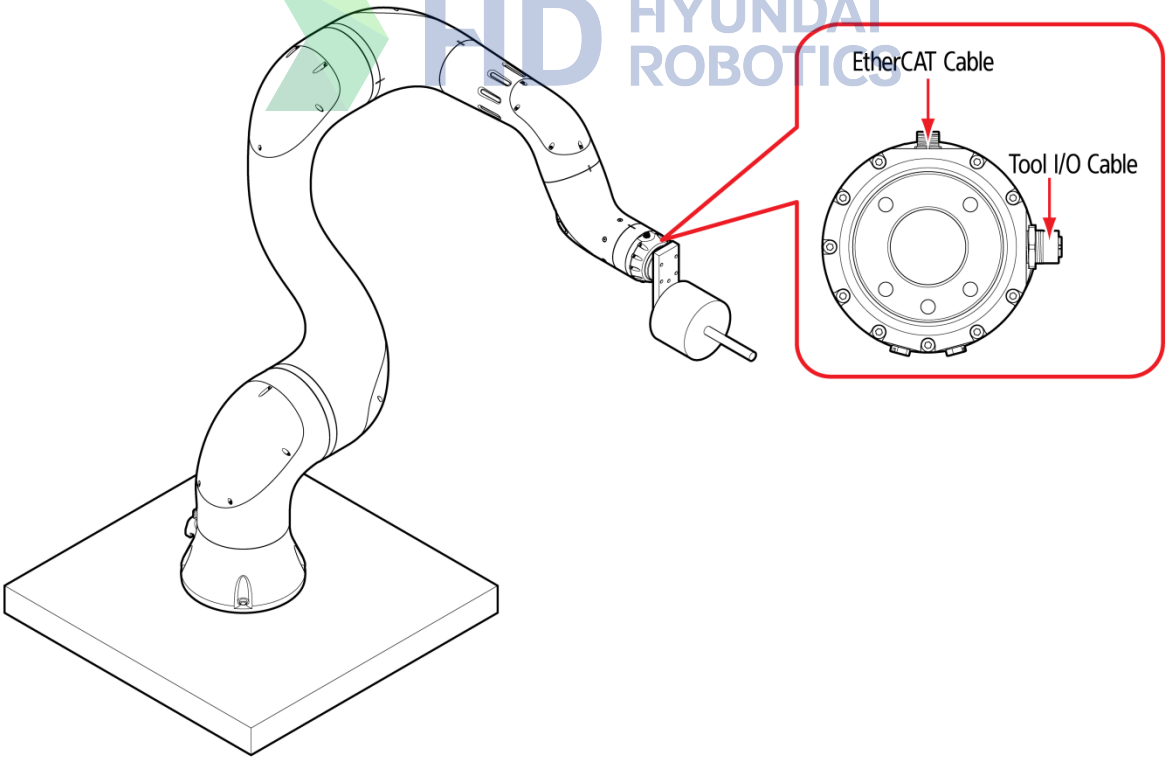


2. Insert the tool into the tool flange, and fixate the tool to the flange by using hex wrench bolts (M6 (12.9), four pieces) and pins (ø6).
   - The proper tightening torque of the bolts is 127 kgf/cm.



3. To the connectors of the tool flange, connect the tool I/O cable and the EtherCAT cable.

   - If a pneumatic line needs to be used, assemble the one-touch fittings (M5), and connect the hoses (Φ3.2, two pieces) to the air outlets.

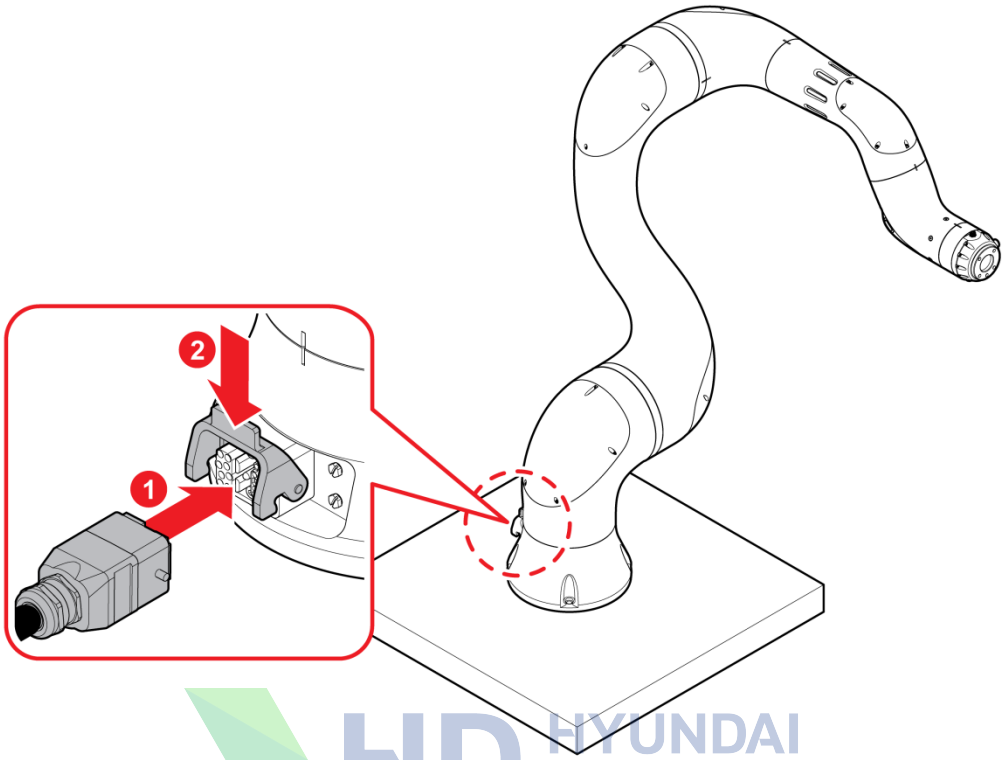


Notes	• The connection methods may vary depending on the tools to be used. For more details of the tool connection method, see the manual of the tool. • For more details of the tool I/O and the pin map of EtherCAT, see "**3.3.1 Tool flange connection point**."

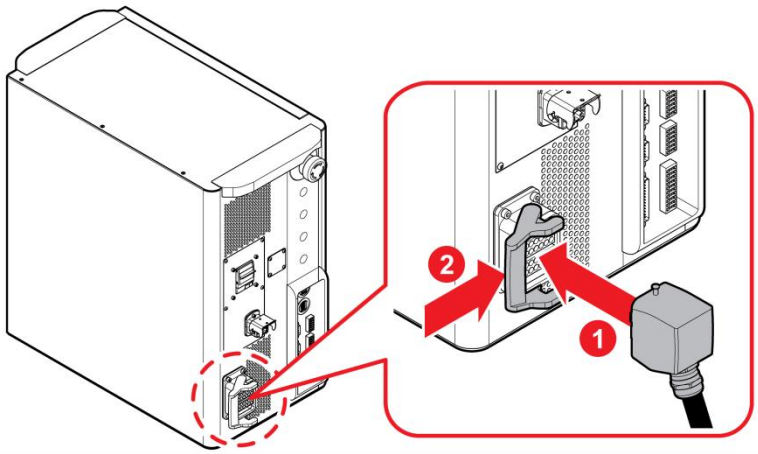
3.2.4 Wiring

Check the connection ports of the manipulator and the controller, and connect them with the proper cable.

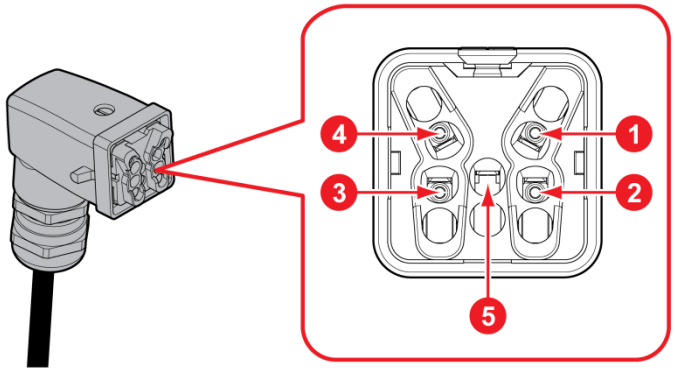
1. Insert the robot connection cable into the connection terminal of the base of the manipulator, and clamp the cable with the connection ring so that the cable cannot be disconnected.



2. Insert the other end of the robot connection cable into the connection terminal on the front of the controller, and clamp the cable with the connection ring so that the cable cannot be disconnected.

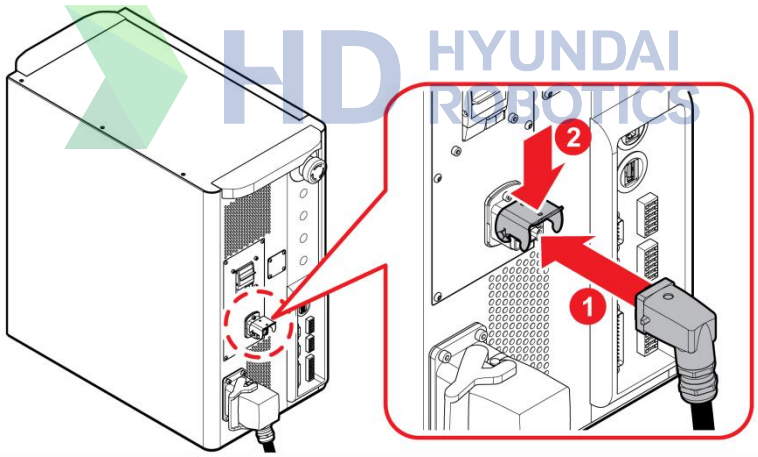


3. Connect the teach pendant connection cable of the controller to the cable connector of the teach pendant.



No.	Name	Description	Specification
1	R	AC220V L-phase	16 AWG
2	(R)	AC220V L-phase addition (connected for power increase)	16 AWG
3	(T)	AC220V T-phase addition (connected for power increase)	16 AWG
4	T	AC220V T-phase	16 AWG
5	FG	Frame ground	16 AWG

4. Referring to the power connector pin map, connect one end of the power cable to the power connector.



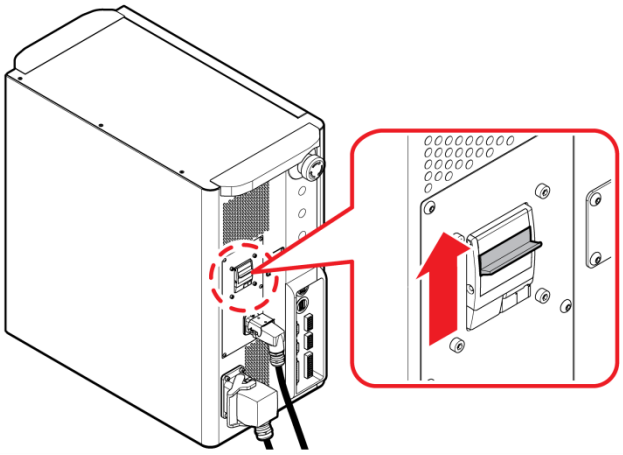
5. Connect the other end of the power cable to the power source.

⚠ Caution	• Make sure to power off the product before carrying out any types of wiring, termination, and electrical work. • Check the shapes of the cable connectors, and connect the proper cables to them without applying excessive force. Excessive force may bend or damage the pins. • Do not modify or extend cables arbitrarily. • Hyundai Robotics will not take responsibility for product damages caused by the customer's carelessness, unskillful operation, and other errors. Never arbitrarily modify, disassemble, or repair the product.

3.2.5 Power on

The power to the collaborative robot is supplied through the power connector of the controller.

Push the switch of the power breaker upward. When the power is applied, the robot system will boot, the display of the teaching pendant will turn on, and the LED lamp of the manipulator will light up in white.



3.3 Robot interface

Connect tools and external devices while paying attention to the following precautions.

- Make sure to power off the product before carrying out any types of wiring, termination, and electrical work.
- Check the shapes of the cable connectors, and connect the proper cables to them without applying excessive force. Excessive force may bend or damage the pins.
- Do not modify or extend cables arbitrarily.
- Use the device after checking the allowable temperature and pressure.

Hyundai Robotics will not take responsibility for product damages caused by the customer's carelessness, unskillful operation, and other errors. Never arbitrarily modify, disassemble, or repair the product.

3.3.1 Tool flange connection point

Connect the tool to the connection port of the tool flange at the tip of the collaborative robot.

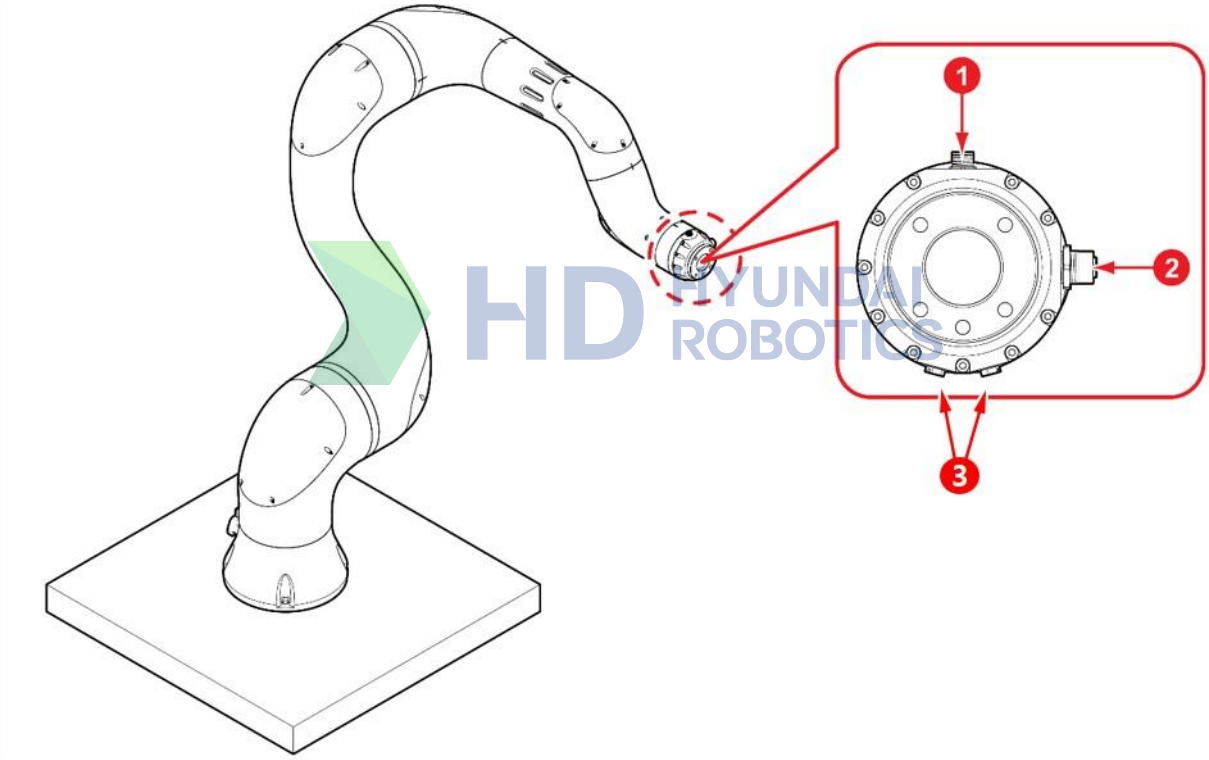


Figure 15 Tool flange connection point

No.	Description
1	EtherCAT connection port (T4031017041-000 (TE)): for EtherCAT communication
2	Tool I/O connection port (T4131012121-000 (TE)): for controlling tool motion
3	Air outlet (YL012, YL015): Pneumatic hoses (ø3.2, 2) are connected and used for the movement of the tools.

3.3.1.1 T4031017041-000 (TE) pin map

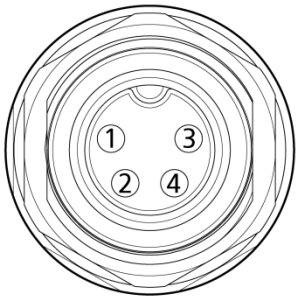


Figure 16 Pin map of Ethercat connection terminal

No.	Description	No.	Description
1	TX +	3	RX +
2	TX -	4	RX -

3.3.1.2 T4131012121-000 (TE) pin map

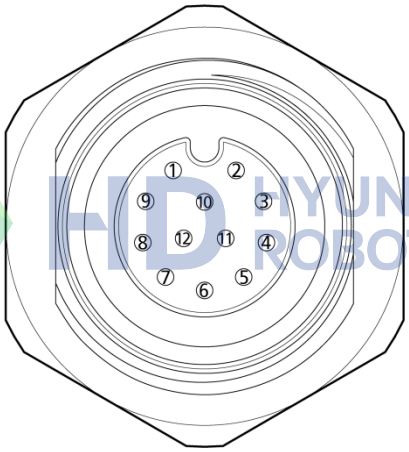


Figure 17 Pin map of Tool I/O connection terminal

No.	Description	No.	Description
1	Digital output CH0	7	Digital input CH2
2	Digital output CH1	8	Digital input CH3
3	Digital output CH2	9	Analog input CH0
4	Digital output CH3	10	Analog input CH1
5	Digital input CH0	11	Voltage output
6	Digital input CH1	12	GND

3.3.1.3 Air hose

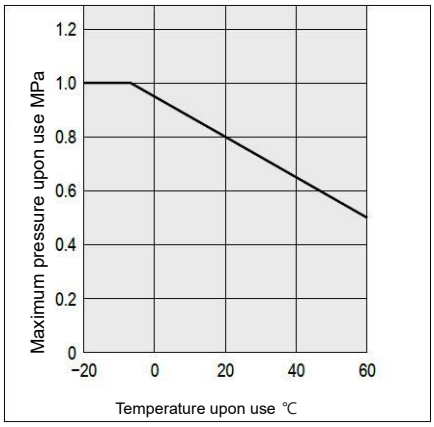


Figure 18 Graph of the allowable temperature-pressure for the air hose

3.3.2 External device interface

You can connect various external devices to the external device interface on the front of the controller.

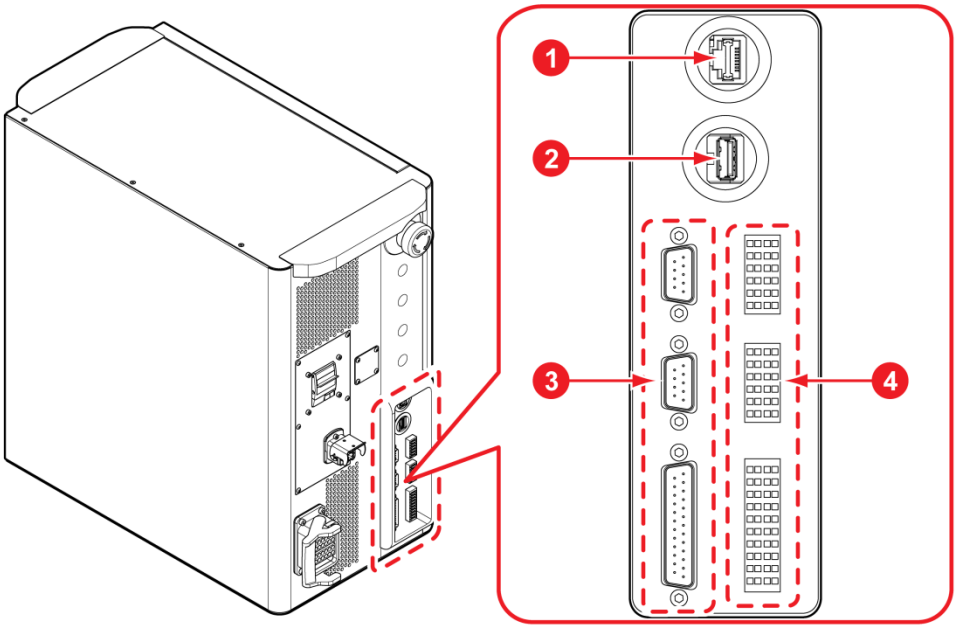


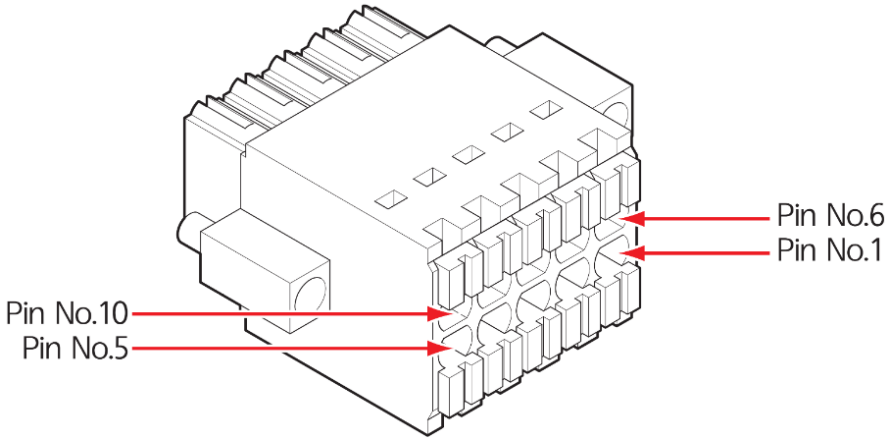
Figure 19 External device interface

No.	Description
1	LAN port
2	USB port
3	D-sub connectors • 9-pin (COM1, COM2): serial communication (RS485, 422, 232) • 25-pin (SDIO): common digital I/O
4	Terminal blocks • TB1: common analog I/O • TB2: dedicated safety signal input • TB3: system signal I/O

Notes	
	• The external device interface is described based on the composition of basic connections. • If you wish to install additional optional items and connect them to the external device interface, you may change the composition of basic connections. For more details on the installation of additional optional items and the composition of connections, consult with our Customer Support Team.

3.3.2.1 Terminal block (TB1): common analog I/O signals

You can connect common analog I/O signals, two at a time, to Terminal Block, TB1. Select among five types of input/output ranges depending on the setting: -10 ~ +10 V, -5 ~ +5 V, 0 ~ 10 V, 0 ~ 5 V, and 4 ~ 20 mA. For more details on signal connection, see "**4.3.2.5 Connection of common digital I/O signals (TBAIO)**."



Pin number	1	2	3	4	5
Name	GAIN0_N	GAIN1_N	GND_A	GND_A	-
Usage	Ground of GAIN0 for common analog input	Ground of GAIN1 for common analog input	Common analog ground	Common analog ground	-
Internal connections of the controller	SCM TBAIO/1	SCM TBAIO/2	SCM TBAIO/3	SCM TBAIO/4	
	BD6B3H DSW1/6 OFF	BD6B3H DSW1/7 OFF	BD6B3H DSW1/8 OFF	BD6B3H DSW1/9 OFF	BD6B3H DSW1/10 OFF

Pin number	6	7	8	9	10
Name	GAIN0	GAIN1	GAOUT0	GAOUT1	-
Usage	Common analog input 0	Common analog input 1	Common analog output 0	Common analog output 1	-
Internal connections of the controller	SCM TBAIO/5	SCM TBAIO/6	SCM TBAIO/7	SCM TBAIO/8	
	BD6B3H DSW1/6 OFF	BD6B3H DSW1/7 OFF	BD6B3H DSW1/8 OFF	BD6B3H DSW1/9 OFF	BD6B3H DSW1/10 OFF

This signal is connected to the Safety control module installed inside the controller. For more details on signal connection, refer to **"4.3.2.5 Connection of common digital I/O signals (TBAIO)"**.

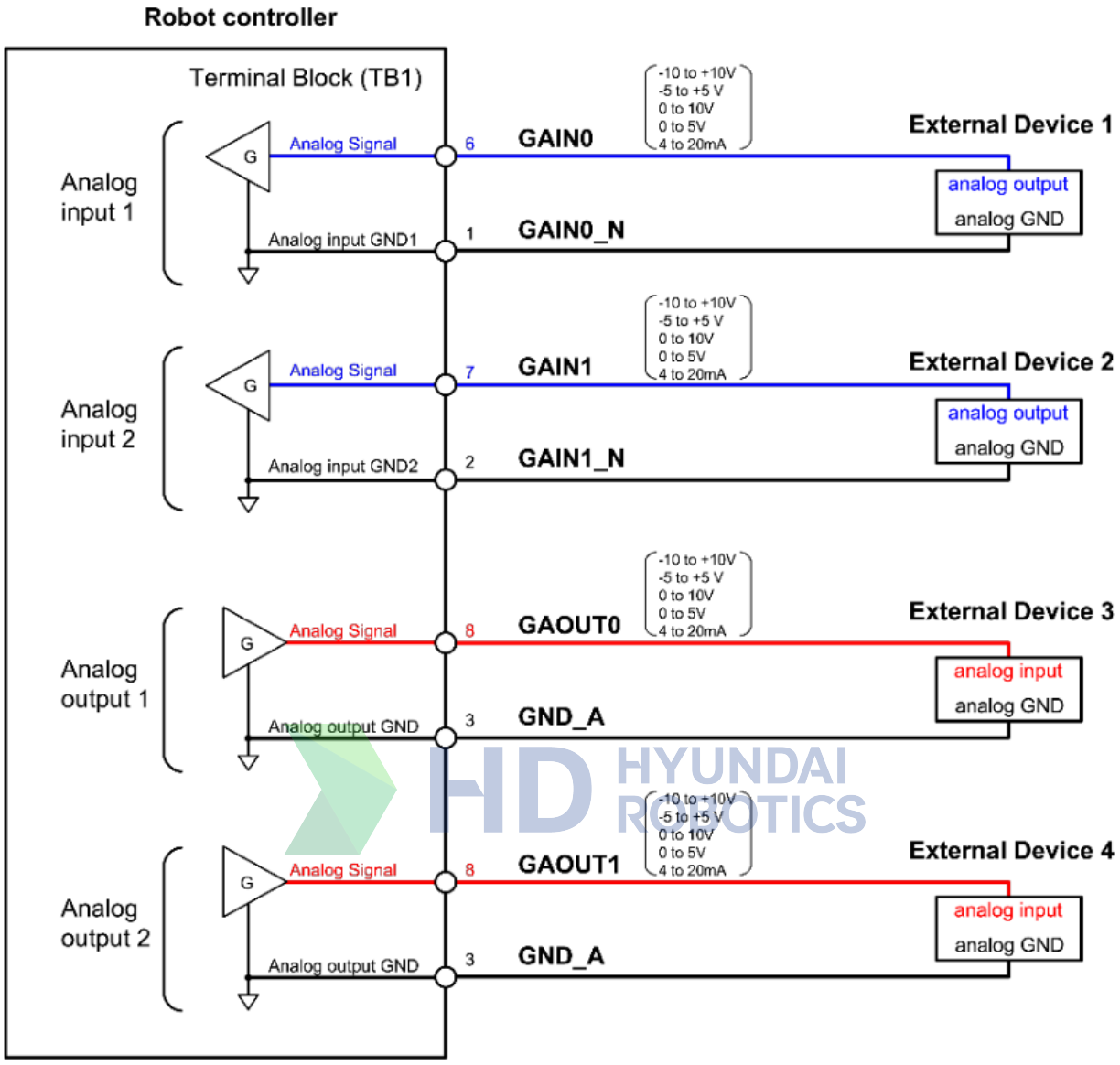
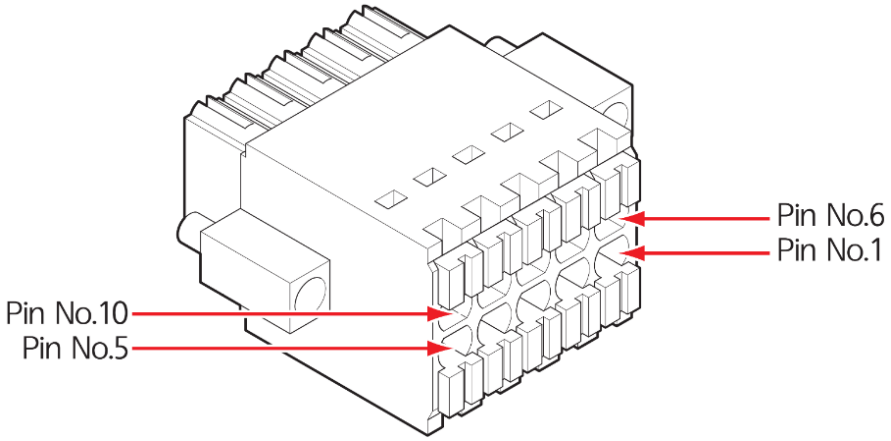


Figure 20 Method for connecting universal analog signals

⚠ Caution	• Set all the pins from 6 to 10 of BD6B3H DSW1 at the OFF position. • If you set all the pins from 6 to 10 of BD6B3H DSW1 at the ON position, the pin combinations of 1-6, 2-7, 3-4, and 5-10 of the Terminal Block (TB1) will be short-circuited. Therefore, pay attention not to set them at the ON position.

3.3.2.2 Terminal block (TB2): dedicated safety signal input

You can connect I/O signals dedicated to the robot system, such as the signals of safeguarding devices, through Terminal Block, TB2.



Pin number	1	2	3	4	5
Name	SF_POW1	SF_POW2			
Usage	Protective stop input common (Channel 1)	Protective stop input common (Channel 2)	-	-	-
Internal connections of the controller	SCM TBSYS1/1	SCM TBSYS1/2	-	-	-
	BD6B3H CN2/1	BD6B3H CN2/3	BD6B3H CN2/5	BD6B3H CN2/7	BD6B3H CN2/9
	BD6B3H DSW1/1 OFF	BD6B3H DSW1/2 OFF	BD6B3H DSW1/3 OFF	BD6B3H DSW1/4 OFF	BD6B3H DSW1/5 OFF

Pin number	6	7	8	9	10
Name	SG1	SG2	-	-	-
Usage	Protective stop input (Channel 1)	Protective stop input (Channel 2)	-	-	-
Internal connections of the controller	SCM TBSYS1/9	SCM TBSYS1/10	-	-	-
	BD6B3H CN2/2	BD6B3H CN2/4	BD6B3H CN2/6	BD6B3H CN2/8	BD6B3H CN2/10
	BD6B3H DSW1/1 OFF	BD6B3H DSW1/2 OFF	BD6B3H DSW1/3 OFF	BD6B3H DSW1/4 OFF	BD6B3H DSW1/5 OFF

This signal is connected to the Safety control module installed inside the controller. For more details on signal connection, refer to "4.3.2.3 Safety I/O signal connection (TBSDI, TBSDO)"

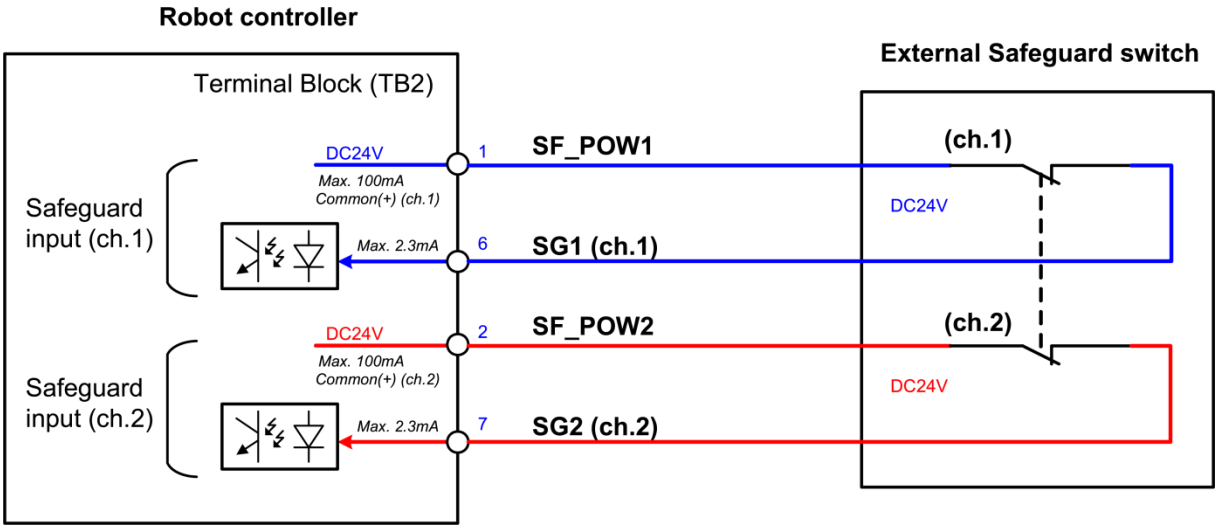


Figure 21 Method for connecting dedicated safety signals (protective devices) in the case of contact switches

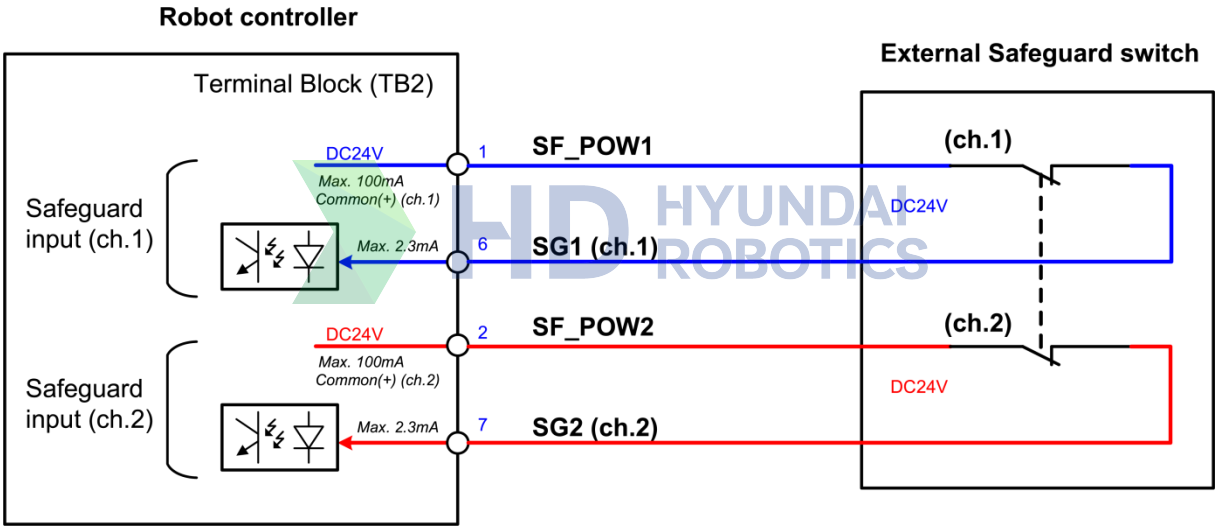
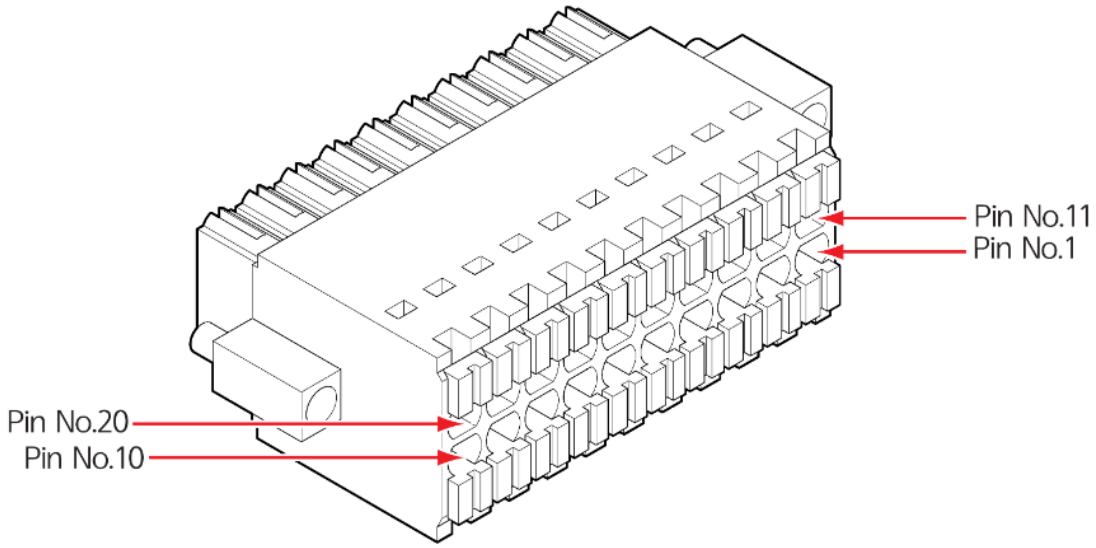


Figure 22 Method for connecting dedicated safety signals (protective devices) in the case of semiconductor type outputs

⚠ Caution	• BD5B3T is a lower version of BD6B3H, please be careful with DSW1. DSW1 removed from BD6B3H. • Set all the pins from 1 to 5 of BD5B3T DSW1 at the OFF position. • If you set all the pins from 1 to 5 of BD5B3T DSW1 at the ON position, the pin combinations of 1-6, 2-7, 3-4, and 5-10 of the Terminal Block (TB2) will be short-circuited. Therefore, pay attention not to set them at the ON position.

3.3.2.3 Terminal block (TB3): system signal I/O

You can connect system signal I/Os, eight at a time, to Terminal Block, TB3. You can compose the robot system by connecting various peripheral devices, such as emergency stop devices, safeguarding (protective) devices, PLCs, and conveyor belt encoders.



Pin number	1	2	3	4	5
Name	EX_IO_P24V	EX_IO_GND	GDOUT0	GDOUT1	GDOUT2
Internal connections of the controller	SCM TBDIO/1	SCM TBDIO/2	SCM TBDIO/3	SCM TBDIO/4	SCM TBDIO/5
	BD6B3H CN1/1	BD6B3H CN1/3	BD6B3H CN1/5	BD6B3H CN1/7	BD6B3H CN1/9
Pin number	6	7	8	9	10
Name	GDOUT3	GDOUT4	GDOUT5	GDOUT6	GDOUT7
Internal connections of the controller	SCM TBDIO/6	SCM TBDIO/7	SCM TBDIO/8	SCM TBDIO/9	SCM TBDIO/10
	BD6B3H CN1/11	BD6B3H CN1/13	BD6B3H CN1/15	BD6B3H CN1/17	BD6B3H CN1/19
Pin number	11	12	13	14	15
Name	EX_IO_P24V	EX_IO_GND	GDIN0	GDIN1	GDIN2
Internal connections of the controller	SCM TBDIO/11	SCM TBDIO/12	SCM TBDIO/13	SCM TBDIO/14	SCM TBDIO/15
	BD6B3H CN1/2	BD6B3H CN1/4	BD6B3H CN1/6	BD6B3H CN1/8	BD6B3H CN1/10
Pin number	16	17	18	19	20
Name	GDIN3	GDIN4	GDIN5	GDIN6	GDIN7
Internal connections of the controller	SCM TBDIO/16	SCM TBDIO/17	SCM TBDIO/18	SCM TBDIO/19	SCM TBDIO/20
	BD6B3H CN1/12	BD6B3H CN1/14	BD6B3H CN1/16	BD6B3H CN1/18	BD6B3H CN1/20

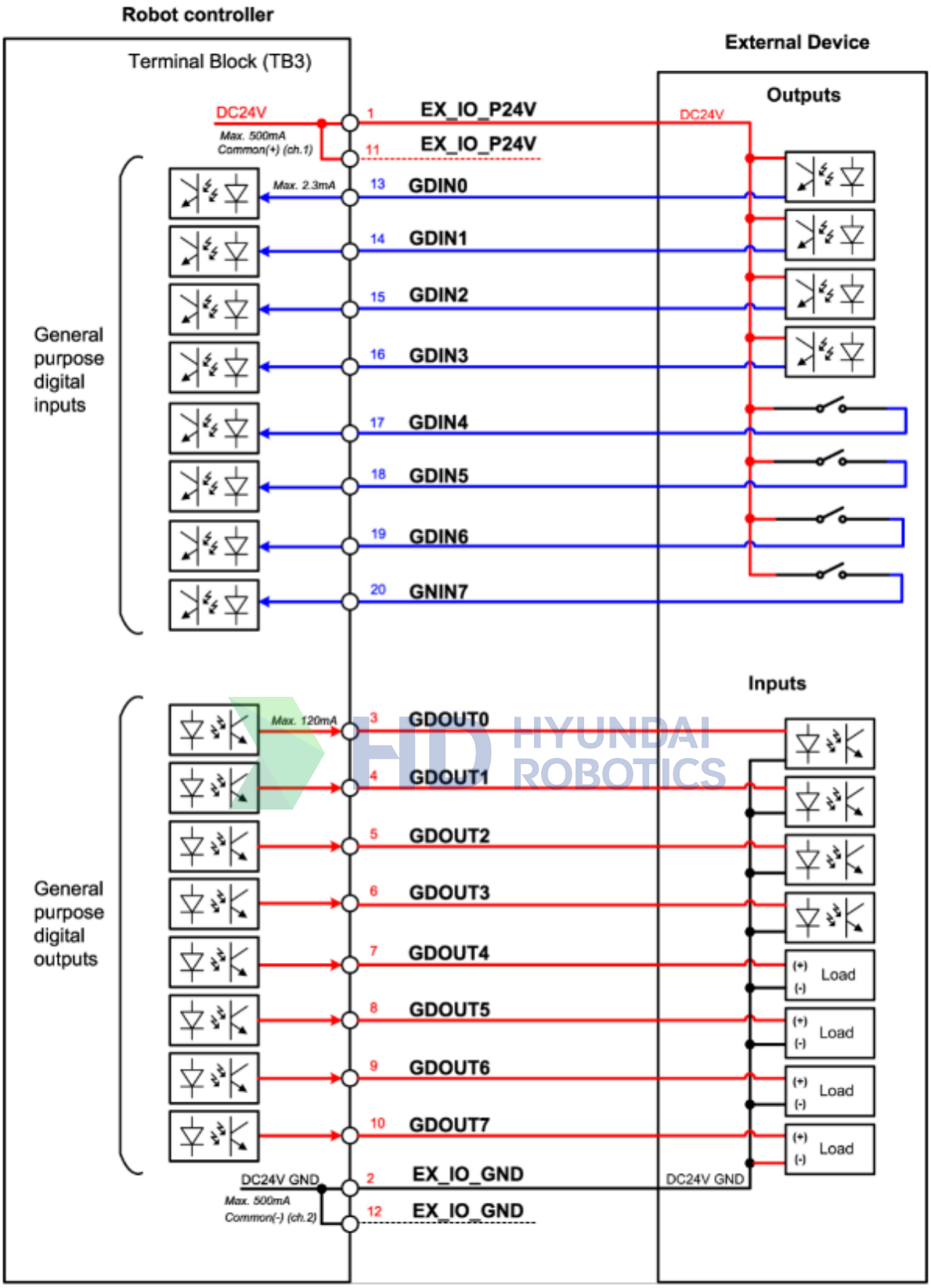


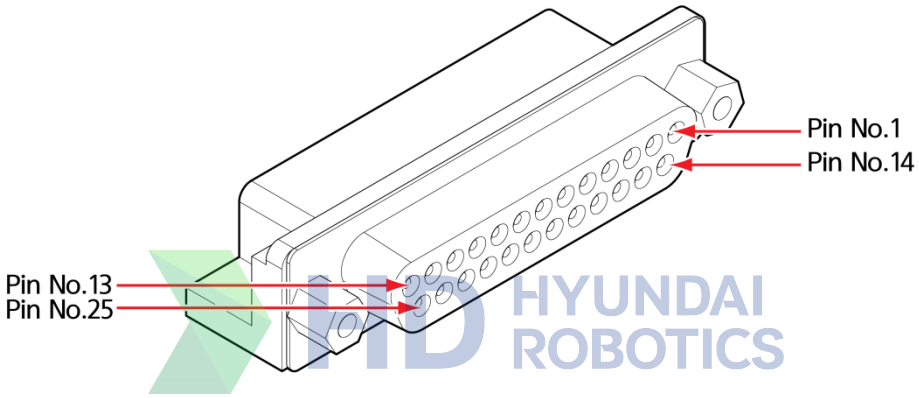
Figure 23 Method for connecting universal digital input and output signals

3.3.2.4 D-sub 25-pin connector (SDIO): common digital I/O

You can connect digital I/O signals for external safety signals, eight at a time, to the D-sub 24-pin connector (SDIO). For more details on signal connection, see "**General purpose safety I/O signals**."

Set the safety I/O signals according to usages, referring to "**Safety Function Manual for Collaborative Robots**." For example, if you will not use the teach pendant and will use an enabling switch, connect it to the common safety signal input and assign input signals. The types of I/O signals that can be assigned are as follows:

- Input signals: STOP0, STOP1, STOP2, SOS, Reduced mode, Enable SW, Motor on, Mode switch-manual, Mode switch-auto, Mode switch-remote, Cartesian space #1 - #12
- Output signals: STO activation status, SOS activation status, Reduced mode activation status, Not reduced mode, Robot moving, Robot not stopping, Mode switch-manual, Mode switch-auto, Mode switch-remote, Cartesian space status #1 - #12, Violation alarm, TCP speed violation, TCP orientation violation, TCP force violation, Collision detection, Momentum violation, Power violation, SOS violation, Joint position violation, Joint speed violation, Cartesian space violation #1 - #12



* Internal connections of the controller (SCM TBSIO)

Pin number	1	2	3	4	5
Name	SDIN0	SDIN1	SDIN2	SDIN3	SDIN4
Usage	Safety signal input 0 (Channel 1)	Safety signal input 1 (Channel 1)	Safety signal input 2 (Channel 1)	Safety signal input 3 (Channel 1)	Safety signal input 4 (Channel 2)
Internal connections of the controller	SCM TBSDI Pin 9	SCM TBSDI Pin 10	SCM TBSDI Pin 11	SCM TBSDI Pin 12	SCM TBSDI Pin 13
Pin number	6	7	8	9	10
Name	SDIN5	SDIN6	SDIN7	SIO_POW1	SIO_POW2
Usage	Safety signal input 5 (Channel 2)	Safety signal input 6 (Channel 2)	Safety signal input 7 (Channel 2)	Safety signal input common (Channel 1)	Safety signal input common (Channel 1)
Internal connections of the controller	SCM TBSDI Pin 14	SCM TBSDI Pin 15	SCM TBSDI Pin 16	SCM TBSDI Pin 1, 2	SCM TBSDI Pin 3, 4
Pin number	11	12	13	14	15
Name	SIO_POW3	SIO_POW4	-	SDOUT0	SDOUT1
Usage	Safety signal input common (Channel 2)	Safety signal input common (Channel 2)	-	Safety signal output 0 (Channel 1)	Safety signal output 1 (Channel 1)

Internal connections of the controller	SCM TBSDI Pin 5, 6	SCM TBSDI Pin 7, 8	-	SCM TBSDO Pin 9	SCM TBSDO Pin 10

Pin number	16	17	18	19	20
Internal of the controller	11	12	13	14	15
Name	SDOUT2	SDOUT3	SDOUT4	SDOUT5	SDOUT6
Usage	Safety signal output 2 (Channel 1)	Safety signal output 3 (Channel 1)	Safety signal output 4 (Channel 2)	Safety signal output 5 (Channel 2)	Safety signal output 6 (Channel 2)
Internal connections of the controller	SCM TBSDO Pin 11	SCM TBSDO Pin 12	SCM TBSDO Pin 13	SCM TBSDO Pin 14	SCM TBSDO Pin 15
Pin number	21	22	23	24	25
Internal of the controller	16	1, 2	3, 4	5, 6	7, 8
Name	SDOUT7	SIO_GND1	SIO_GND1	SIO_GND2	SIO_GND2
Usage	Safety signal output 7 (Channel 2)	Safety signal output common (Channel 1)	Safety signal output common (Channel 1)	Safety signal output common (Channel 2)	Safety signal output common (Channel 2)
Internal connections of the controller	SCM TBSDO Pin 16	SCM TBSDO Pin 1, 2	SCM TBSDO Pin 3, 4	SCM TBSDO Pin 5, 6	SCM TBSDO Pin 7, 8

This signal is connected to the Safety control module installed inside the controller. For more details on signal connection, refer to **"4.3.2.3 Safety I/O signal connection (TBSDI, TBSDO).**

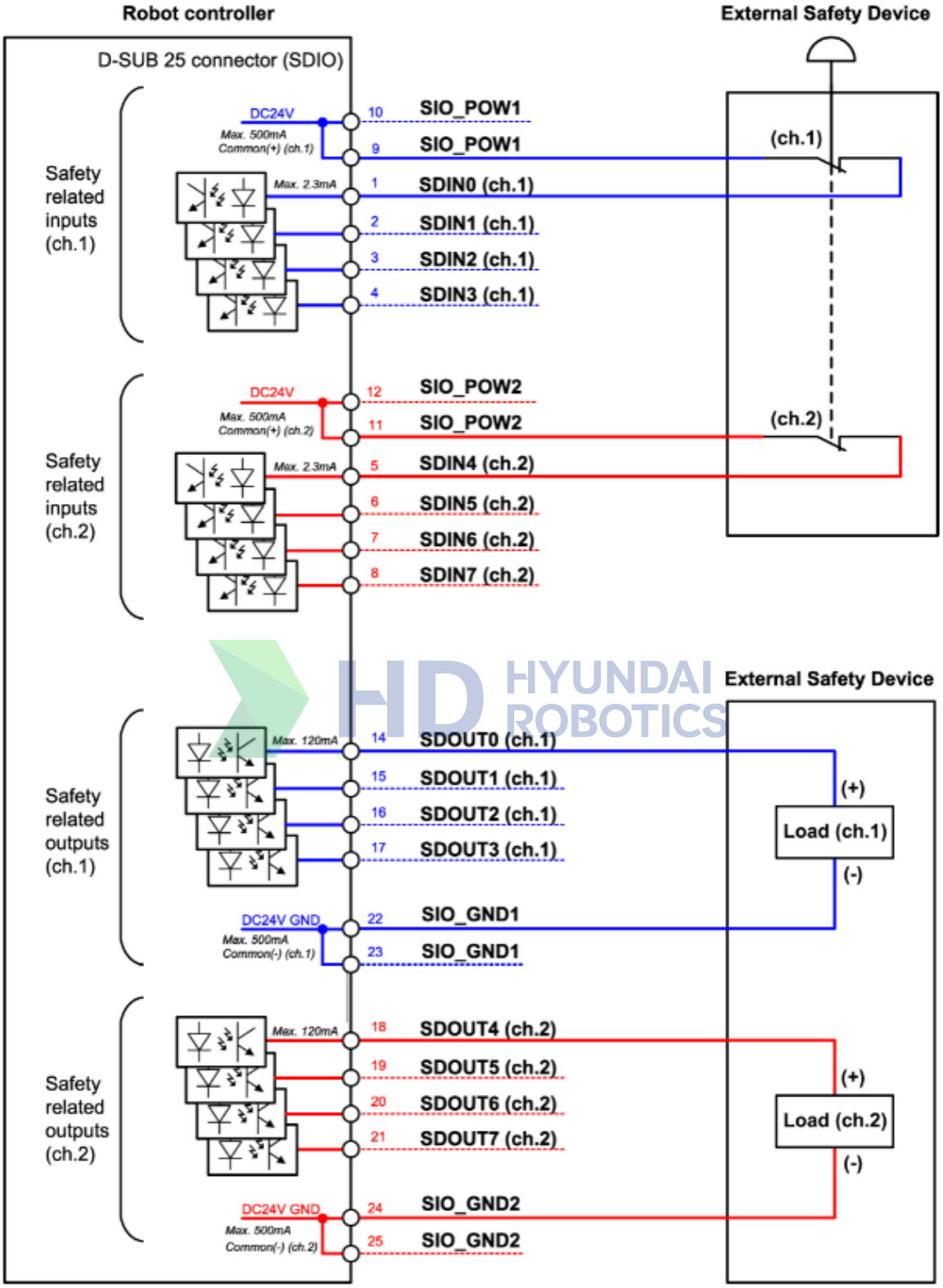


Figure 24 Method for connecting universal safety input and output signals

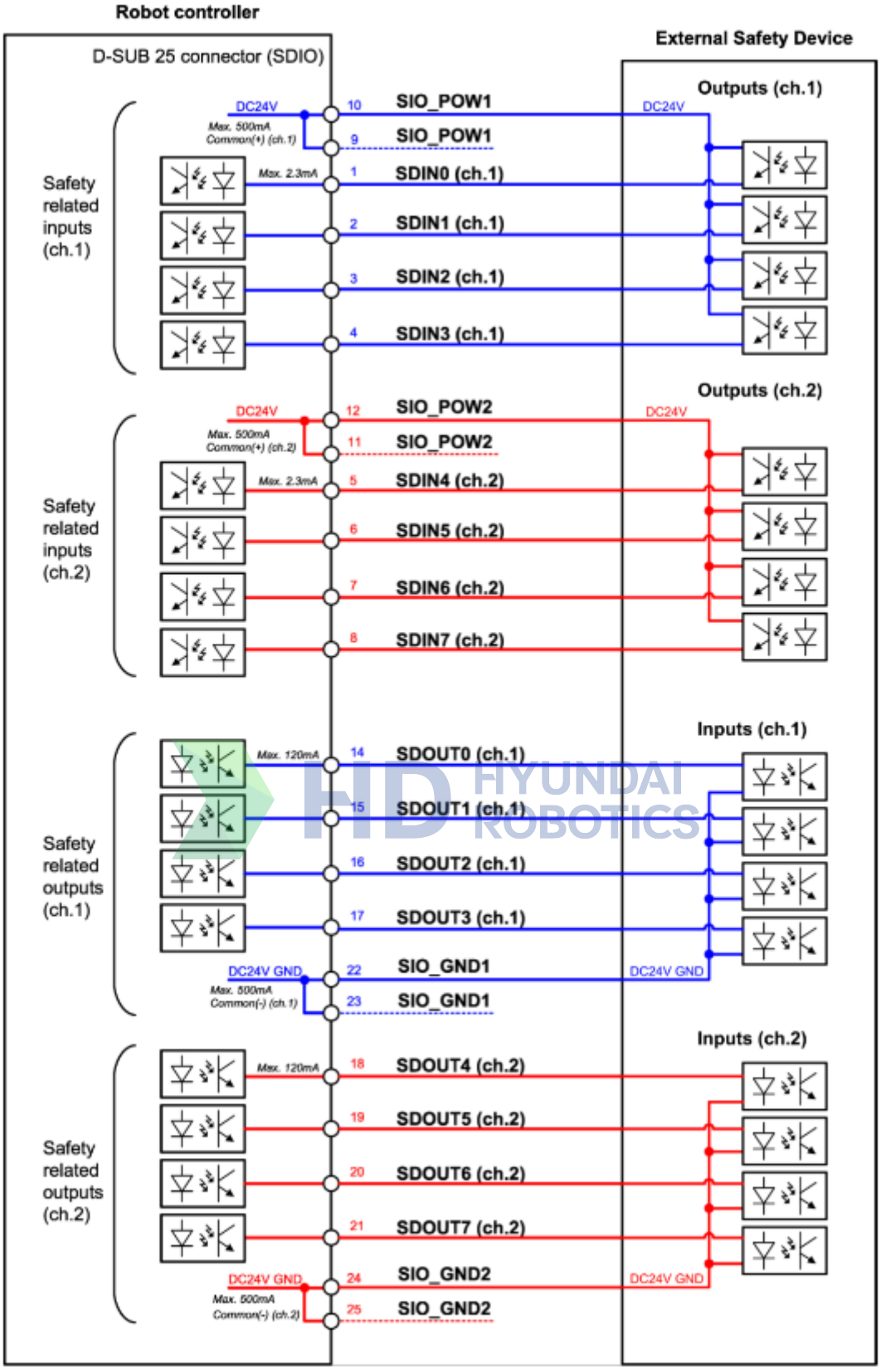


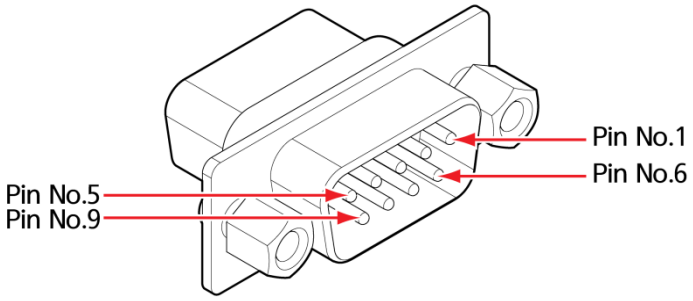
Figure 25 Method for connecting universal safety input and output signals (PLCs)

⚠ Caution	• Separate safety signals and common I/O signals, and never connect safety signals to other PLCs than safety PLCs. If you connect safety signals to other PLCs, it will lead to the malfunction of the safety stop function and may cause safety accidents, including physical injuries. • All the I/Os of safety grade are of redundancy structure. Make sure to separate the relevant channels to prevent signal faults from compromising the safety function.

	• Make sure to power off the product before carrying out any types of wiring, termination, and electrical work. • Hyundai Robotics will not take responsibility for product damages caused by the customer's carelessness, unskillful operation, and other errors. Never arbitrarily modify, disassemble, or repair the product. • Make sure to check the safety functions before robot installation and check for anomalies at regular intervals afterward.

3.3.2.5 D-sub 9-pin connector (COM1, COM2): serial communication (RS485, 422)

You can connect D-sub 24-pin connectors (SDIOs) to two ports for external communication. For more details of signal connection, see "**4.3.5 Microcomputer module**."



* Internal connections of the controller (miniH6COM COM1, COM2) / * n=1, 2 (COM port number)

Pin number	1	2	3	4	5
Internal connections of the controller	1	2	3	4	5
Name	COMn_422_485 _TX-	COMn_422_485 _TX+	COMn_422 _RX+	COMn_422 _RX-	GND
Pin number	6	7	8	9	-
Internal connections of the controller	6	7	8	9	-
Name	COMn_DSR#	COMn_RTS#	COMn_CTS#	COMn_RI_V#	-

3.4 Stopping distance and time

You can measure the stopping distance and time of the robot system by setting its extension, speed, and load.

- Extension: 33%, 66%, 100%
- Speed: 33%, 66%, 100%
- Load: 33%, 66%, 100% (YL005: 5 kg, YL012: 12 kg, YL015: 15 kg)
- Stop categories: STOP0, STOP1 (per IEC60204-1)

3.4.1 STOP 0

At STOP0, the stopping distance and time of the models at different extension and speed values are as follows:

- Extension: 100%
- Speed: 33%, 66%, 100%
- Load: maximum load of the model (L=100%)

Division		Stopping distance (degree)			Stopping time (s)		
		S=33%	S=66%	S=100%	S=33%	S=66%	S=100%
YL005	S-axis	0.550	3.525	16.198	0.21	0.15	0.32
	H-axis	0.514	2.070	15.813	1.55	1.02	1.45
	V-axis	0.168	0.532	24.938	0.30	0.34	0.33
YL012	S-axis	2.199	16.557	28.334	0.06	0.32	0.35
	H-axis	5.166	15.463	22.911	0.10	0.16	0.19
	V-axis	3.720	8.858	22.945	0.27	0.24	0.73
YL015	S-axis	3.67	16.63	29.14	0.10	0.31	0.36
	H-axis	7.75	18.36	24.12	0.15	0.19	0.20
	V-axis	3.31	9.60	22.00	0.24	0.26	0.70

3.4.2 STOP1

At STOP1, the stopping distance and time of the models at different axial extension and speed values are as follows:

■ YL005

- Extension: E=33%, 66%, 100%
- Speed: S=33%, 66%, 100%
- Load: L=33%

Division		Stopping distance (degree)			Stopping time (s)		
		S=33%	S=66%	S=100%	S=33%	S=66%	S=100%
S-axis	E=33%	8.329	17.603	29.826	0.35	0.37	0.42
	E=66%	8.423	18.171	31.690	0.36	0.39	0.45
	E=100%	8.431	18.511	33.046	0.38	0.41	0.49
H-axis	E=33%	8.250	17.641	32.52	0.36	0.37	0.44
	E=66%	7.985	17.602	31.018	0.36	0.39	0.45
	E=100%	8.082	18.272	32.476	0.37	0.41	0.48
V-axis	E=33%	9.813	20.444	32.037	0.33	0.35	0.36
	E=66%	9.930	20.444	32.922	0.34	0.36	0.37
	E=100%	10.046	210.023	33.806	0.34	0.36	0.39

- Load: L=66%

Division		Stopping distance (degree)			Stopping time (s)		
		S=33%	S=66%	S=100%	S=33%	S=66%	S=100%
S-axis	E=33%	8.376	17.413	30.112	0.36	0.37	0.42
	E=66%	8.489	18.010	31.837	0.37	0.39	0.45
	E=100%	8.634	19.116	34.981	0.38	0.42	0.51
H-axis	E=33%	8.153	17.518	30.6356	0.36	0.38	0.43
	E=66%	7.832	17.314	30.097	0.36	0.39	0.44
	E=100%	8.697	19.078	38.541	0.37	0.41	0.53
V-axis	E=33%	9.871	20.210	32.745	0.32	0.35	0.36
	E=66%	9.988	20.794	33.807	0.34	0.34	0.38
	E=100%	10.338	21.962	37.347	0.34	0.36	0.41

- Load: L=100%

Division		Stopping distance (degree)			Stopping time (s)		
		S=33%	S=66%	S=100%	S=33%	S=66%	S=100%
S-axis	E=33%	5.719	14.809	31.864	0.21	0.30	0.41
	E=66%	6.017	16.300	29.596	0.22	0.31	0.40
	E=100%	5.900	16.061	35.736	0.22	0.31	0.47
H-axis	E=33%	5.676	15.044	31.785	0.21	0.30	0.41
	E=66%	5.562	13.812	29.522	0.21	0.29	0.41
	E=100%	5.627	14.605	34.695	0.21	0.30	0.49
V-axis	E=33%	7.642	17.023	35.928	0.21	0.26	0.36
	E=66%	6.469	17.488	35.957	0.19	0.26	0.36
	E=100%	6.232	15.776	31.187	0.19	0.26	0.34

■ YL012

- Extension: 33%, 66%, 100%
- Speed: 33%, 66%, 100%
- Load: L=33%

Division		Stopping distance (degree)			Stopping time (s)		
		33%	66%	100%	33%	66%	100%
S-axis	E=33%	8.495	17.6748	30.3306	0.35	0.37	0.42
	E=66%	8.878	19.114	34.9893	0.37	0.4	0.49
	E=100%	9.851	23.295	50.5274	0.42	0.49	0.7
H-axis	E=33%	7.26	15.75	37.625	0.36	0.38	0.59
	E=66%	6.61	14.321	27.943	0.37	0.4	0.51
	E=100%	6.54	14.328	27.161	0.38	0.42	0.52
V-axis	E=33%	8.836	18.296	32.290	0.35	0.35	0.4
	E=66%	8.729	18.168	32.140	0.34	0.36	0.42
	E=100%	8.244	17.625	31.155	0.34	0.37	0.43

- Load: L=66%

Division		Stopping distance (degree)			Stopping time (s)		
		S=33%	S=66%	S=100%	S=33%	S=66%	S=100%
S-axis	E=33%	8.496	17.870	31.366	0.36	0.38	0.43
	E=66%	9.381	21.190	42.111	0.38	0.43	0.56
	E=100%	10.425	25.579	58.646	0.44	0.54	0.81
H-axis	E=33%	7.343	16.005	38.750	0.36	0.39	0.61
	E=66%	6.356	14.488	24.233	0.37	0.42	0.47
	E=100%	7.078	16.945	30.983	0.39	0.47	0.57
V-axis	E=33%	8.76	18.239	32.138	0.34	0.36	0.41
	E=66%	8.59	18.556	32.875	0.35	0.38	0.44
	E=100%	8.418	18.246	35.909	0.36	0.39	0.49

- Load: L=100%

Division		Stopping distance (degree)			Stopping time (s)		
		S=33%	S=66%	S=100%	S=33%	S=66%	S=100%
S-axis	E=33%	6.030	12.550	24.556	0.27	0.28	0.31
	E=66%	6.030	16.547	36.715	0.27	0.32	0.40
	E=100%	9.487	23.590	57.097	0.33	0.39	0.49
H-axis	E=33%	3.942	8.823	18.909	0.27	0.29	0.36
	E=66%	4.602	20.483	20.483	0.28	0.35	0.35
	E=100%	5.794	14.276	40.436	0.29	0.33	0.47
V-axis	E=33%	3.851	8.172	14.366	0.27	0.28	0.30
	E=66%	4.778	11.540	19.565	0.28	0.30	0.33
	E=100%	6.303	13.537	30.094	0.29	0.30	0.38

■ YL015

- Extension: 33%, 66%, 100%
- Speed: 33%, 66%, 100%
- Load: L=33%

Division		Stopping distance (degree)			Stopping time (s)		
		33%	66%	100%	33%	66%	100%
S-axis	E=33%	8.149	16.866	27.422	0.35	0.36	0.39
	E=66%	8.434	17.720	30.570	0.36	0.38	0.43
	E=100%	8.971	20.04	38.027	0.39	0.43	0.53
H-axis	E=33%	7.177	15.097	18.261	0.34	0.36	0.36
	E=66%	7.384	15.840	23.646	0.34	0.38	0.4
	E=100%	7.425	16.467	22.945	0.36	0.39	0.4
V-axis	E=33%	10.038	20.790	23.213	0.32	0.33	0.35
	E=66%	10.097	20.790	23.455	0.33	0.34	0.35
	E=100%	10.216	21.503	23.661	0.33	0.35	0.36

- Load: L=66%

Division		Stopping distance (degree)			Stopping time (s)		
		S=33%	S=66%	S=100%	S=33%	S=66%	S=100%
S-axis	E=33%	8.102	16.867	27.853	0.35	0.36	0.39
	E=66%	8.660	18.4623	33.020	0.37	0.4	0.46
	E=100%	9.594	22.1098	45.7479	0.4	0.46	0.62
H-axis	E=33%	7.260	15.345	20.954	0.34	0.36	0.37
	E=66%	7.342	15.593	21.429	0.35	0.37	0.4
	E=100%	7.672	16.4172	23.496	0.37	0.39	0.43
V-axis	E=33%	10.038	20.5115	25.792	0.32	0.35	0.36
	E=66%	10.336	21.978	26.297	0.33	0.35	0.38
	E=100%	10.395	22.216	35.194	0.34	0.36	0.42

- Load: L=100%

Division		Stopping distance (degree)			Stopping time (s)		
		S=33%	S=66%	S=100%	S=33%	S=66%	S=100%
S-axis	E=33%	8.149	17.056	28.427	0.35	0.37	0.4
	E=66%	8.936	19.61	36.561	0.38	0.41	0.51
	E=100%	10.183	24.3242	52.796	0.43	0.51	0.73
H-axis	E=33%	6.481	13.781	24.930	0.35	0.37	0.41
	E=66%	7.384	16.17	26.631	0.35	0.38	0.45
	E=100%	6.568	17.159	35.384	0.37	0.41	0.57
V-axis	E=33%	10.276	21.622	25.515	0.33	0.35	0.36
	E=66%	10.573	23.998	37.385	0.36	0.39	0.43
	E=100%	10.811	23.166	64.063	0.36	0.39	0.72

3.5 Safety setting

For the details on the safety setting of collaborative operation, see the "**Safety Function Manual for Collaborative Robots**."

3.6 Programming and restarting

If the robot system boots up normally upon powering on, and if there are no safety issues, you can carry out programming and restarting.

The robot will identify the existence of safety issues through self-diagnosis and check its conditions. After this process, you can configure the common setting of the robot and safety setting for collaborative operation. Check the final setting values, carry out programming, and restart it.

- For more details on how to set and operate the robot, see "**Operation Manual for Hi6 Controllers**."
- For the details on the safety setting of collaborative operation, see the "**Safety Function Manual for Collaborative Robots**."

3.7 Axis limiting devices

■ Mechanical axis limiting devices

Note that the collaborative robot does not support mechanical axis restriction devices.

■ Safety-rated soft axis and space limiting

The collaborative robot is capable of safety-rated soft axis and space limiting. For more details, see the "**Safety Function Manual for Collaborative Robots**."

■ Dynamic limiting functions

Note that the collaborative robot does not support dynamic restriction functions.

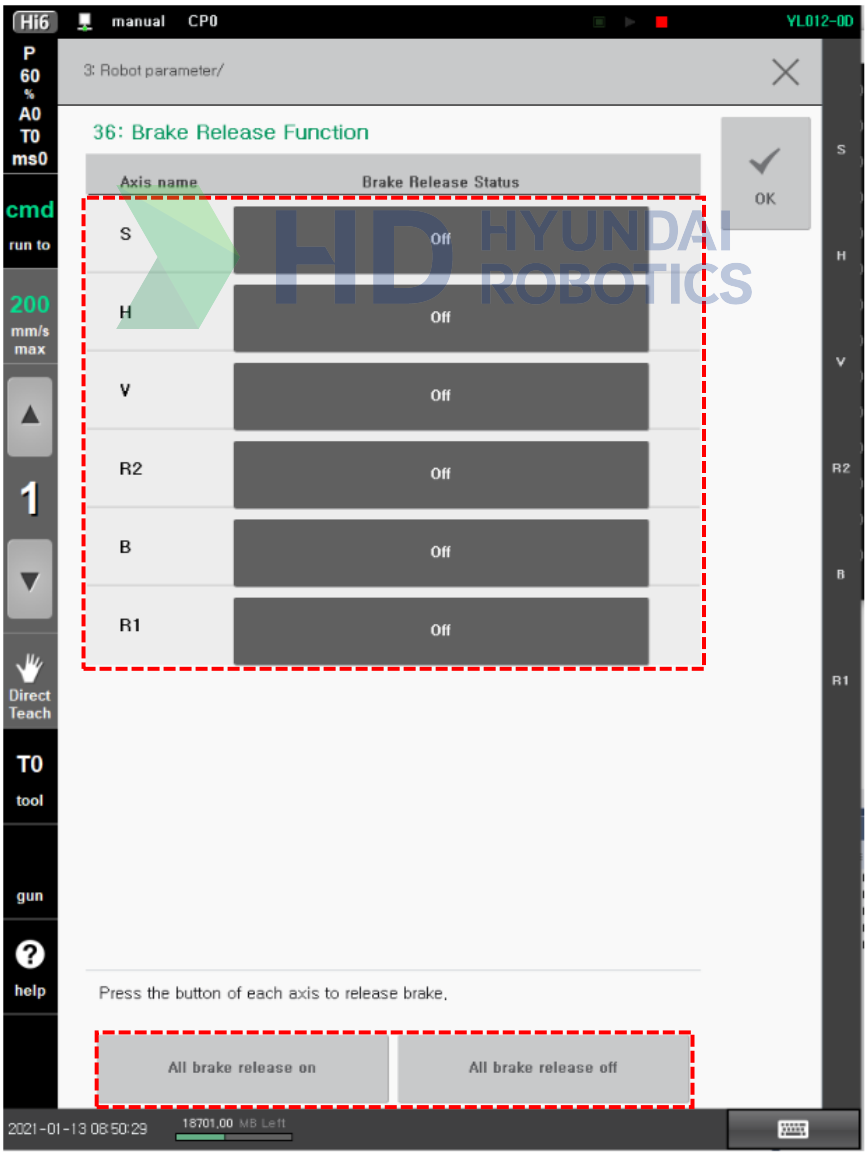
3.8. Movement without drive power

In case of emergency or occurrence of abnormal situations, you can configure the setting in such a way that the drive power of the robot is cut off and the axes can be moved for any workers isolated in the hazard area to make an emergency escape.

⚠ Caution	• If you release an axis of the robot when driving power is not applied to the robot, the axis may sag or drop. For safety, hold the axis using a device such as a crane that can support the axis before releasing it. • To prepare for emergencies and abnormal situations, all workers that install, use, and repair the robot system must undergo training in movement without driving power.

Movement without drive power can be used by using the **[Brake Release Function]** menu of the teach pendant.

1. Return the safety input with the robot motor powered off.
2. Touch the **[Set up 〉 3 : Robot parameter 〉 36 : Brake Release Function]** menu on the teach pendant screen.
3. Check the robot's condition and release the brake on the desired axis.



- To release the brake for each asxis, touch the **[Lock]** button of the desired axis. The brake of the corresponding axis is released only while touching the **[Lock]** button. When you release the **[Lock]** button, the brake is locked again.
- To release the brakes for all axes at once, touch the **[All brake release on]** button. If you touch the **[All brake release off]** button, the brakes of all axes are locked at once.

⚠ Caution	You can release the brake of the axis only in the **[Brake Release Function]** menu of the teach pendant. All brakes are locked as soon as you leave this menu.

3.9. Other safety precautions

- If the robot is operated manually without using the collaborative operation functions at a workplace where safety fences are installed for operating general industrial robots, all workers should stay out of the safeguarded space.
- Any protective devices that were temporarily stopped in a mode other than the automatic mode should be reactivated to function completely before entering the automatic mode. For example, automatic safeguard can be disabled in the manual mode. Before entering the automatic mode, the inputs of the automatic safeguard must be enabled.

4. Maintenance

To use the product for a long time without anomalies, it should be checked and maintained at regular intervals. The maintenance of the robot system must be carried out by Hyundai Robotics or a service provider designated by it.

The purpose of maintenance works is to maintain the robot system at the operable state or to restore it to the operable state in case problems arise. Maintenance activities include not only robot system repairs but also problem diagnosis.

In checking the robot system, the applicable work safety regulations of the country or locality must be complied with. All the possibilities of risks should be tested during maintenance, and risk assessment should be carried out to verify if the system meets the safety requirements after maintenance.

In carrying out maintenance works of the collaborative robot or the controller, make sure to comply with the following safety instructions:

- Before maintenance, disconnect the power cables, and ensure that other power sources connected to the robot or the controller are turned off.
- During maintenance, keep the existing safety setting of the software as it is.
- During maintenance, take precautions so that foreign matters such as water or dust do not penetrate into the product.
- If a defective part is found, replace it with a new one having the same specifications with the part to be replaced, and return the defective part to Hyundai Robotics. Make sure to use parts, consumables, and software certified by Hyundai Robotics.
- Upon completing maintenance, reactivate the safety functions.
- Record the details of the maintenance and repair works in the technical file relating to the entire robot system.

4.1 Checking of the collaborative robot

This section describes the types, intervals, and methods of checking the collaborative robot.

The types of checks include routine checks and time-based checks according to intervals and check categories. In addition to the checks, overhaul checks should be carried out at the intervals of 35,000 operating hours.

Type of checks	Interval	Division
Routine checks	From time to time	Devices, motors, and reducers
Time-based checks	Three months	Wires, and bolts
	One year	Brakes

Note	The check intervals vary depending on operations carried out by the robot: if the robot carries out severe handling operations, it is recommended to carry out checks at 1/2 of the specified intervals.

4.1.1 Check sheet

The intervals, methods, and criteria for checking the mechanical parts of the collaborative robot are as follows:

Division	From time to time	Three months	One year	Method	Criteria
Manipulator	O			Visual inspection of dust and impurities	Clean
Wiring		O		• Visual inspection on damaged cables • Visual inspection on loose cable ties	• No damaged cables • No loose cable ties
Bolts		O		Visual inspection on broken paint markings	No broken paint markings
Motors	O			• Check on abnormal overheating • Check on abnormal noise	• No abnormal overheating • No abnormal noise
Reducer	O			• Check on abnormal overheating • Check on abnormal noise • Check on abnormal vibration	• Temperature maintained as usual • No abnormal noise • Vibration maintained as usual
Brakes			O	• Operation upon the brake release switch ON/OFF (Caution: When the brake release switch is turned ON, the arm or motion axis will fall. Therefore, make sure to turn OFF the brake release switch within one second.) • Visual check on brake abrasion state • Check on abnormal brake noise	• Robot stopped at brake OFF • Insignificant quantity of brake dust • No abnormal brake noise
Clearances		O		Check on motion lag when each axis makes forward and reverse rotations	No motion lag felt by hand

- When the robot is used in severe conditions (e.g., excessive handling), carry out checks at intervals shorter than the specified intervals to ensure the performance of the robot system.
- Check all cables and replace any damaged cables.
- For checking on anomalies of power transmission devices (motors, reducers, etc.), check on abnormal noise in the automatic mode or the teaching mode.

4.1.2 Wiring check

The internal wiring of the collaborative robot uses cables that can withstand bending. Because disconnection or short circuit caused by damaged cables may lead to malfunction of the robot, make sure to check on the wiring at regular intervals.

Before starting activities such as robot teaching within the operating space of the robot (excluding cases where the driving power of the industrial robot is cut off), make sure to check the following safety check requirements. If any problems are found, resolve them and take necessary actions immediately.

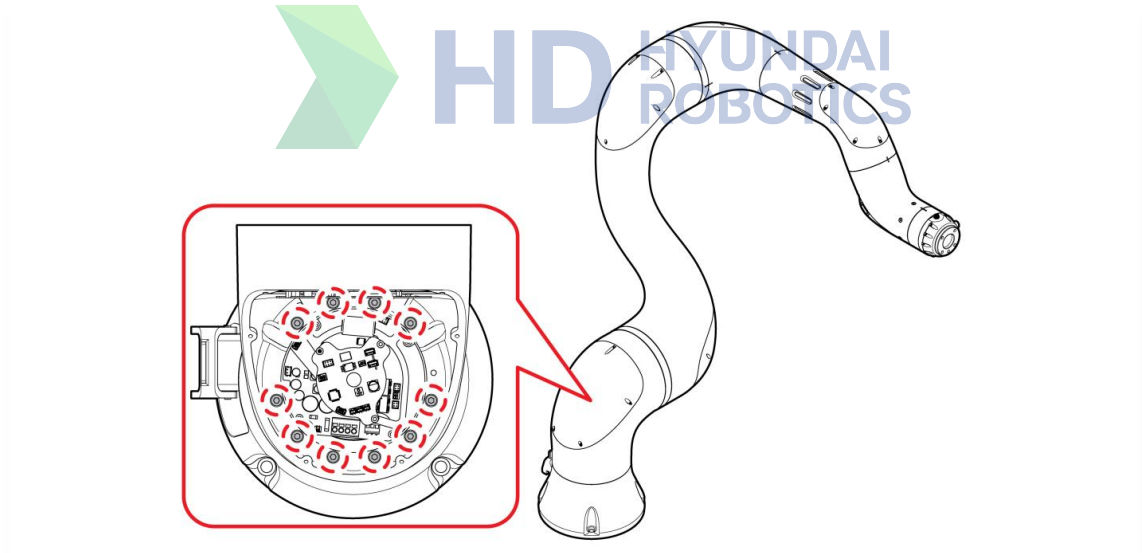
- Check on damaged shields and cables of the external power source.
- Check on the malfunction of the robot manipulator.
- Check on the operability of the emergency stop function.

4.1.3 Bolt check

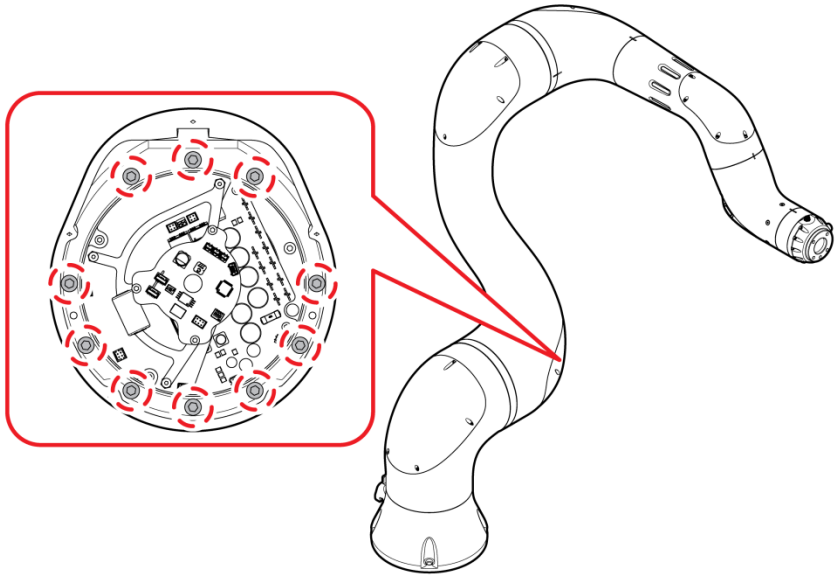
Check on the major bolts and the recommended fastening torques. Because the bolts to be checked vary depending on operations carried out by the robot, contact our Customer Support Team for more details.

Fasten the bolts mounting the integrated driving module of each axis with a torque wrench to adequate torques, and mark them with paint.

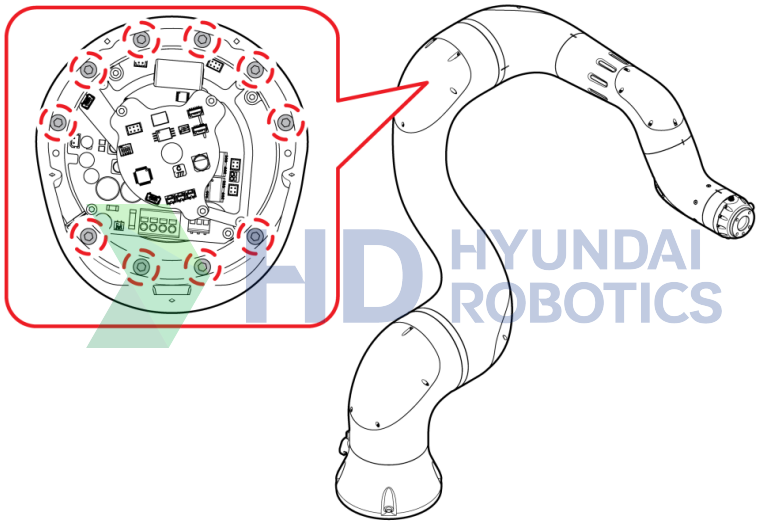
- S-axis parts to be checked – Bolts : 10 X M5-18 / torque: 8.2 Nm (83 kgf/cm)



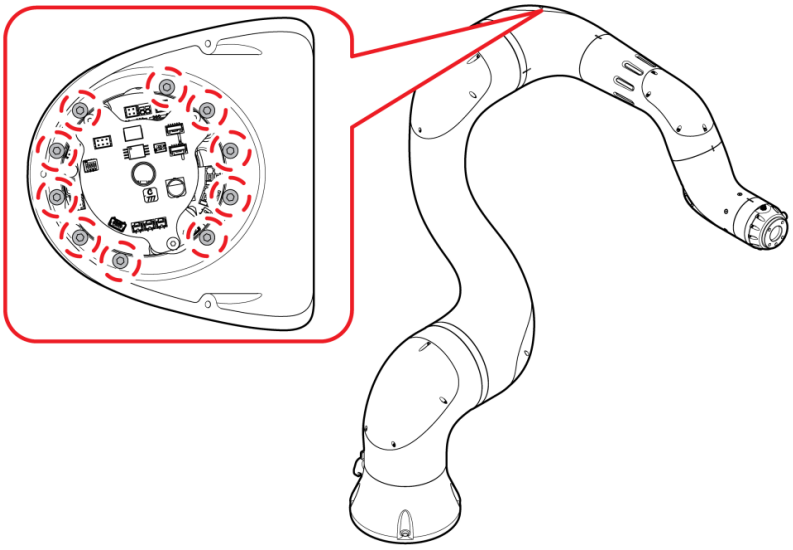
- H-axis parts to be checked – Bolts : 10 X M6-20 / torque: 13.82 Nm (141 kgf/cm)



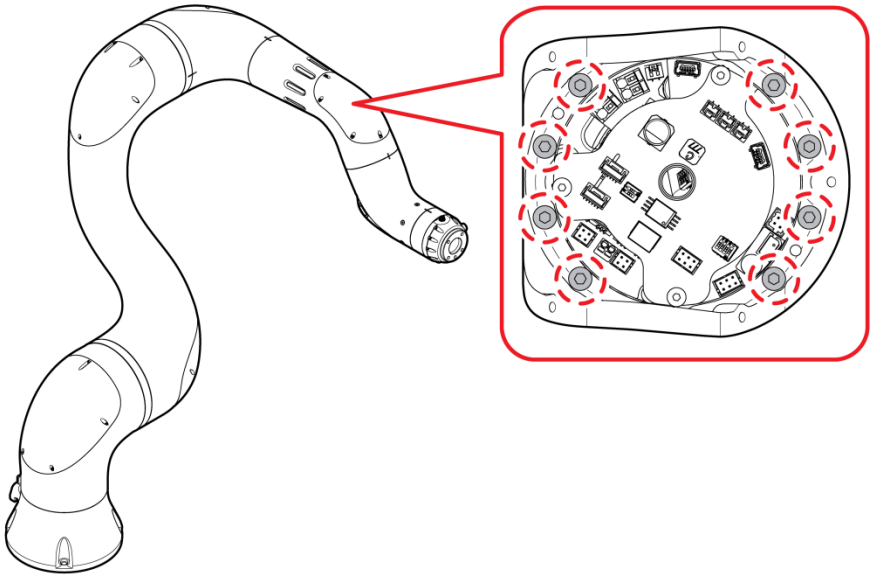
- V-axis parts to be checked – Bolts : 10 X M5-20 / torque: 8.2 Nm (83 kgf/cm)



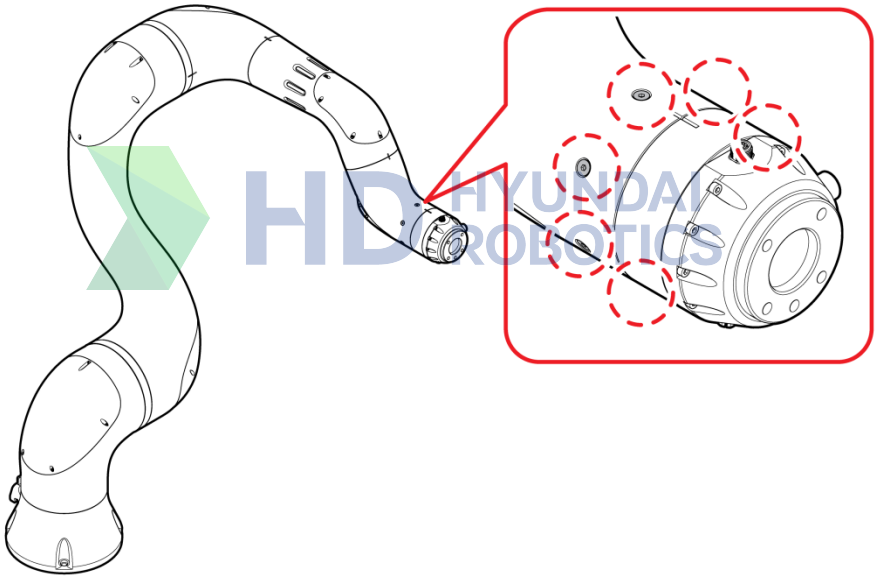
- R2-axis parts to be checked – Bolts : 10 X M4-25 / torque: 4.02 Nm (41 kgf/cm)



- B-axis parts to be checked – Bolts : 8 X M4-20 / torque: 4.02 Nm (41 kgf/cm)



- R1-axis parts to be checked – Bolts : 6 X M4-10 Countersunk head (12.9) / torque: 4.02 Nm (41 kgf/cm)



4.2 Maintenance of the collaborative robot

4.2.1 Replacement of internal wiring

Check the internal wiring of the collaborative robot at three-month intervals. Check on damaged wires, cables, and cable-protecting springs, and replace any defective parts immediately.

- The wiring replacement intervals vary depending on operating conditions, the robot's operating speed, and how long the robot operates continuously.
- Regardless of the major operation and operating conditions of the robot, replace the cables at the intervals of 16,000 hours.
- Replace wires in units.
- Wiring between the collaborative robot and the controller must be carried out in the specified length.

⚠ Caution	• The internal wiring should be done with cables of bending resistance. Only use cables of the specified types. • For purchasing an internal cable, identify the wiring type by consulting with our Customer Support Team. • Before replacing cables, cable-protecting springs, or hoses, check that the replacement parts are not broken or damaged.

4.2.2 Replacement of the integrated driving module

Replacement of the integrated driving module must be carried out by qualified experts who have taken the relevant training provided by Hyundai Robotics. In the event it is necessary to replace the integrated driving module, contact our Customer Support Team to consign the work to experts.

4.2.2.1 Replacement timing

Replace the integrated driving module when any of the following anomalies is found:

- Anomalies of reducers

  If a reducer is damaged, abnormal noise and vibration will occur. An abnormal reducer may lead to overloading, abnormal deviation, and abnormal overheating that obstruct normal operation. It may also make the robot stop or create a deviation in its position. In such cases, replace the integrated driving module.

  The integrated driving module should also be replaced when the grease is replaced.

- Anomalies of motors

  An abnormal motor may lead to abnormal operations such as shaking at stopping, vibration in operation, and irregular cycles (pulsation). It may also generate abnormal noise and overheating.

  The phenomena of abnormal motors are similar to those of reducers. In such cases, replace the integrated driving module, and contact our Customer Support Team to request analysis.

- Anomalies of the brake

  An abnormal brake will make the axes fall in the operation ready [brake OFF] state or generate overloading and abnormal noise by being actuated in the operation ready [brake ON] state. You can check on anomalies of the brake by the following methods:

- While the motor is not turned on, turn ON the brake release switch so that the robot can be moved. Before turning ON the brake release switch, take actions so that the robot arm cannot fall by gravity.

- In the operation ready state, turn the brake release switch ON/OFF, and check that the brake operation sound is heard. In most cases, if the brake operation sound is not heard, there is a wire disconnection. In such a case, replace the integrated driving module.

⚠ Caution	• Take precautions because the robot arm may fall when the brake release switch is turned ON/OFF. • The brake release switch is on the circuit board placed near the door inside the controller.

- Anomalies of the encoder

  An abnormal encoder will lead to deviation in position, malfunction, rush, etc. It may also lead to shaking at stopping and irregular cycles (pulsation). In such cases, check the error code through the teach pendant, and replace the integrated driving module as necessary. Phenomena such as abnormal mechanical noise, overheating, and vibration are not related to anomalies of the encoder.

⚠ Caution	• In replacing the integrated driving module, it is likely that the worker will place some parts on the floor. Before the replacement, secure the area so that no parts can be lost or damaged. • Replacement of the integrated driving module must be carried out by qualified experts who have taken the relevant training provided by Hyundai Robotics. In the event it is necessary to replace the integrated driving module, contact our Customer Support Team to consign the work to experts. • After the robot is stopped and before the worker touches the integrated driving module, its temperature should be checked. • In the case of the gigabit Ethernet option, because the module replacement is not simple, contact our Customer Support Team to consign the work to experts.

4.2.2.2 Weight of the integrated driving module

In replacing the integrated driving module, take precautions regarding its weight.

Model	S	H	V	R2	B	R1
YL005	4.34 kg	4.34 kg	2.07 kg	2.07 kg	1.83 kg	1.83 kg
YL012	6.14 kg	9.97 kg	6.14 kg	2.07 kg	2.07 kg	1.83 kg
YL015	6.14 kg	9.97 kg	6.14 kg	2.07 kg	2.07 kg	1.83 kg

4.2.2.3 Tools and parts

The tools and parts required for the replacement of the integrated driving module are as follows:

- Off-the-shelf torque wrenches and extensions
- Bolts: hex socket head, strength 12.9, electroless nickel plated, or normal nickel plated
- Pins: dowel pins of H7 tolerance or spring pins

Model	Axis	Torque wrenches	Bolts	Dowel pins	Other parts
YL005	S	M3, M4, M5	4XM3-6, 4XM3-10, 12XM4-20, 12XM5-18	3XPIN5-10	
	H	M3, M4, M5	8XM3-6, 12XM4-20, 12XM5-18	3XPIN5-10	
	V	M3, M4	8XM3-6, 12XM3-30, 9XM4-25	PIN3-6, 2XPIN4-15	
	R2	M3, M4	10XM3-6, 12XM3-30, 9XM4-20	PIN3-6, 2XPIN4-15	
	B	M3, M4	4XM3-5 small-diameter head, 6XM3-6, 12XM3-18, 6XM4-10, 8XM3-25	PIN3-6, PIN4-10	
	R1	M2.5, M3	6XM4-10 countersunk head, 4XM3-5 small-diameter head		
YL012	S	M3, M5	5XM3-6, 10XM5-18, 12XM5-40	3XPIN5-10	
	H	M3, M6	10XM3-6, 12XM6-20, 12XM6-45	3XPIN5-10	One-touch straight fitting (KQH23-00A1)
	V	M3, M5	10XM3-6, 10XM5-20, 12XM5-40	3XPIN5-10	
	R2	M3, M4	11XM3-6, 12XM3-30, 10XM4-25	PIN3-6, 2XPIN4-15	One-touch straight fitting (KQH23-00A1)
	B	M3, M4	4XM3-5 small-diameter head, XM3-6, 12XM3-30, 8XM4-20	PIN3-6, 2XPIN4-15	3XM3 NUT, M3 rubber washer, one-touch straight fitting (KQH23-00A1)
	R1	M2.5, M3	6XM4-10 countersunk head, 4XM3-5 small-diameter head		One-touch straight fitting (KQH23-00A1)
YL015	S	M3, M5	5XM3-6, 10XM5-18, 12XM5-40	3XPIN5-10	
	H	M3, M6	10XM3-6, 12XM6-20, 12XM6-45	3XPIN5-10	One-touch straight fitting (KQH23-00A1)
	V	M3, M5	10XM3-6, 10XM5-20, 12XM5-40	3XPIN5-10	
	R2	M3, M4	11XM3-6, 12XM3-30, 10XM4-20	PIN3-6, 2XPIN4-15	One-touch straight fitting (KQH23-00A1)
	B	M3, M4	4XM3-5 small-diameter head, 6XM3-6, 12XM3-30, 8XM4-20	PIN3-6, 2XPIN4-15	3XM3 NUT, M3 rubber washer, one-touch straight fitting (KQH23-00A1)

Model	Axis	Torque wrenches	Bolts	Dowel pins	Other parts
	R1	M2.5, M3	6XM4-10 countersunk head, 4XM3-5 small-diameter head		One-touch straight fitting (KQH23-00A1)

4.2.2.4 Recommended posture in disassembling the integrated driving module

In replacing the integrated driving module, setting the axis at the following posture will facilitate the disassembling work.

For example, in replacing the module of the H-axis of YL012, the disassembling work will be easier if the robot's posture is set at angles of 95° , 65° , or 35° , which are the angles at which the angular interval (30°) is added or subtracted from the reference angle (95°).

Model		S	H	V	R2	B	R1
YL005	Reference angle	Not applicable	Not applicable	-30	30	-15	Not applicable
	Angular gap	Not applicable	Not applicable	30	30	30	Not applicable
YL012	Reference angle	-40	95	-140	108.5	63.5	Not applicable
	Angular gap	30	30	30	30	30	Not applicable
YL015	Reference angle	-40	95	130	-161	86	Not applicable
	Angular gap	30	30	30	30	30	Not applicable

⚠ Caution	If the robot cannot be driven, carry out the primary disassembling of the module, then rotate the module using the brake release module. Carry out the rest of the disassembling.

4.2.2.5 Method for replacing the integrated driving module

Referring to "**6.1 Block diagrams**" first identify the position and composition of the integrated driving module of each axis.

1. Move the axis for which the integrated driving module will be replaced with the recommended posture.
2. Power off the module by turning off the power breaker.
3. Remove the bolts with a torque wrench, and remove the front or rear frame cover of the pertaining axis.
4. Disconnect the wires of the integrated driving module.
5. If it has a pneumatic hose, cut one end of the hose.
6. Remove the bolts at the servo drive side using a torque wrench.

⚠ Caution	Retain the removed robot parts securely on a flat floor.

7. Remove the bolts at the reducer with a torque wrench.

   If you failed to set the robot at the recommended posture, release the brake by removing the brake connector of the servo drive, forcibly rotate the module, and remove the bolts.

8. Apply Loctite 518 on the contacting surface of the replacement module.

9. Replace the old module with a new one.
10. Set the mounting position using the pin, and fixate the new module by fastening bolts with a torque wrench.
11. Connect the wires of the integrated driving module.
12. Using the one-touch straight fitting (KQH23-00A1), reconnect the pneumatic hose that was cut at Step 5.
13. Put the front or rear frame cover on the axis, and fixate it by fastening bolts with a torque wrench.
14. Referring to the "**Encoder offset**" section of the "**Operation Manual for Hi6 Controller,**" correct the offset of the encoder of the axis of which the module has been replaced.

⚠ Caution	Before correcting the encoder offset, set the operation preparation at ON, and ensure that the power is connected by pressing the enabling switch of the teach pendant for two to three seconds.

15. Run the robot, and check that it operates normally.

4.2.3 Encoder backup battery replacement

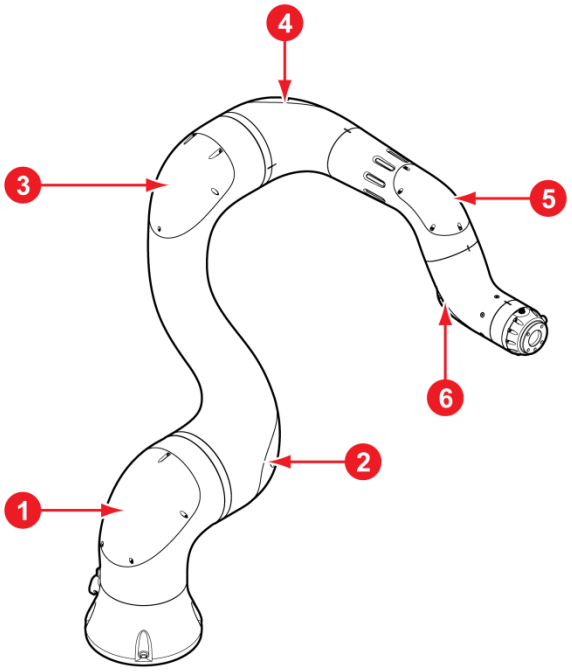
A dedicated battery attached to the serial encoder retains the position data of each axis regardless of whether power is supplied to the controller. The battery should be replaced at two-year intervals.

The method for replacing the encoder backup battery of each axis is as follows:

1. While the controller power is on, press the emergency stop switch.

⚠ Caution	Before correcting the encoder offset, set the operation preparation at ON, and ensure that the power is connected by pressing the enabling switch of the teach pendant for two to three seconds.

2. Identify the position of the battery of each axis, and remove the frame cover of the battery by removing bolts with a torque wrench.



No.	Axis	Cover	Bolts
1	S	Lower frame cover	Hex socket bolts (M3X6, five pieces)
2	H	Upper frame cover	Hex socket bolts (M3X6, five pieces)
3	V	Upper frame cover	Hex socket bolts (M3X6, six pieces)
4	R2	Arm frame cover	Hex socket bolts (M3X6, five pieces)
5	B	Arm pipe cover	Hex socket bolts (M3X6, six pieces)
6	R1	Handgrip	M3 small-diameter bolts (four pieces)

3. Identify the orientation of the battery terminals, and replace the old battery with a new one.

⚠ Caution	• Only use the battery of the designated specifications (ER6C (AA 3.6 V) / manufacturer: Maxcell). • Identify the orientation of the battery terminals, and insert the battery correctly. • Do not recycle or arbitrarily dispose of the battery. The battery should be disposed of as an industrial waste according to the applicable national or local laws and regulations.

4. Put the frame cover on the axis, and fixate it by fastening bolts with a torque wrench.

4.2.4 Grease replacement

Because the collaborative robot uses harmonic reducers, it does not require grease replacement at regular intervals.

- However, because cases may occur where the grease should be replaced depending on the service environment of the robot, check on abnormal noise or temperature of the reducers at regular intervals.
- Grease replacement requires the replacement of the integrated driving module. If grease replacement is necessary, contact our Customer Support Team.

4.3 Controller check and maintenance

Because the controller is fixated to a floor, it is not subject to mechanical damages. Therefore, the controller does not need to be checked for mechanical damages over the course of its service life. However, when the controller is repositioned or when it has been impacted, its cables and connectors must be checked.

4.3.1 Internal structure

Identifying the structure and part names of the controller is useful for learning how to install and maintain it.

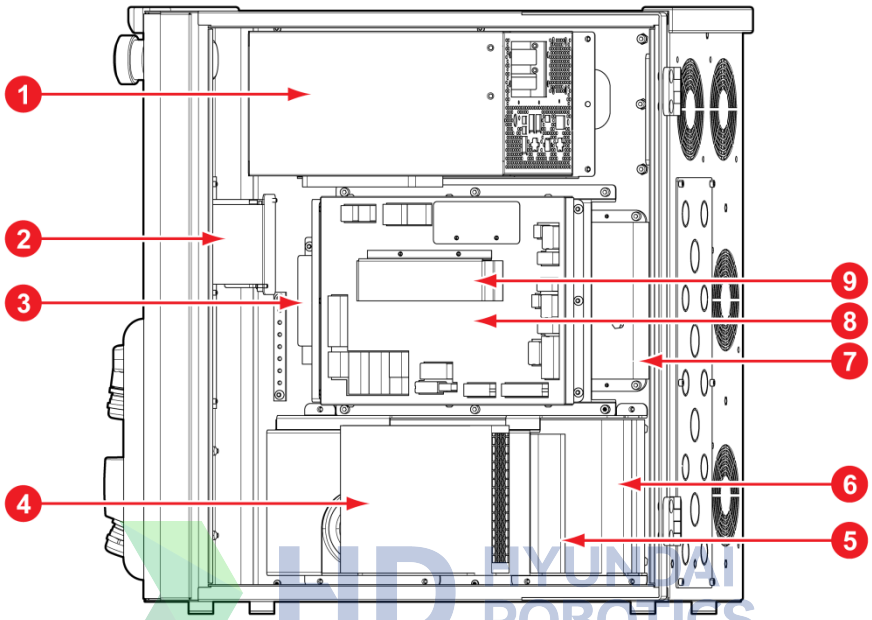


Figure 26 Internal structure of the controller

No.	Name		Description
1	Microcomputer module	miniH6COM	This has overall control of the collaborative robot.
2	Power switch and breaker	CP1	This turns on/off the main power of the controller.
3	Noise filter	NF1	This filters conductive noise.
4	Buffer power	BUFFER	This supplies power to the microcomputer module for a certain period in case of a blackout.
5	Power supply 2	SMPS2	This is the power source (48 V DC) of the joint actuator.
6	Power supply 1	SMPS1	This is the power source (48 V DC) for the controlling.
7	Regenerative discharge module	RDM	This discharges the regenerative power generated by the motor of the joint actuator.
8	Safety control module	SCM	This controls the safety functions of the collaborative robot.
9	Power precharge module	PPM	This precharges the power for the joint actuator of the collaborative robot.

4.3.2 Safety control module

The safety control module (SCM) monitors and controls the safety of the collaborative robot. For more details on its functions, see the "**Safety Function Manual for Collaborative Robots**."

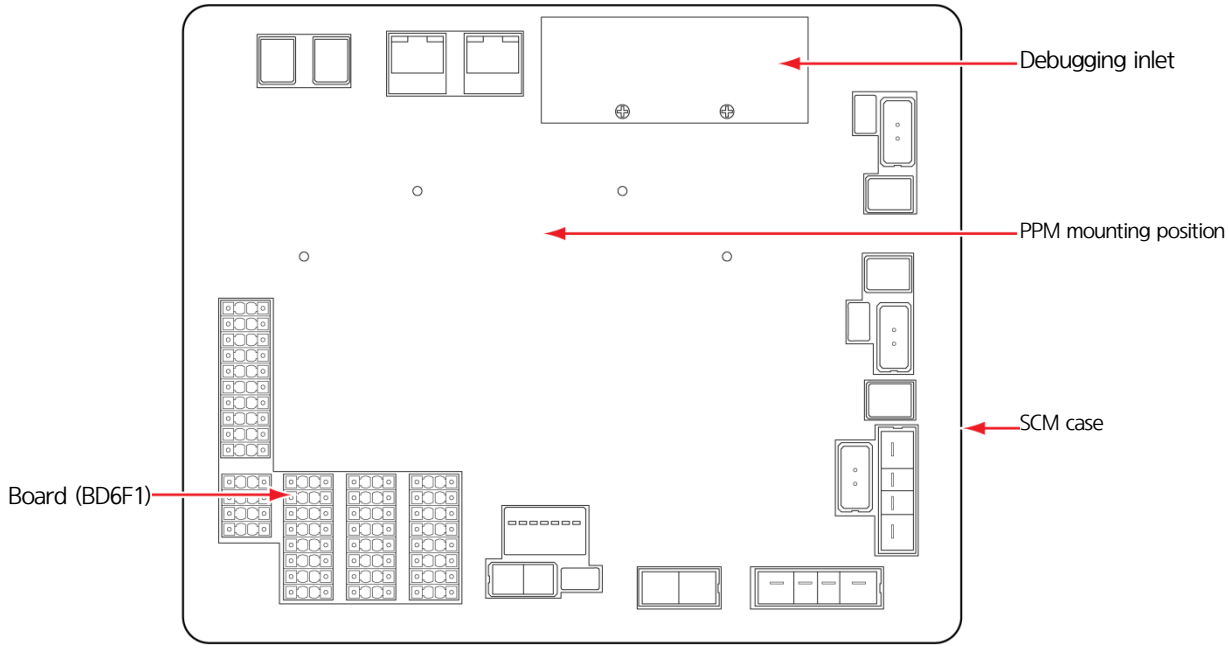


Figure 27 Safety control module (SCM)

4.3.2.1 Connection and display

The connector layout, usages, and connecting devices used by the SCM are as follows:

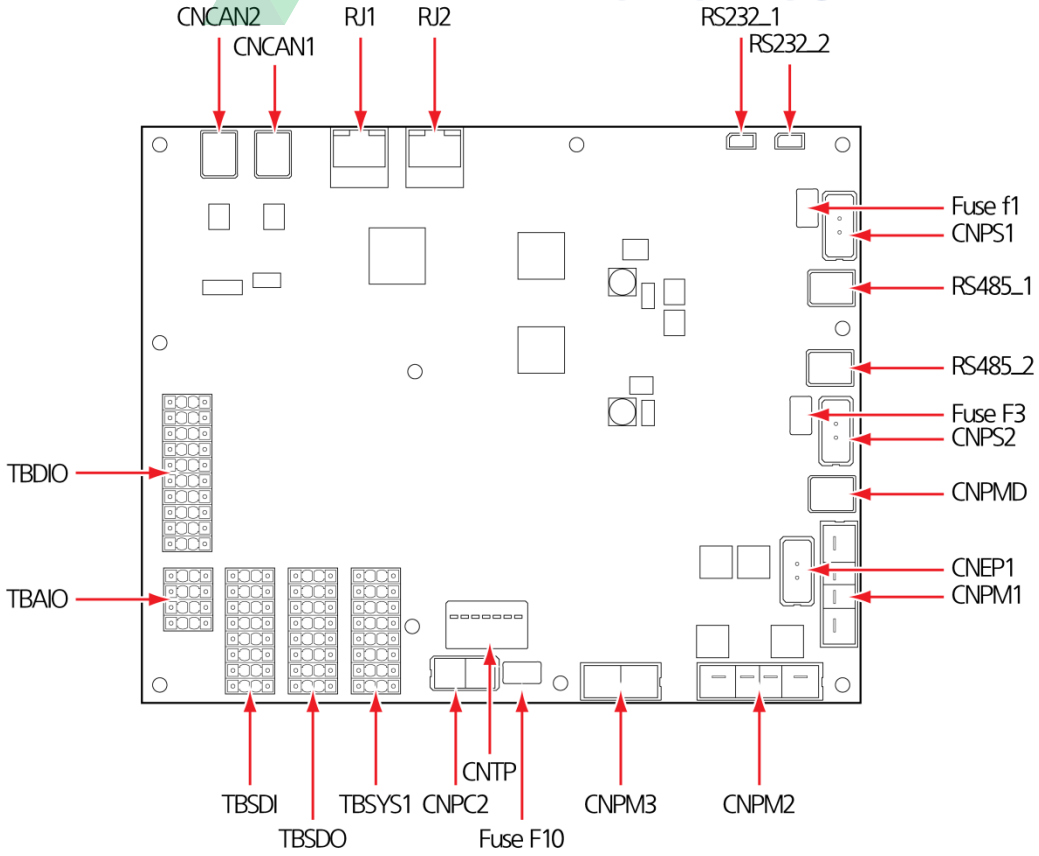


Figure 28 Safety control board (BD6F1)

Connector	Usage	External connecting device
CNPS1, 2	Power input for the safety circuit, 24 V DC (Channels 1 and 2)	Power supply (SMPS2)
CNCAN1	Data communication (exchange of torque data) with the torque sensors (Channel 1) of the mechanical parts	Robot cable connection terminal (CNM)
CNCAN2	Data communication (exchange of torque and position data) with the torque sensors (Channel 2) and encoder (Channel 2) of the mechanical parts	Robot cable connector (CNM)
RJ1	EtherCAT communication port	Robot cable connector (CNM)
RJ2	EtherCAT communication port	Microcomputer module (miniH6COM)
CNPM1	Power input for driving motors of the mechanical parts (48 V DC)	Power supply (SMPS1)
CNPM2	Power output for driving motors of the mechanical parts (48 V DC)	Robot cable connector (CNM)
CNPM3	Power output for charging the motor driving power lines (48 V DC)	Power precharge module (PPM)
CNEP1	Power input for charging the motor driving power lines (48 V DC)	Safety control module (SCM)
CNRDM	Exchange of information on the state of regenerative discharge action	Regenerative discharge module (RDM)
CNPC2	Power input for I/O	Power supply (SMPS2)
TBSYS1	Input for the emergency stop switch and protective stop switch (safeguard), control of power charging function, and connection of monitoring signals	External safety switch, power precharge module (PPM)
TBSDO	Connection of safety output signals	Safety device
TBSDI	Connection of safety input signals	Safety device
TBAIO	Connection of general analog I/O signals	General analog devices
TBDIO	Connection of general digital I/O signals	General digital devices
RS485_1, 2	Connection of RS-485 serial communication (reserved function)	-
RS232_1, 2	Connection of RS-232 serial communication (reserved function)	-

4.3.2.2 Connection of I/O signals for the robot system (TBSYS1)

The I/O signals dedicated to the robot system are connected through TBSYS1, the terminal block of the safety control module.

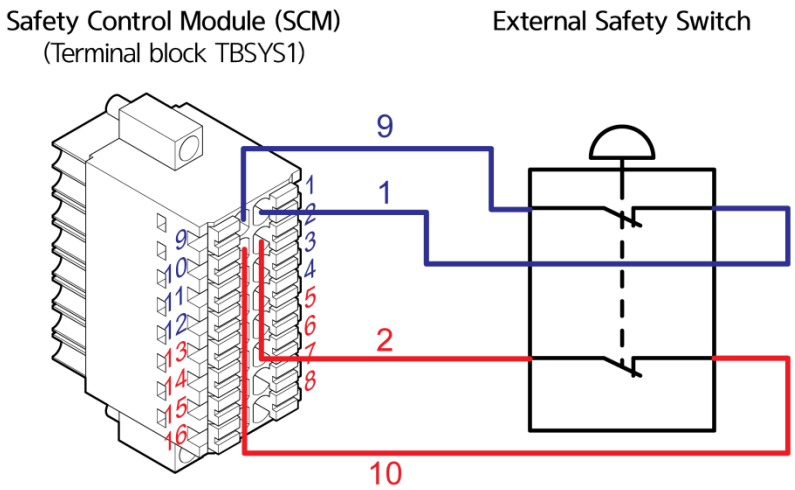


Figure 29 Connection of I/O signals for the robot system (TBSYS1)

* The pins 3 through 8 and 11 through 16 are used as dedicated signals inside the control system.

No.	Name	Usage	No.	Name	Usage
1	SF_POW1	Protective stop input common (Channel 1)	9	SG1	Protective stop input (Channel 1)
2	SF_POW2	Protective stop input common (Channel 2)	10	SG2	Protective stop input (Channel 2)
3	SF_POW1	Emergency stop input common (Channel 1) - Connection of the emergency stop switch of the control box	11	ES1	Emergency stop input (Channel 1) - Connection of the emergency stop switch of the control box
4	SF_POW2	Emergency stop input common (Channel 2) - Connection of the emergency stop switch of the control box	12	ES2	Emergency stop input (Channel 2) - Connection of the emergency stop switch of the control box
5	IN_POW1	PRIN input common	13	/PRIN	Precharge relay state input
6	IN_POW2	Reserved signal input common	14	RSV_IN2	Reserved signal input
7	SF_GND1	PRON output common	15	/PRON	Precharge relay actuation output
8	SF_GND2	Reserved signal output common	16	RSV_OUT2	Reserved signal output

4.3.2.3 Safety I/O signal connection (TBSDI, TBSDO)

The safety input signals of the safety control module receive the inputs from the emergency stop switch and the safeguard through Terminal Block, TBSDI.

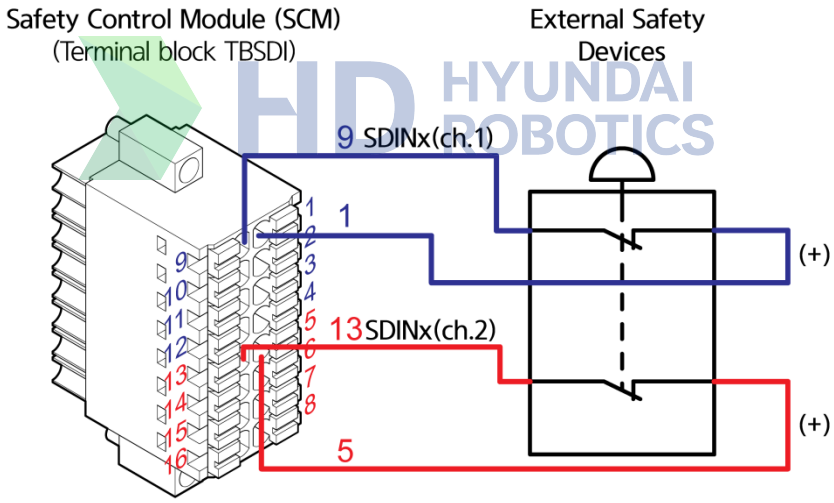


Figure 30 Safety input signal connection (TBSDI)

No.	Name	Usage	No.	Name	Usage
1	SIO_POW1	Safety signal input common (Channel 1)	9	SDIN0	Safety signal input 0 (Channel 1)
2	SIO_POW1	Safety signal input common (Channel 1)	10	SDIN1	Safety signal input 1 (Channel 1)
3	SIO_POW1	Safety signal input common (Channel 1)	11	SDIN2	Safety signal input 2 (Channel 1)
4	SIO_POW1	Safety signal input common (Channel 1)	12	SDIN3	Safety signal input 3 (Channel 1)
5	SIO_POW2	Safety signal input common (Channel 2)	13	SDIN4	Safety signal input 4 (Channel 2)
6	SIO_POW2	Safety signal input common (Channel 2)	14	SDIN5	Safety signal input 5 (Channel 2)
7	SIO_POW2	Safety signal input common	15	SDIN6	Safety signal input 6 (Channel 2)

No.	Name	Usage	No.	Name	Usage
		(Channel 2)			
8	SIO_POW2	Safety signal input common (Channel 2)	16	SDIN7	Safety signal input 7 (Channel 2)

The safety signals of the safety control module receive output to the safety devices necessary for the application through Terminal Block, TBSDO.

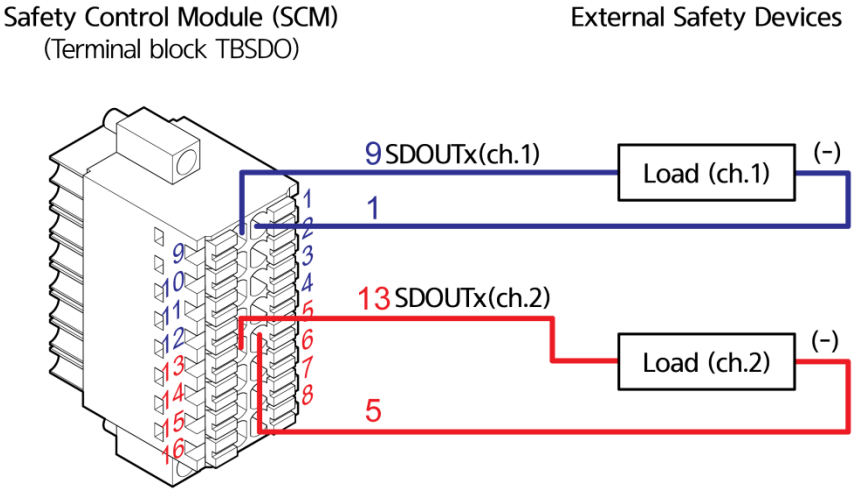


Figure 31 Safety output signal connection (TBSDO)

No.	Name	Usage	No.	Name	Usage
1	SIO_GND1	Safety signal output common (Channel 1)	9	SDOUT0	Safety signal output 0 (Channel 1)
2	SIO_GND1	Safety signal output common (Channel 1)	10	SDOUT1	Safety signal output 1 (Channel 1)
3	SIO_GND1	Safety signal output common (Channel 1)	11	SDOUT2	Safety signal output 2 (Channel 1)
4	SIO_GND1	Safety signal output common (Channel 1)	12	SDOUT3	Safety signal output 3 (Channel 1)
5	SIO_GND2	Safety signal output common (Channel 2)	13	SDOUT4	Safety signal output 4 (Channel 2)
6	SIO_GND2	Safety signal output common (Channel 2)	14	SDOUT5	Safety signal output 5 (Channel 2)
7	SIO_GND2	Safety signal output common (Channel 2)	15	SDOUT6	Safety signal output 6 (Channel 2)
8	SIO_GND2	Safety signal output common (Channel 2)	16	SDOUT7	Safety signal output 7 (Channel 2)

4.3.2.4 Connection of common digital I/O signals (TBDIO)

Common digital input signals are connected through Terminal Block, TBDIO (eight signals at the maximum can be connected). In the following example, External Device is input to GDIN1, and External Device 2 is input to GDIN6.

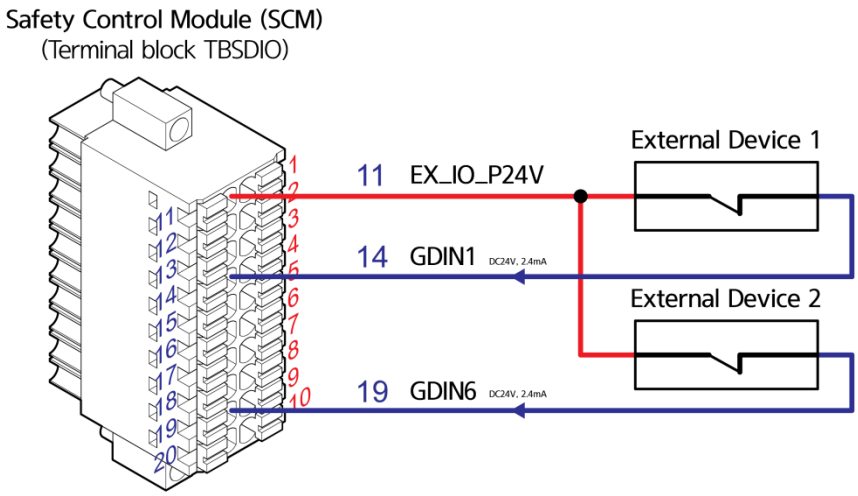


Figure 32 Connection of common digital input signals (TBDIO)

Common digital output signals are connected through Terminal Block, TBDIO (eight at the maximum). In the following example, the load of External Device 1 is operated through the output to GDOUT2, and the load of External Device 2 is operated through the output to GDOUT7.

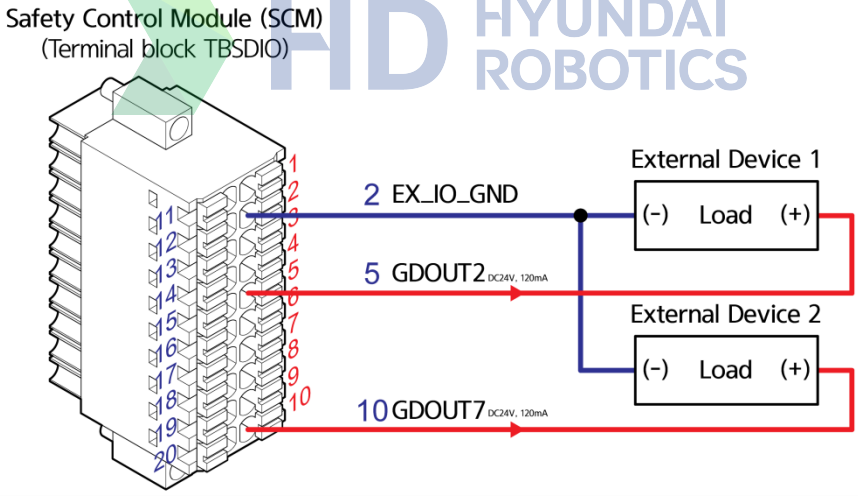


Figure 33 Connection of common digital output signals (TBDIO)

No.	Name	Usage	No.	Name	Usage
1	EX_IO_P24V	Common digital signal power	11	EX_IO_P24V	Common digital signal power
2	EX_IO_GND	Common digital signal power GND	12	EX_IO_GND	Common digital signal power GND
3	GDOUT0	Common digital signal output 0	13	GDIN0	Common digital signal input 0
4	GDOUT1	Common digital signal output 1	14	GDIN1	Common digital signal input 1
5	GDOUT2	Common digital signal output 2	15	GDIN2	Common digital signal input 2
6	GDOUT3	Common digital signal output 3	16	GDIN3	Common digital signal input 3

No.	Name	Usage	No.	Name	Usage
7	GDOUT4	Common digital signal output 4	17	GDIN4	Common digital signal input 4
8	GDOUT5	Common digital signal output 5	18	GDIN5	Common digital signal input 5
9	GDOUT6	Common digital signal output 6	19	GDIN6	Common digital signal input 6
10	GDOUT7	Common digital signal output 7	20	GDIN7	Common digital signal input 7

4.3.2.5 Connection of common digital I/O signals (TBAIO)

Common analog input signals are connected through TBAIO (two at the maximum). In the following example, External Device 1 is input to GAIN0, and External Device 2 is input to GAIN1.

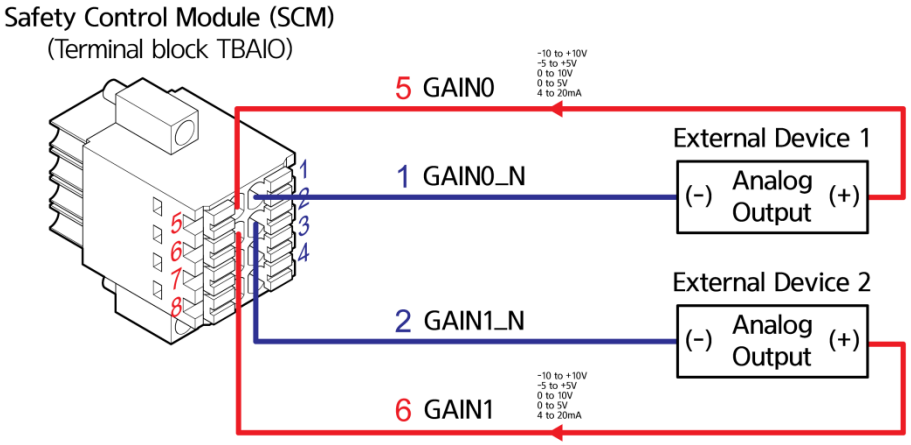


Figure 34 Connection of common digital input signals (TBAIO)

Common analog output signals are connected through TBDIO (two at the maximum). In the following example, the load of External Device 1 is operated through the output to GAOUT0, and the load of External Device 2 is operated through the output to GAOUT1.

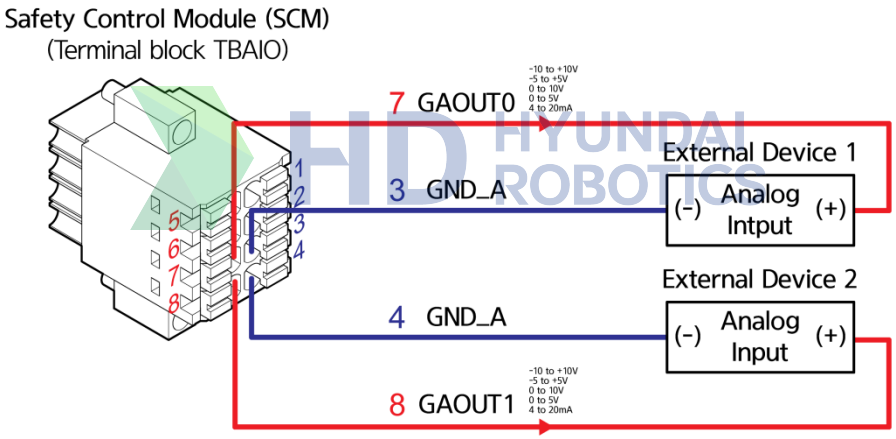


Figure 35 Connection of common analog output signals (TBAIO)

No.	Name	Usage	No.	Name	Usage
1	GAIN0_N	Ground of GAIN0 for common analog input	5	GAIN0	Common analog input 0
2	GAIN1_N	Ground of GAIN1 for common analog input	6	GAIN1	Common analog input 1
3	GND_A	Common analog GND	7	GAOUT0	Common analog output 0
4	GND_A	Common analog GND	8	GAOUT1	Common analog output 1

4.3.2.6 Information on major components

The safety control module is not allowed to be subjected to maintenance because it is classified as a safety management item. Specification information on its major components other than the fuses is not provided.

Component	Usage	Specification
F1, F3	Fuses for preventing the overcurrent of the power to the safety circuit (Channels 1 and 2)	3A (Littelfuse 0453 003)
F10	Fuse for preventing the overcurrent of the power to the external I/O	5A (Littelfuse 0453 005)

4.3.3 Power precharge module (PPM)

The PPM precharges power for driving the motor of the joint actuator installed for the collaborative robot. It is composed of relays that open/close the charging system and a resistor that prevents inrush current.

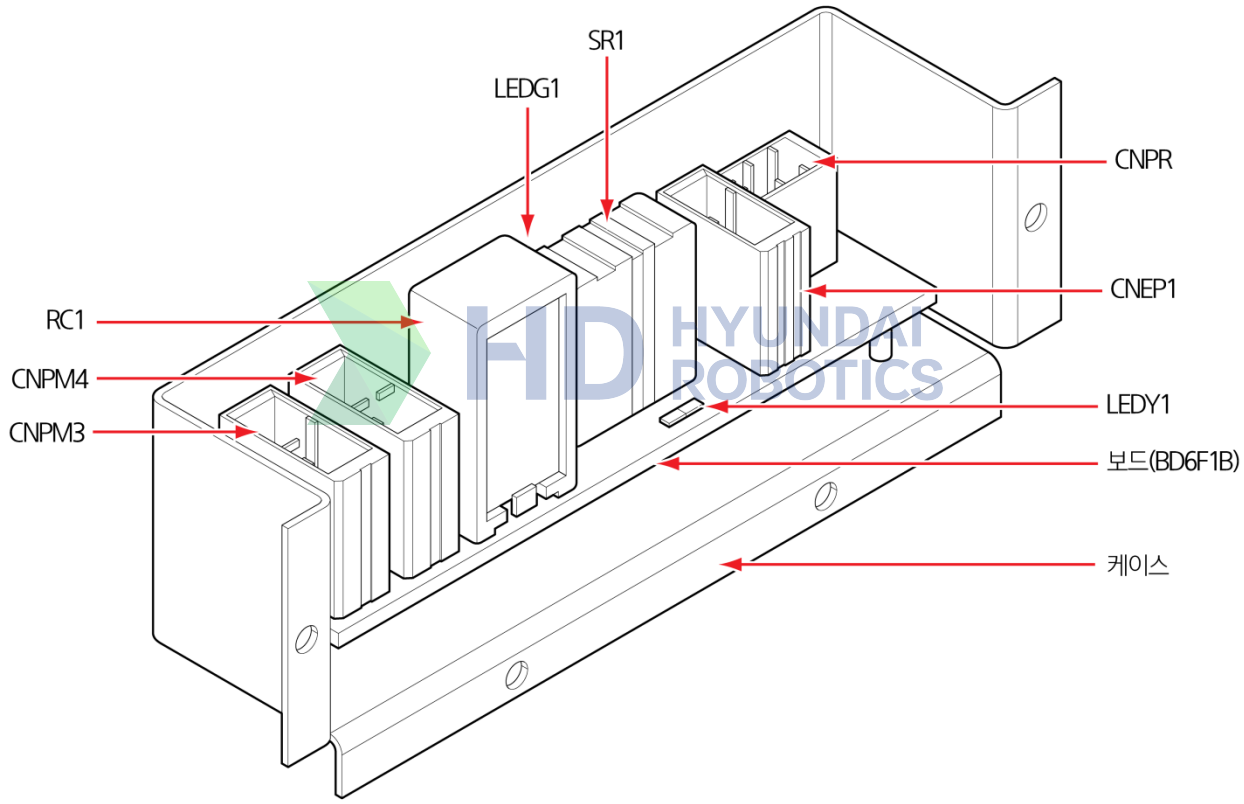


Figure 36 Power precharge module (PPM)

4.3.3.1 Connection and display

The connector layout, usage, and connecting devices used by the PPM are as follows:

Connector	Usage	External connecting device
CNPM3	Output terminal of the 48 V DC output power (for the motor)	Regenerative discharge module (RDM) CNPM3
CNPM4	Input terminal of the 48 V DC output power (for the motor)	Safety control module (SCM) CNPM3
CNEP1	Input terminal of the 48 V DC source power (for the motor)	Safety control module (SCM) CNEP1

Connector	Usage	External connecting device
CNPR	Control of the power charge function and connection of monitoring signals	Safety control module (SCM) TBSYS1

The details of the state display of the PPM are as follows:

LED	Usage	Display details
LEDY1	Indication of the state of operating command for the relays that open/close the charging system	• Lamp on: Under charging command • Lamp off: Not under charging command
LEDG1	Indication of the operating state of the relays that open/close the charging system	• Lamp on: Under charging • Lamp off: Not under charging

4.3.3.2 Information on major components

The PPM utilizes small power resistors to prevent inrush current and is connected serially to the charging system. Because the opening/closing of the charging system may have a significant impact on the system, the PPM utilizes safety relays for state monitoring.

Component	Usage	Specification
Resistor for preventing inrush current (RC1)	Prevention of inrush current during precharging	• PQR10 10Ω • 10 W (ceramic wire-wound resistor)
Safety relay (SR1)	Opening/closing of the precharging system	• V23047-A1024-A501 • 5 A, 250 V AC • Force-guided relay

4.3.4 Regenerative discharge module (RDM)

The RDM prevents strong electricity components from being damaged by regenerative power generated by the deceleration of the motor. It is composed of a board, a regenerative discharge resistor, and a case.

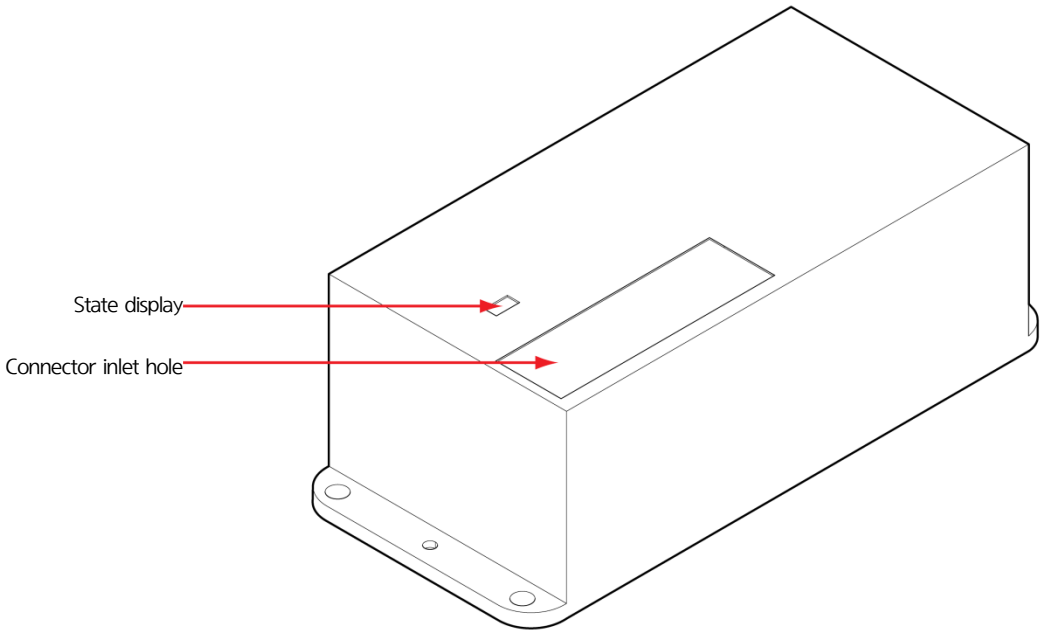


Figure 37 Outside view of the RDM

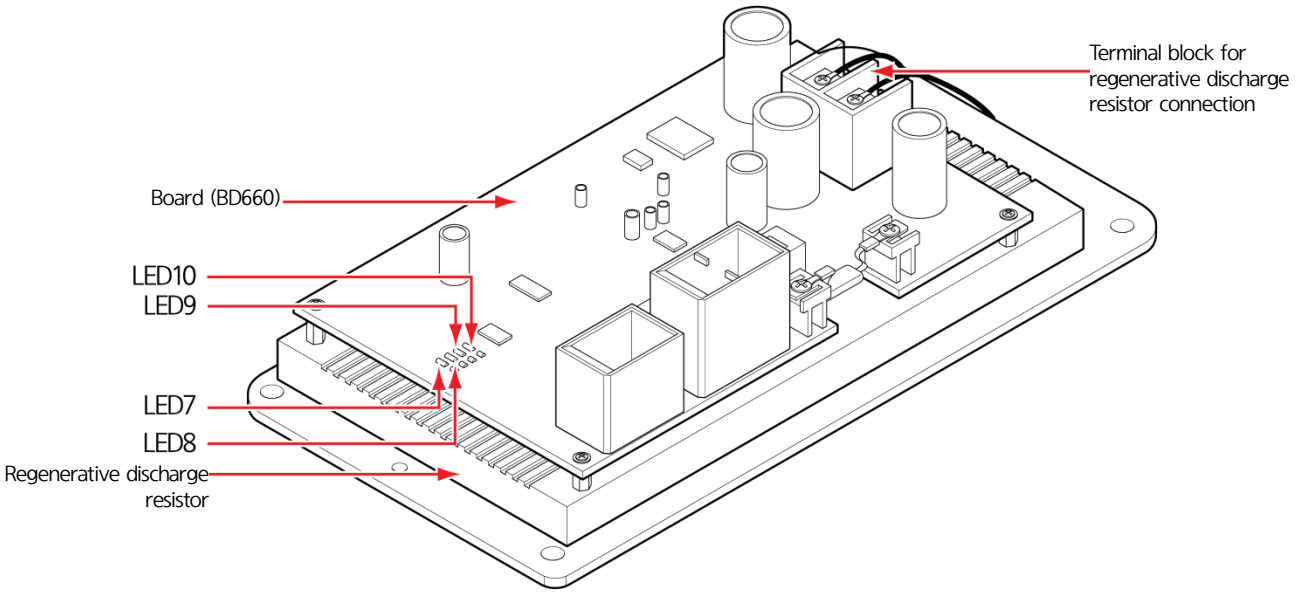


Figure 38 Inside view of the RDM

4.3.4.1 Connection and display

The connector layout, usage, and connecting devices used by the RDM are as follows:

Connector	Usage	External connecting device
CNPM3	Connection of 48 V DC power line (for the motor)	Power precharge module (PPM) CNPM3
CNRDM	Connection of state information signals	Safety control module (SCM) CNPMD

The details of the state display of the RDM are as follows:

LED	Usage	Display details (lamp state)
LED7	Detection of overheating of the regenerative discharge resistor or overcurrent of the discharge current	Overheating of the regenerative discharge resistor (95° C) or Overcurrent of the discharge current (15 A)
LED8	Detection of disconnection of the regenerative discharge resistor	The regenerative discharge resistor is disconnected (displayed even during the regenerative discharge operation)
LED9	Detection of the regenerative discharge operation	Under regenerative discharge operation
LED10	Detection of regenerative discharge overtime	Occurrence of regenerative discharge operation for 10 ms or longer

4.3.4.2 Information on major components

The regenerative discharge board uses fuses for protecting components against overcurrent and a regenerative discharge resistor. The fuses are mounted at the upstream of the board and at the upstream of the regenerative discharge resistor, while the resistor is mounted at the downstream of the board. For the inside composition and component specifications, see the following figure and table.

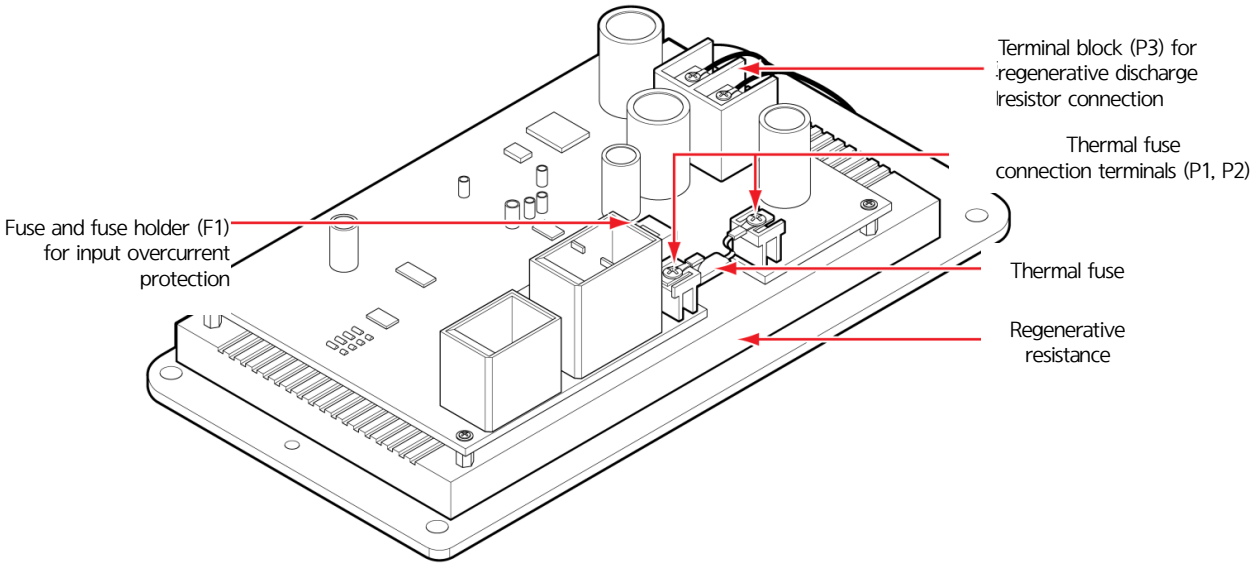


Figure 39 Inside view of the RDM

Component	Usage	Specification
Thermal fuse	Protection from the overcurrent of regenerative operation and overheating of the regenerative discharge resistor	15 A, 93° C
Fuse for protecting from overcurrent of the input terminal	Protection from the overcurrent of input power	58 V, 20 A
Regenerative discharge resistor	Resistor for discharging regenerative current	5 Ω, 100 W

4.3.5 Microcomputer module

The microcomputer module (miniH6COM, EBC-GF53) drives and controls the collaborative robot based on the Hi6 control platform. For more details on this module, see "**Operation Manual for Hi6 Controllers**."

The composition of the external interface, COM ports, and power connector of the microcomputer module is as follows:

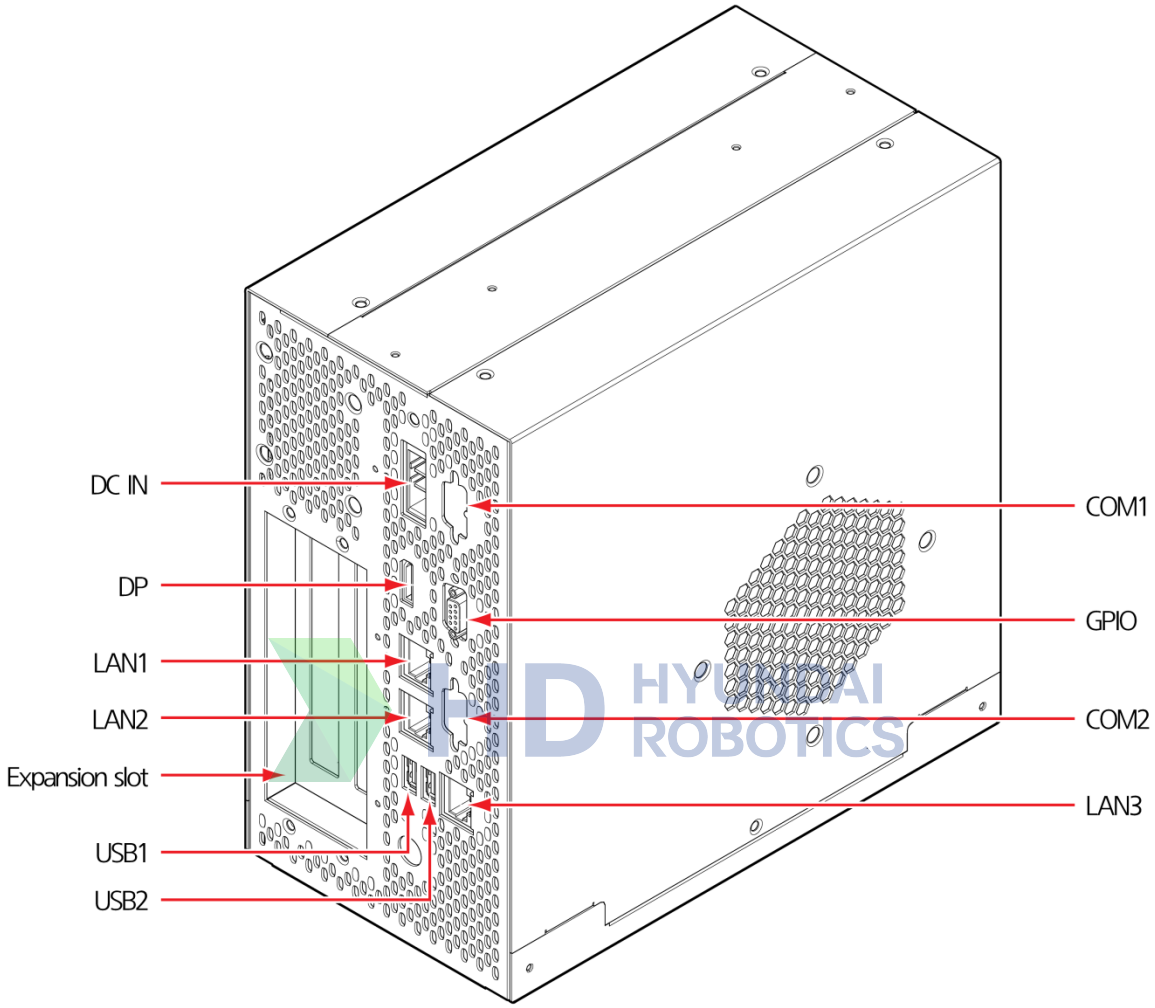


Figure 40 External interface of the microcomputer module

Port	Usage	Specification	Count
DP	Display	Display port	1
LAN1, LAN2, LAN3	Wired LAN	Giga LAN	3
USB1, USB2	USB	USB2.0	2
COM1, COM2	Serial communication	RS-232/422/485	2
GPIO	Digital I/O	8-bit, Dsub-9	1
DC IN	Power input	12-24 V DC, 10A	1
-	Extension slot	PCIe x1, PCI	2

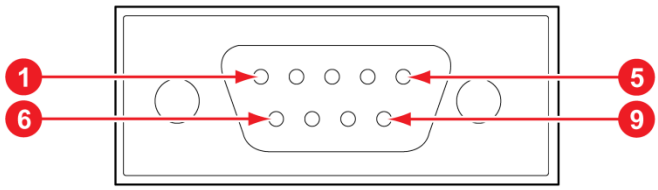


Figure 41 COM port (male) pin map

No.	Name	No.	Name
1	COMn_422_485_TX-	6	COMn_DSR#
2	COMn_422_485_TX+	7	COMn_RTS#
3	COMn_422_RX+	8	COMn_CTS#
4	COMn_422_RX-	9	COMn_RI_V#
5	GND		

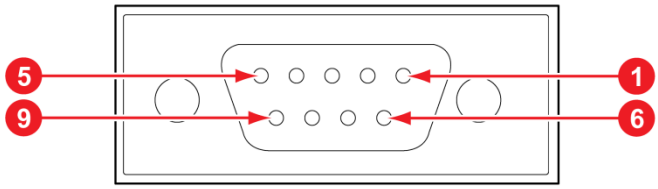


Figure 42 COM port (female) pin map

No.	Name	No.	Name
1	GPIO_GPIO0	6	GPIO_GPIO4
2	GPIO_GPIO1	7	GPIO_GPIO5
3	GPIO_GPIO2	8	GPIO_GPIO6
4	GPIO_GPIO3	9	GPIO_GPIO7
5	GND		

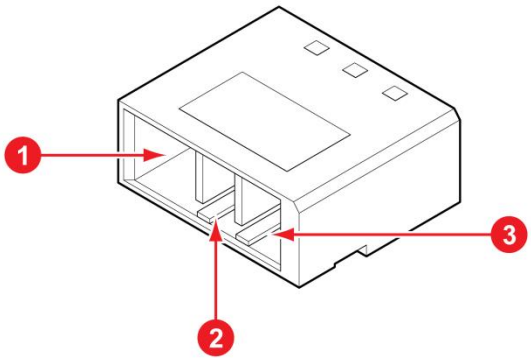


Figure 43 DCIN (power connector) pin map

No.	Name	No.	Name
1	DC24V	3	GND

No.	Name	No.	Name
②	FG		

4.3.6 Power supply

For the stable driving of the collaborative robot, SMPSs and buffer modules of the outputs of 48 V DC and 24 V DC are used.

Component	Usage	Specification
SMPS1	Power supply for motor driving	• 2,000 W, 48 V DC • RSP-2000-48, 295 (L) × 127 (W) × 41 (H) mm, 1.95 kg
SMPS2	Power supply for controlling	• 320 W, 24 V • RSP-320-24, 215 (L) × 115 (W) × 30 (H) mm, 0.9 kg
BUFFER	Power buffer for controlling	• 24 V DC, 40 A • QUINT4-BUFFER/24DC/40, 125 (L) × 130 (W) × 56 (H) mm, 1 kg

4.3.7 Teach pendant

The teach pendant (TP600) directly manipulates the collaborative robot and checks its state of operation and setting.

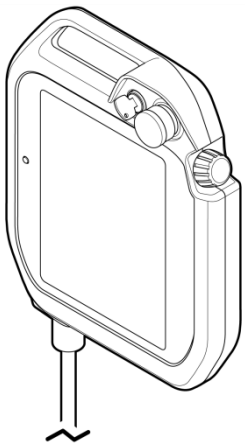


Figure 44 Teach pendant

The teach pendant is connected with the microcomputer module (miniH6COM, EBC-GF53) through Ethernet communication and has major functions as follows:

- Monitoring: operating program, data of the axes, I/O signals, robot state, etc.
- History management: system version, operating time, error history, stoppage history, etc.
- File management: upload/download of versions and teach programs
- Parameter setting: user environment, control, robot, application, automatic integer setting, etc.
- Robot teaching: registration of jog and teaching programs
- Robot operation: motor on, start, stop, and mode setting

The teach pendant has a three-step enabling switch, an emergency stop switch, etc. for user safety. At its lower part, it has a USB connection port (Type A) for storing or downloading files to USB memory sticks, etc. For more details on how to use the teach pendant, see the "**Operation Manual for Hi6 Controllers**" and the "**Safety Function Manual for Collaborative Robots**."

4.3.8 PCI communication card (optional)

The peripheral component interconnect (PCI) communication installed in the collaborative robot controller enables industrial communication. This section describes the models, composition, and functions of a PCI communication card for Ethernet, which is a general model. For more details, see Hilscher's "**PC Cards CIFX 50 Model**" (PC Cards CIFX 50 50E 70E 100EH UM 51 EN).

The names and functions of the PCI communication card models are as follows:

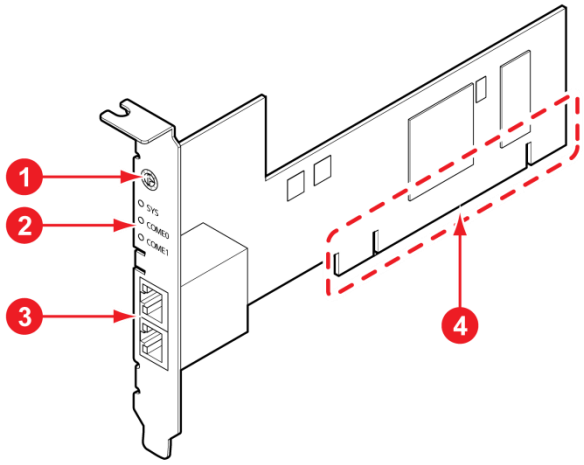


Figure 45 Outside view (left) and front view (right) of PCI communication card

No.	Name	Description
1	Rotary switch	This sets communication channels according to slot numbers. According to the position of the MiniH6COM PCI slot, set the rotary switch at 1 to 2 from the top.

2	LED lamp	• SYS: This displays the system state.
		  • Green: The system is in normal operation.
		  • Yellow: The system is waiting for the boot loader.
		• COM0, COM1: These display the communication states.
		  • Green: The communication is in normal operation.
		  • Red: A communication error has occurred.

3	Communication connection terminal	This enables communication with external devices through a communication cable.
4	PCI bus	This, which is a bus for PC communication, enables communication with external PCs.

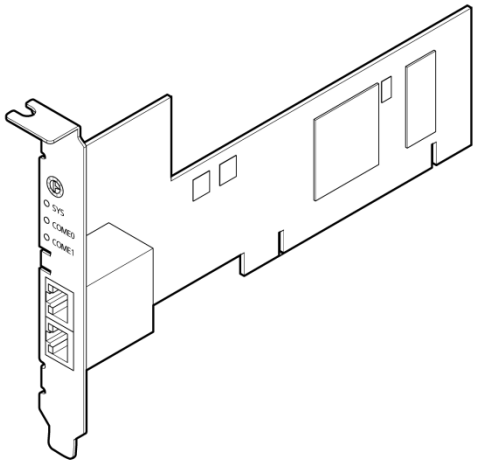


Figure 46 PCI communication card models

Model name	Description	Connector
CIFX 50-RE/ML-HRC	HRC real-time Ethernet master PCI	RJ45 socket

Model name	Description	Connector
CIFX 50-RE-HRC	HRC real-time Ethernet slave PCI	RJ45 socket
CIFX 50E-RE/ML-HRC	HRC real-time Ethernet master PCIe	RJ45 socket
CIFX 50E-RE-HRC	HRC real-time Ethernet slave PCIe	RJ45 socket
CIFX 50-CC-HRC	CC-link slave PCI	CombiCon male connector, 5-pin
CIFX 50E-CC-HRC	CC-link slave PCIe	CombiCon male connector, 5-pin
CIFX 50-DN/ML-HRC	DeviceNet master PCI	CombiCon male connector, 5-pin
CIFX 50-DN-HRC	DeviceNet slave PCI	CombiCon male connector, 5-pin
CIFX 50E-DN/ML-HRC	DeviceNet master PCIe	CombiCon male connector, 5-pin
CIFX 50E-DN-HRC	DeviceNet slave PCIe	CombiCon male connector, 5-pin
CIFX 50-DP/ML-HRC	PROFIBUS master PCI	Dsub female connector, 9-pin
CIFX 50-DP-HRC	PROFIBUS slave PCI	Dsub female connector, 9-pin
CIFX 50E-DP/ML-HRC	PROFIBUS master PCIe	Dsub female connector, 9-pin
CIFX 50E-DP-HRC	PROFIBUS slave PCIe	Dsub female connector, 9-pin
CIFX 50E-CCIES-HRC	CC-Link IE field PCIe	RJ45 socket

4.3.8.1 Connect pin map

The pin composition of communication connectors varies depending on PCI communication cards.

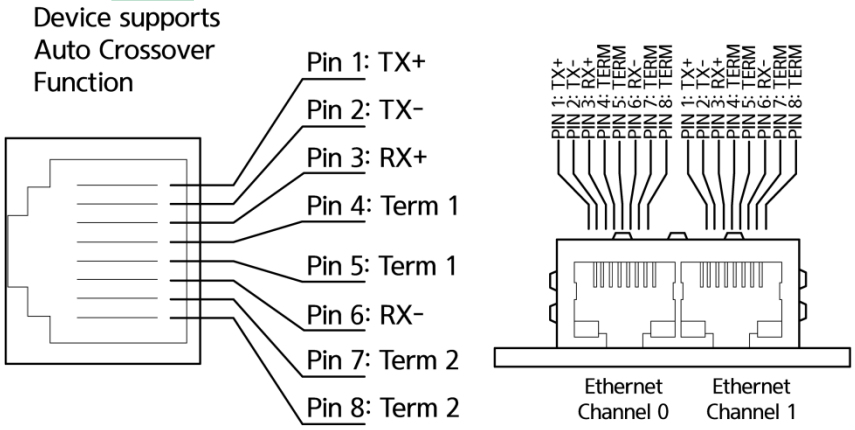


Figure 47 Ethernet pin assignments of RJ45 sockets

No.	Signal	Description
1	TX+	Transmit data +
2	TX-	Transmit data -
3	RX+	Receive data +
4	Term1	Connected to each other and terminated to PE through RC circuit (Bob Smith Termination)
5	Term1	

No.	Signal	Description
6	RX-	Receive data -
7	Term2	Connected to each other and terminated to PE through RC circuit (Bob Smith Termination)
8	Term2	

Isolated RS-485 Interface:

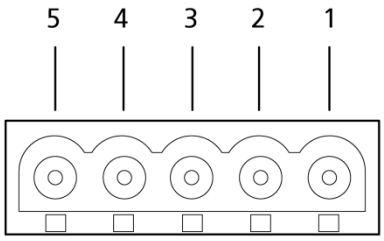


Figure 48 CC-link interface (CombiCon male connector, 5-pin)

No.	Signal	Description
1	DA	Data A
2	DB	Data B
3	DG	Data ground
4	SLD	Shield
5	FG	Field ground

Isolated ISO 11898 Interface:

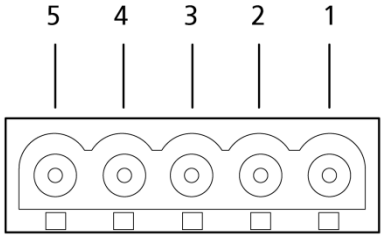


Figure 49 DeviceNet interface (CombiCon male connector, 5-pin)

No.	Signal	Description
1	V-	Reference potential DeviceNet supply voltage
2	CAN_L	CAN Low-Signal
3	Drain	Shield
4	CAN_H	CAN high-signal
5	V+	+24 V DeviceNet supply voltage

Isolated RS-485 Interface:

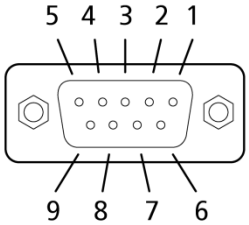


Figure 50 PROFIBUS interface (Dsub female connector, 9-pin

No.	Signal	Description
3	RxD/TxD-P	Receive/Send Data-P respectively, connection B plug
5	DGND	Reference potential
6	VP	Positive supply voltage
8	RxD/TxD-N	Receive/Send Data- N respectively, connection A plug

5. Moving and storing

This section describes the proper methods for moving and storing a collaborative robot.

5.1 Moving method

Check the weight and precautions for the collaborative robot. Move it using the proper method as follows, while paying attention to safety.

To move the collaborative robot manually, set it at the posture adequate for moving. Two or more workers lift it at the same time and move it to the target location.

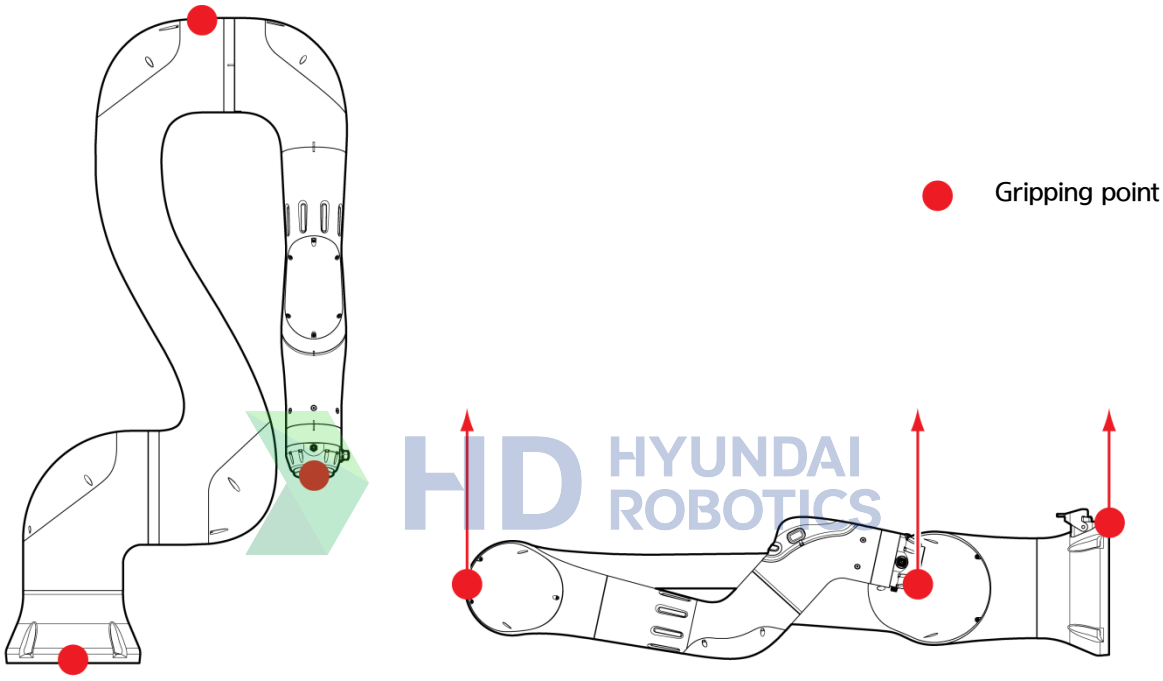


Figure 51 Manual moving

⚠ Caution	• To move the collaborative robot manually, two or more workers should lift it at the same time and move it. • When two or more workers move it at the same time, connections may be damaged. Therefore, take care not to damage them. • Take care when putting down the collaborative robot on the floor, as the frame cover may be damaged.

To move the collaborative robot using a crane, set the robot at the posture adequate for lifting, connect it to the crane with sling belts, lift it, and move it to the target location.

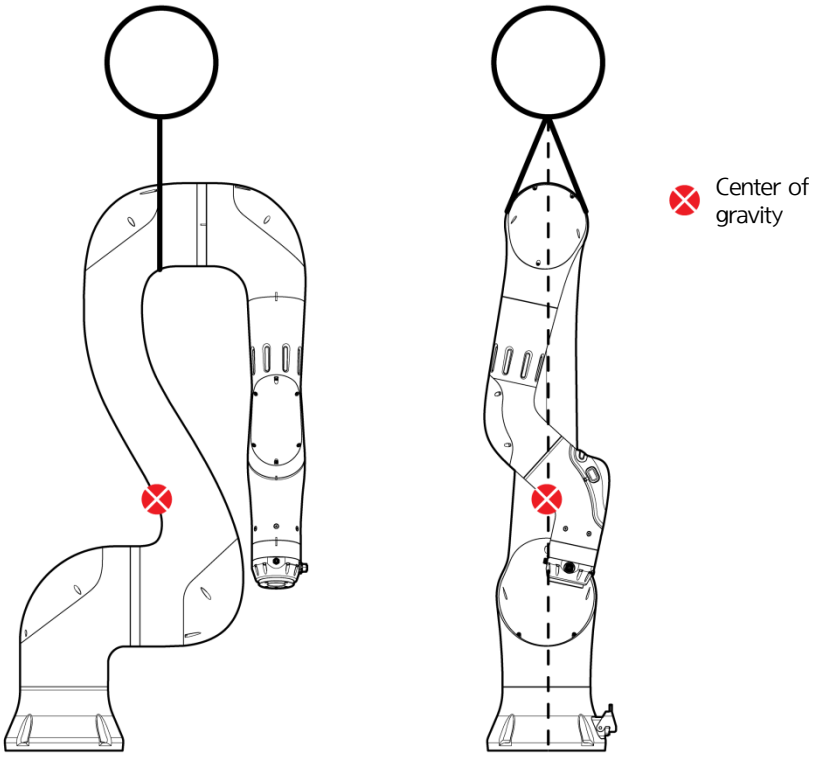


Figure 52 Moving with a crane YL012

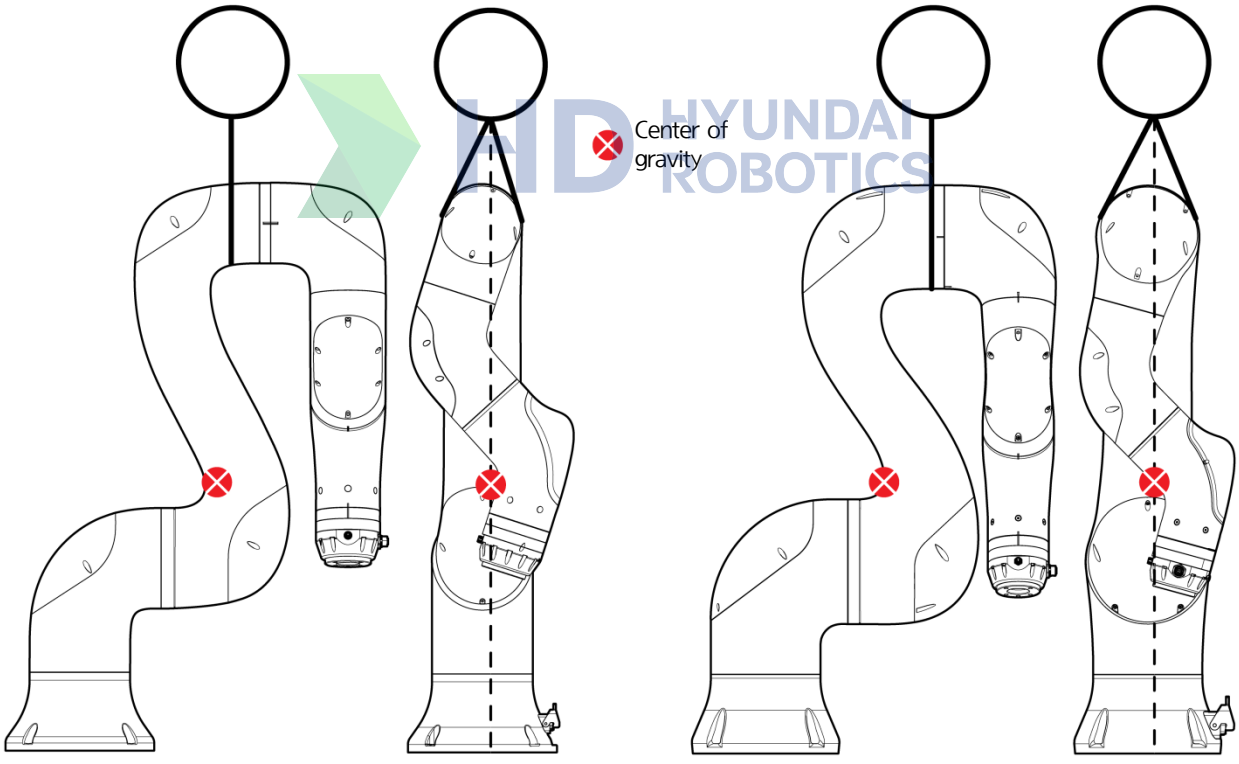


Figure 53 Moving with a crane YL005 (left) / YL015 (DN)

- The adequate robot posture for lifting is the same as that for the manual moving.

  It is recommended to set the posture of the collaborative robot as it was released from the factory, referring to "**5.1.1 Recommended posture**."

- The minimum capacity of the crane should be 0.2 t, while the weights of the collaborative robot models are as follows:

YL005: 27 kg, YL012: 43 kg, YL015: 41 kg

⚠ Warning	• In moving the product using a crane, conform to the local and national safety regulations and the instructions for equipment use. • In moving the product using a crane, ensure that no workers stand under the product. Never work or pass under the crane or the product.

⚠ Caution	If an auxiliary device is attached to the collaborative robot, lifting will become harder because the center of gravity of the robot will move to another point.

5.1.1 Recommended posture

The following was the posture of the collaborative robot when it was released from the factory. Setting the robot at this posture will facilitate moving it.

Model	Weight	S	H	V	R2	B	R1
YL005	27 kg	0	90	-70	0	0	0
YL012	43 kg	0	90	-78	0	0	0
YL015	41 kg	0	90	-73	0	0	0

5.1.2 Packaging box

The specifications of the packaging box for product transportation are as follows:

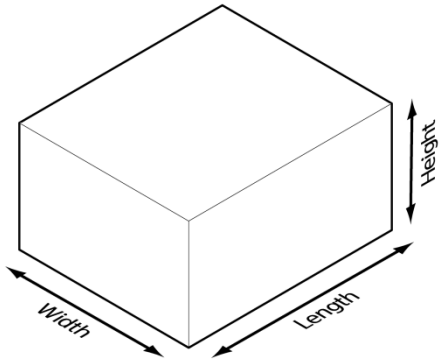


Figure 54 Packaging box for product transportation

Model	Length (L)	Width (W)	Height (H)
YL005			
YL012			
YL015			

5.1.3 Cautions

- Set the robot at an adequate posture for transportation and transport it in its packaging to prevent it from being damaged.
- In moving the collaborative robot manually, maintain the proper posture. If not done, the worker may incur physical injuries.
- To move the collaborative robot manually, two or more workers should lift it at the same time and then move it.
- When two or more workers move it at the same time, connections may be damaged. Therefore, take care not to damage them.
- In moving the collaborative robot using a crane, conform to the local and national safety regulations and the instructions for equipment use.
- After transporting the collaborative robot wrapped with packaging materials, store it at a dry place, or put moisture absorbent in the package. Storing the robot at a high-humidity place may create moisture inside the packaging material, which may cause product anomalies.
- Before moving the product, read and conform to the instructions specified in the maintenance manual. Hyundai Robotics will not take responsibility for product damages caused by the customer's carelessness, unskillful operation, and other errors.

5.2 Storing method

In storing the collaborative robot without installing it, set it at the adequate posture and then store it, referring to the following instructions:

- The adequate robot posture for storing is the same as that for moving it.
- Store the collaborative robot as it is packaged, ensuring its power and communication connections are firmly sealed.
- In storing it for a long time, make sure to take safety measures to prevent it from tumbling.
- In storing the collaborative robot wrapped with packaging materials, store it at a dry place, or put moisture absorbent in the package. Storing the robot at a high-humidity place may create moisture inside the packaging material, which may cause product damages.
- In storing the collaborative robot, avoid a place of high variations in temperature and humidity (where dew condensation occurs), and store it at a dry and cool place of an ambient temperature between -15° C and 40° C.
- Do not store the collaborative robot at a place where chemicals, acid, or alkali products, batteries, circuit breakers, etc. are placed.

⚠ Caution	Storing the collaborative robot by setting it at a posture other than that recommended in the maintenance manual may cause the product to tumble and incur damage.

5.3 Disposal

To secure user safety and protect the environment, specific components should be managed and disposed of by the specified methods. If a component contains hazardous industrial waste, it must not be disposed of with general industrial wastes or domestic wastes.

The materials of the components of the collaborative robot are as follows:

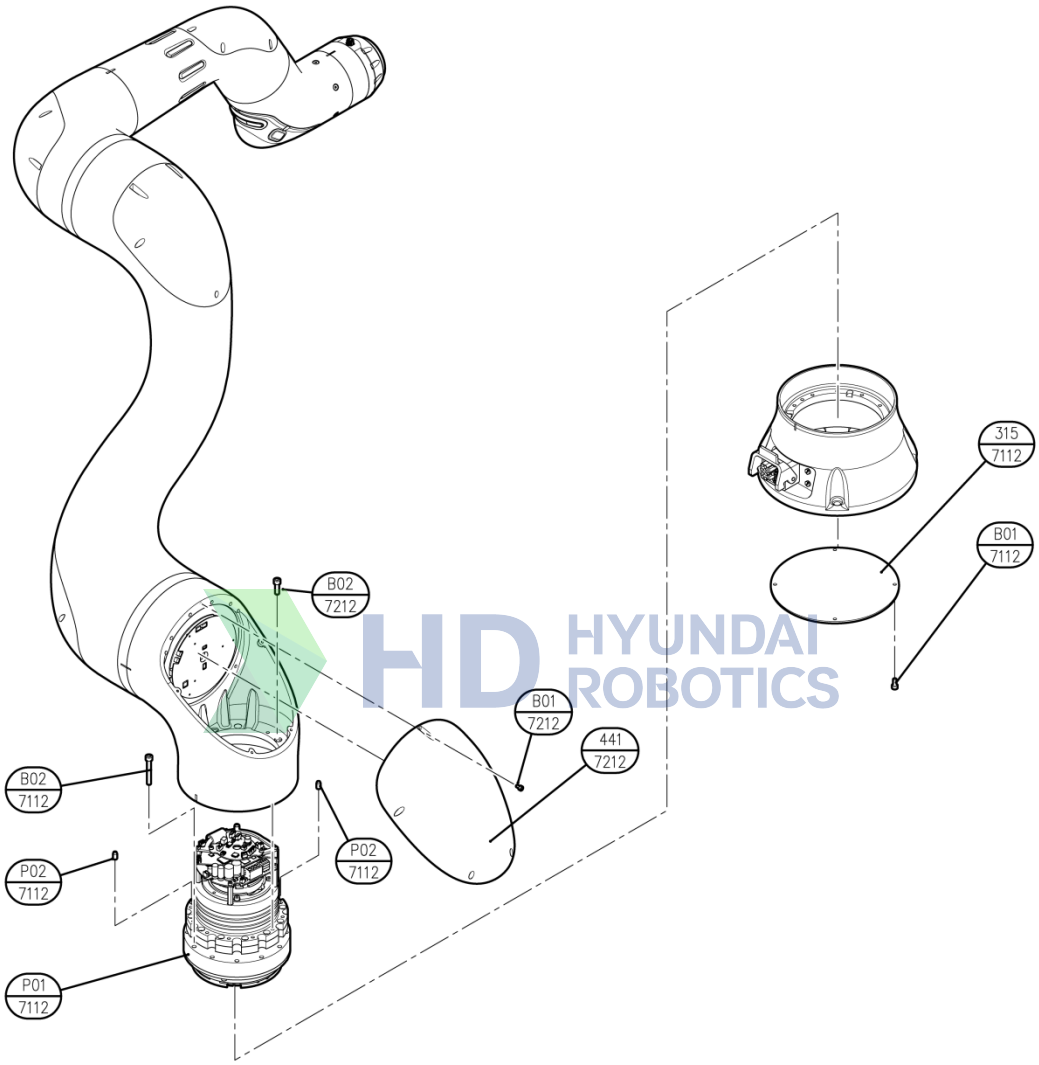
Component	Material
Batteries	Nickel-cadmium or lithium
Wiring devices, motors	Copper
Base body, A2 frame, second arm, wrist body, etc.	Aluminum alloy cast
Brackets, motors	Samarium cobalt (or neodimium)
Wiring devices, connectors	Plastics/rubber
Reducers, bearings	Oil/grease
First arm, wrist cover, etc.	Aluminum alloy cast

In disposing of the robot system in whole or in parts, make sure to comply with the applicable laws and regulations of the pertaining country or locality. For more details on product scrapping and disposal, contact our Customer Support Team.

6. Appendix

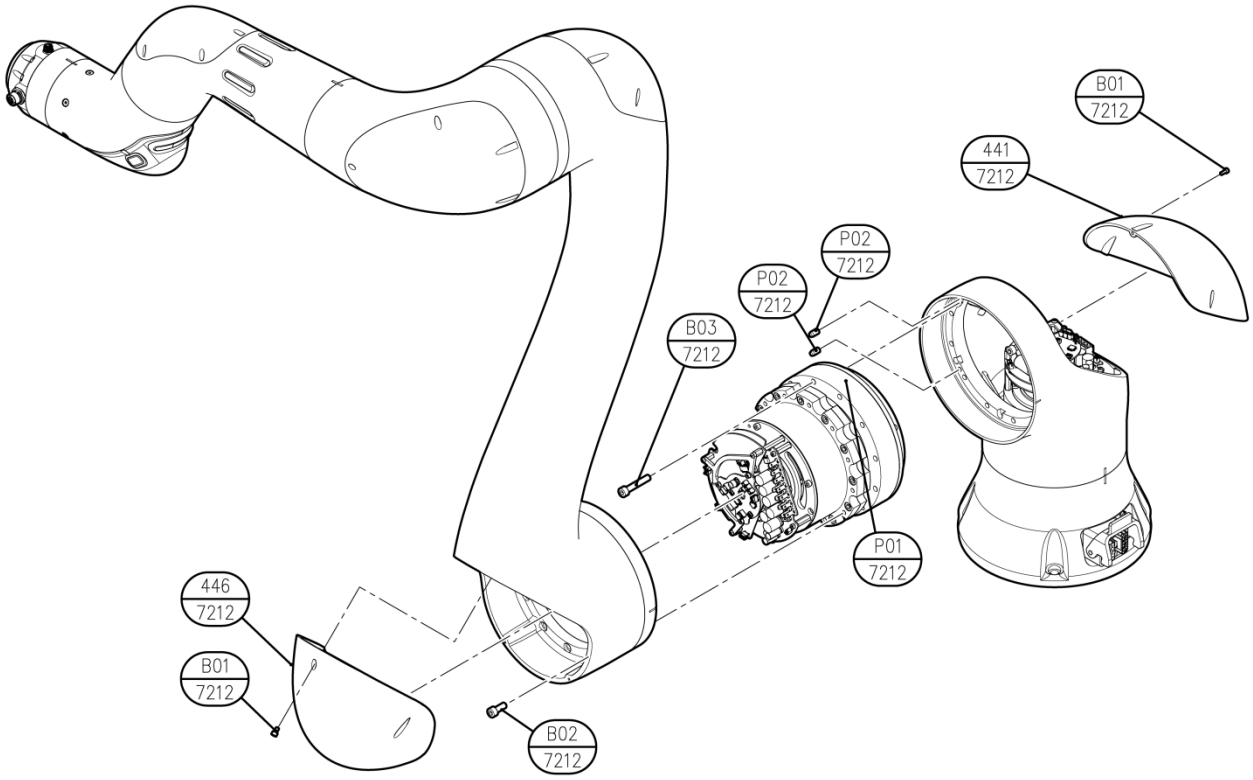
6.1 Block diagrams

6.1.1 YL012 S-axis



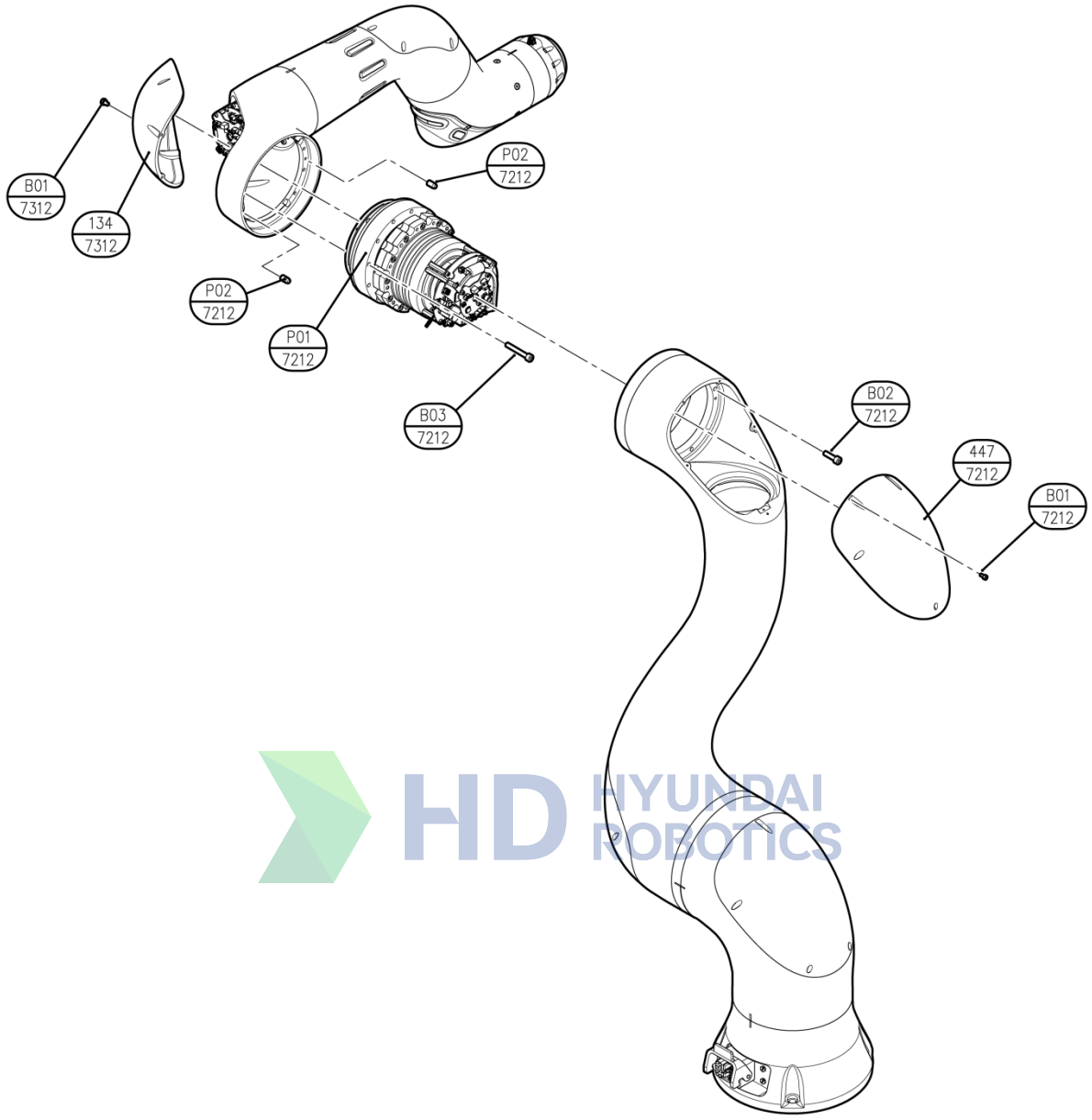
No.	Description	Material (manufacturer)	Quantity
7112-315	BOTTOM COVER	A6061-T6	1
7112-P01	MODULE 32 TS	ABS	1
7112- P02	PARALLEL PIN 5X10		2
7112-B01	HEX SOCEKT BOLT M4X10	12.9	4
7112-B02	HEX SOCEKT BOLT M5X10	12.9	12
7212-441	LOWER FRAME COVER	ABS	1
7212-B01	HEX SOCKET BOLT M3X6	12.9	5
7212-B02	HEX SOCKET BOLT M5X18	12.9	10

6.1.2 YL012 H-axis



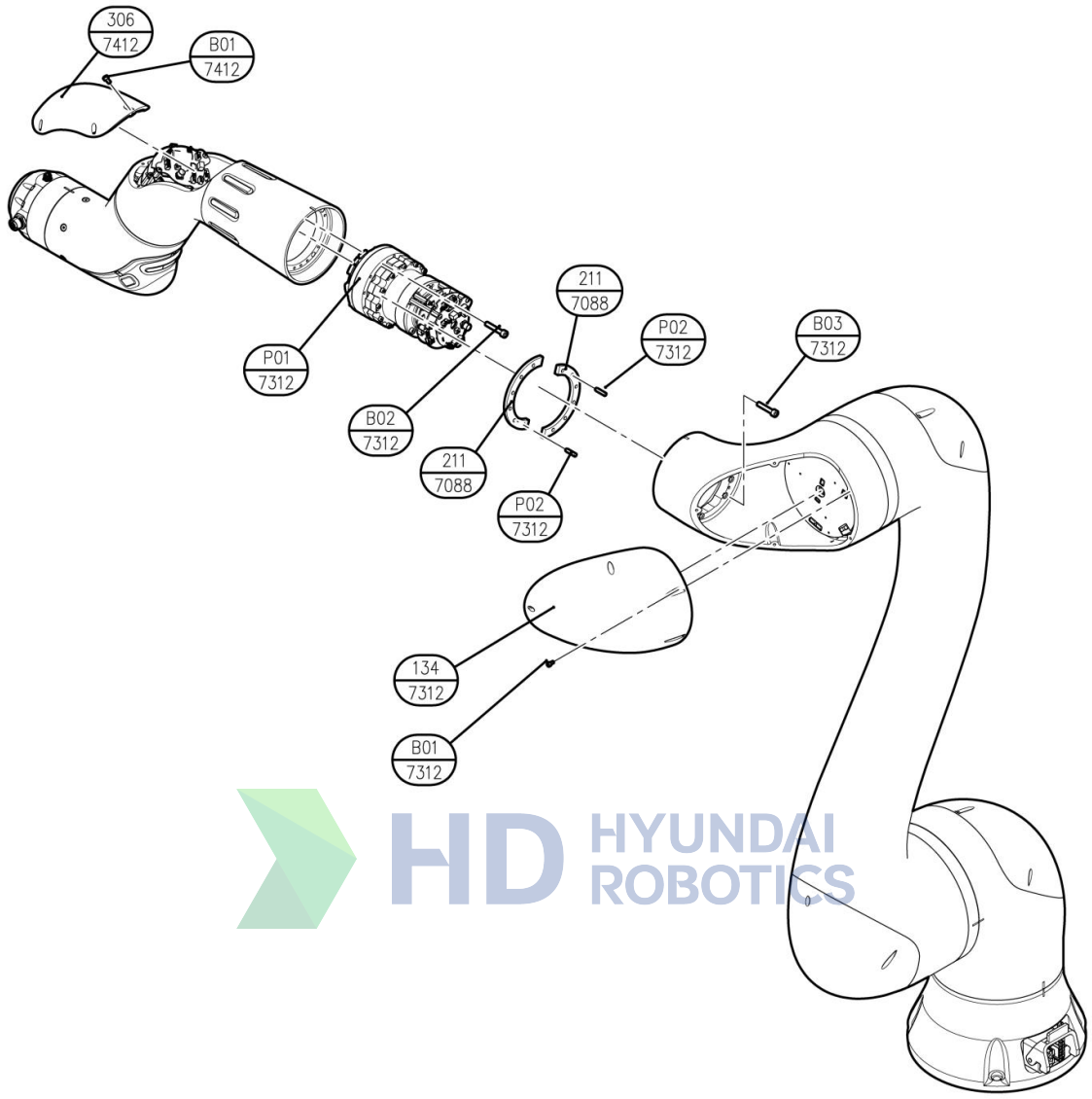
No.	Description	Material (manufacturer)	Quantity
7212-441	LOWER FRAME COVER	ABS	1
7212-446	UPPER FRAME COVER(1)	ABS	1
7212-P01	MODULE 40 TS		1
7212-P02	PARALLEL PIN 5X10		2
7212-B01	HEX SOCEKT BOLT M6X6	12.9	10
7212-B02	HEX SOCEKT BOLT M6X20	12.9	12
7212-B03	HEX SOCEKT BOLT M6X45	12.9	12

6.1.3 YL012 V-axis



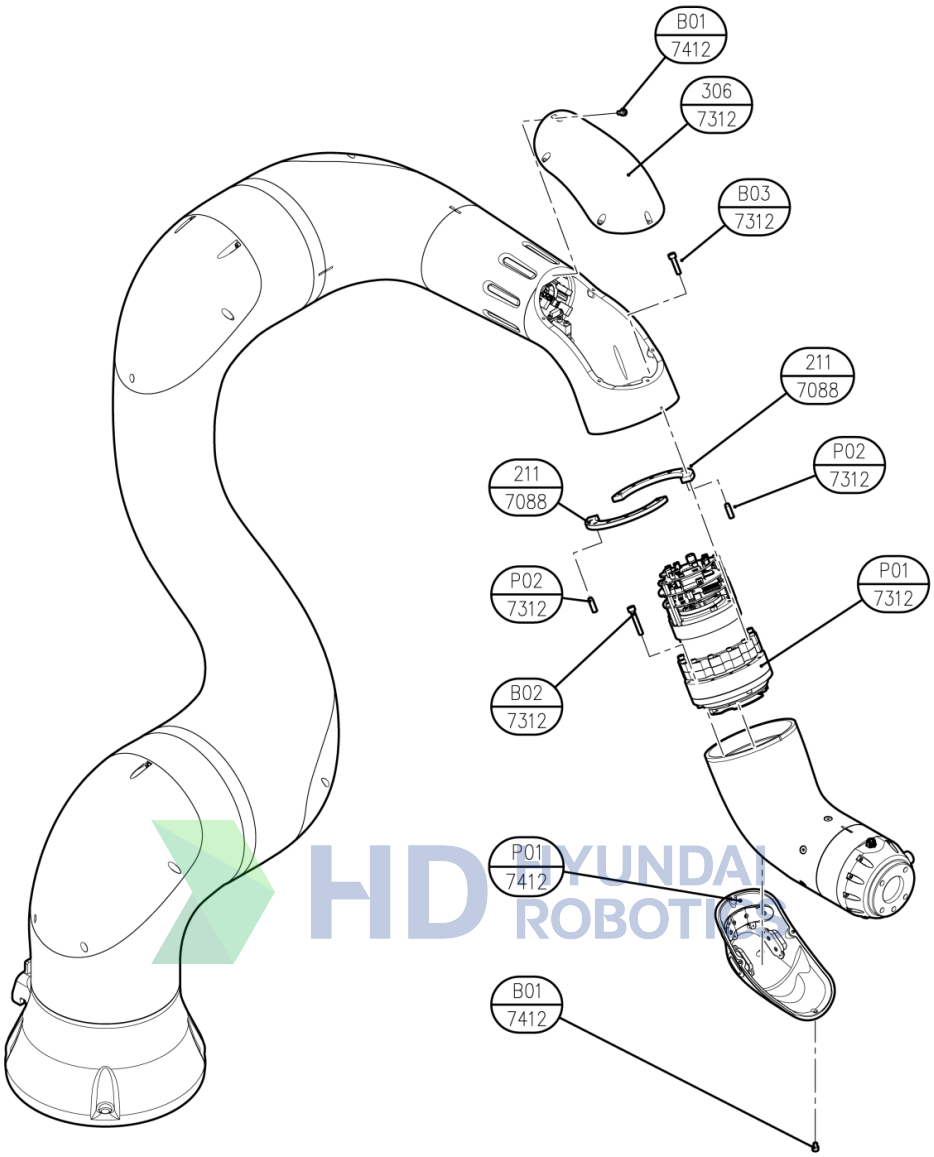
No.	Description	Material (manufacturer)	Quantity
7212-447	UPPER FRAME COVER(2)	ABS	1
7212-P01	MODULE 32 TS		1
7212-P02	PARALLEL PIN 5X10		2
7212-B01	HEX SOCEKT BOLT M3X6	12.9	5
7212-B02	HEX SOCEKT BOLT M5X20	12.9	12
7212-B03	HEX SOCEKT BOLT M5X40	12.9	12
7312-134	ARM FRAME COVER	ABS	1
7312-B01	HEX SOCKET BOLT M3X6	12.9	

6.1.4 YL012 R2-axis



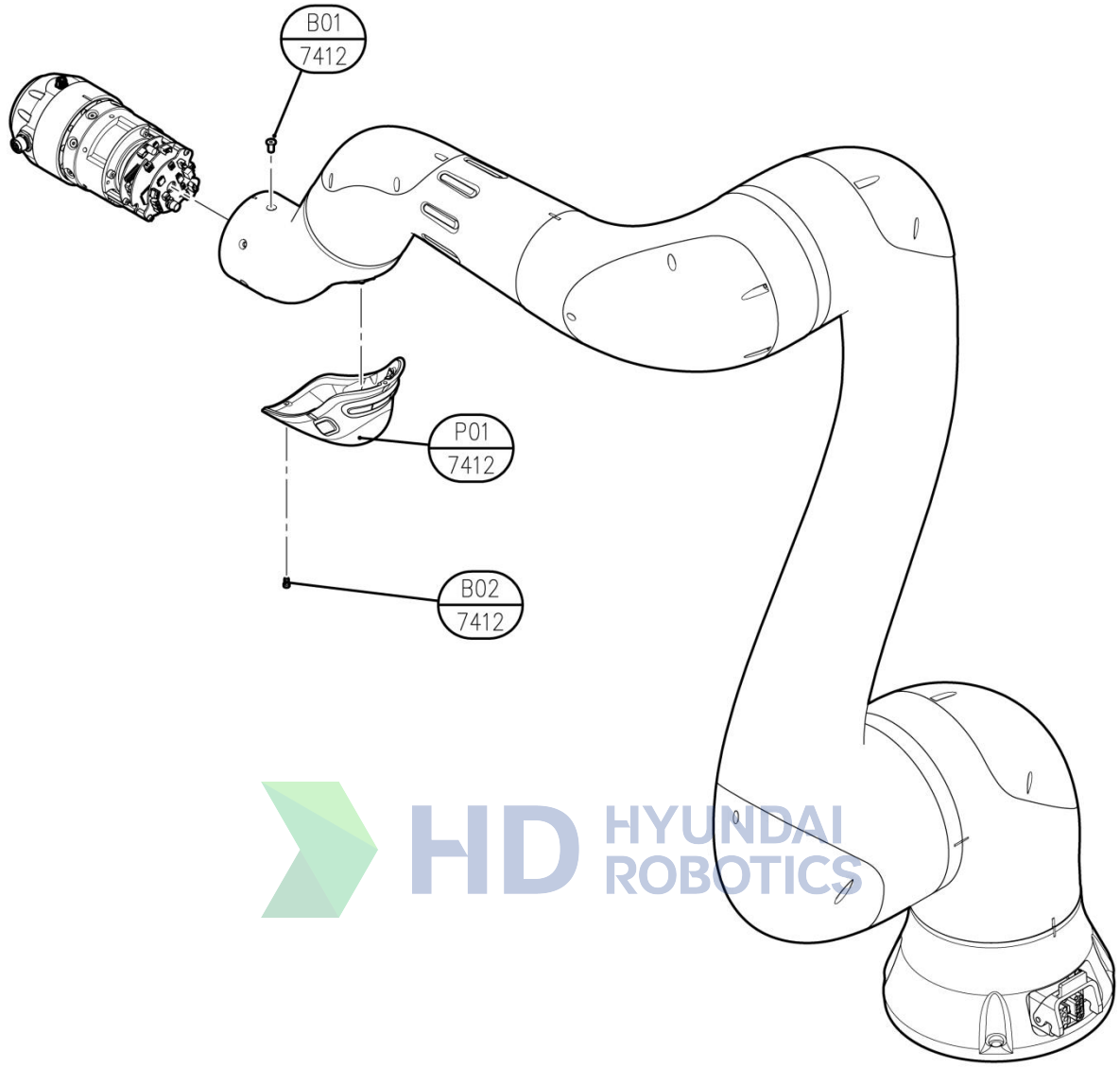
No.	Description	Material (manufacturer)	Quantity
7088-211	WASHER PLATE FOR M20	A6061-T6	2
7312-134	ARM FRAME COVER	ABS	1
7312-P01	MODULE 20 TS		1
7312-P02	PARALLEL PIN M4X15		2
7312-B01	HEX SOCEKT BOLT M3X6	12.9	5
7312-B02	HEX SOCEKT BOLT M3X30	12.9	12
7312-B03	HEX SOCEKT BOLT M4X25	12.9	10
7412-306	ARM PIPE COVER	ABS	1
7412-B01	HEX SOCKET BOLT M3X6	12.9	6

6.1.5 YL012 B-axis



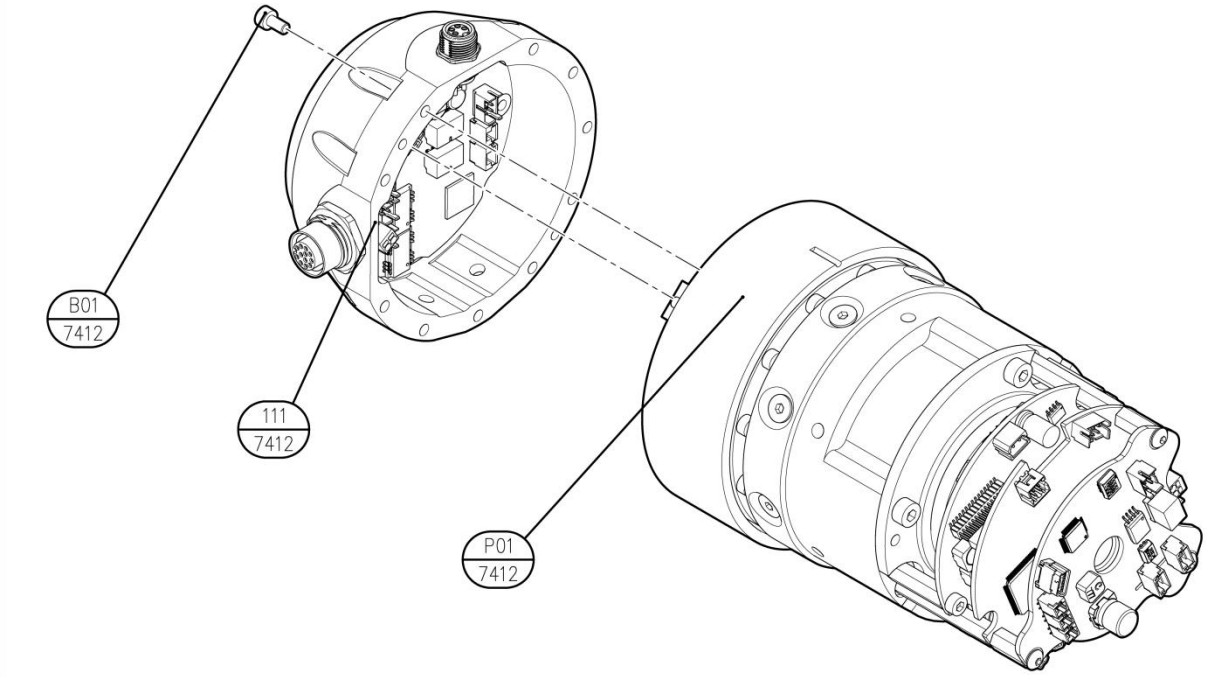
No.	Description	Material (manufacturer)	Quantity
7088-211	WASHER PLATE FOR M20	A6061-T6	2
7312-306	ARM PIPE COVER	ABS	1
7312-P01	MODULE 20 TS		1
7312-P02	PARALLEL PIN M4X15		2
7312-B01	HEX SOCEKT BOLT M3X6	12.9	6
7312-B02	HEX SOCEKT BOLT M3X30	12.9	12
7312-B03	HEX SOCEKT BOLT M4X25	12.9	10
7412-P01	HAND GRIP MODULE		1
7412-B01	M3 SMALL-DIAMETER BOLT		4

6.1.6 YL012 R1-axis



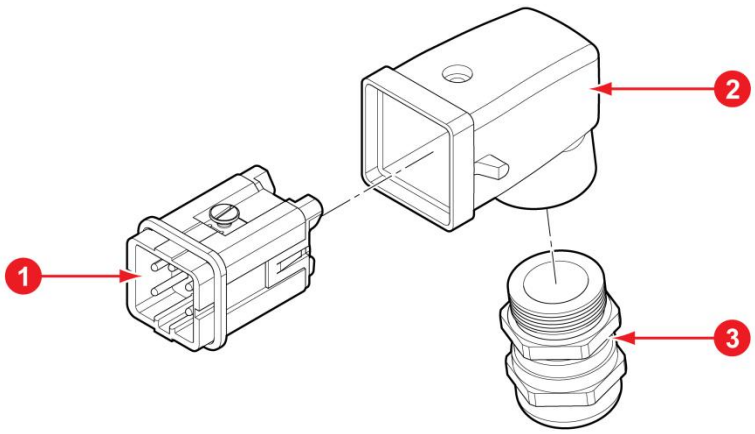
No.	Description	Material (manufacturer)	Quantity
7412-P01	HANDGRIP MODULE		1
7412-B01	HEX SOCEKT FLAT HEAD SCREW M4X10	12.9	6
7412-B02	M3 SMALL-DIAMETER BOLT	12.9	6

6.1.7 YL012 tool flange



No.	Description	Material (manufacturer)	Quantity
7412-111	MECHANICAL INTERFACE	A60610T6	1
7412-P01	MODULE 40 TS		1
7412-B01	HEX SOCEKT FLAT HEAD SCREW M4X10	12.9	6

6.1.8 Power connector



No.	Division	Specification	Order no.	Manufacturer
1	INSERT	HDC HA 4 MS	1498300000	Weidmuller
2	PLUG ENCLOSURE	HDC 04A TWLU 1M20G	1788810000	Weidmuller
3	CABLE ENTRY	VG M20 - MS 68	1772220000	Weidmuller

6.2 System specifications

6.2.1 Collaborative robot

Division				YL005	YL012	YL015
Payload				5 kg	12 kg	15 kg
Structure				Multi-joint type	Multi-joint type	Multi-joint type
Degree of freedom				6-axis	6-axis	6-axis
Driving type				AC servo motor	AC servo motor	AC servo motor
Maximum operating range	Main axis	S	Rotation	±180°	±180°	±180°
		H	Forward/backward	+270° ~ -90°	+270° ~ -90°	+270° ~ -90°
		V	Up/down	±180°	±180°	±180°
	Wrist axis	R2	Rotation 2	±180°	±180°	±180°
		B	Bending	±180°	±180°	±180°
		R1	Rotation 1	±180°	±180°	±180°
Maximum Speed	Main axis	S	Rotation	180° /s	180° /s	180° /s
		H	Forward/backward	180° /s	125° /s	125° /s
		V	Up/down	180° /s	180° /s	180° /s
	Wrist axis	R2	Rotation 2	180° /s	180° /s	180° /s
		B	Bending	180° /s	180° /s	180° /s
		R1	Rotation 1	180° /s	180° /s	180° /s
Position repetition accuracy				±0.1 mm		
Ambient temperature				0 ~ 40° C (273 ~ 313° K)		
Manipulator weight				27 kg	43 kg	41 kg
Operating radius				916 mm	1,305 mm	963 mm
Ingress protection grade				IP54		
Noise				80dB or less		
I/O flange				Digital I/O: 4, Analog Input: 2, Power: 12 V or 24 V (1.5 A)		

Notes	The maximum operating range of the wrist axis can be changed to 360° according to the situation of the application process. Please contact customer support for more information on this.

6.2.2 Controller

Division	Specification
Weight	27 kg
Dimensions	260 (W) × 490 (H) × 510 (D) mm
Ingress protection grade	IP 20
Noise	80dB or less
Digital I/O ports	DIO 8/8 points
Analog I/O ports	AIO 2/2 points
Rated supply voltage	AC 220 V

6.2.3 Teach pendant

Division	Specification
Weight	1186 g
Dimensions	223 (W) × 291 (H) × 73 (D) mm (with mode switch)
Ingress protection grade	IP 54
Screen size	8”
Cable length	5 m

Certifications

Hyundai Robotics acquired certificates of the robot from the following official testing and certification bodies for supplying stable robot systems:

■ CE certificate (1/2)

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

Product Service

Attestation

No. M7 071622 0089 Rev. 01

Holder of Certificate: **Hyundai Robotics Co., Ltd.**
50, Techno sunhwan-ro 3-gil, Yuga-eup, Dalseong-gun
Daegu 43022
REPUBLIC OF KOREA

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

This Attestation is issued on a voluntary basis according to Council Directive 2006/42/EC relating to machinery. It confirms that the listed equipment (partly completed machine) complies with the requirements set in article 13 of the directive. It refers only to the sample submitted to TÜV SÜD Product Service GmbH for testing and certification. For details see: www.tuvsud.com/ps-cert

Test report no.: MAEB01366020

Date, 2020-12-01

(Ro-Hyun Park)

Page 1 of 2
Partly completed machines are designated to be assembled in a machine, which complies with the requirements set in the Machinery Directive 2006/42/EC and for which a Declaration of Conformity according to Annex II A of the Machinery Directive 2006/42/EC needs to be drawn up.

TÜV®

TÜV SÜD Product Service GmbH • Certification Body • Ridlerstraße 65 • 80339 Munich • Germany

CE certificate (2/2)

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

TÜV SÜD Product Service

Attestation

No. M7 071622 0089 Rev. 01

Model(s): **Manipulator: YL005, YL012, YL015**

Controller:Hi6-H10

Parameters:

Manipulator	YL005	YL012	YL015
Payload :	5 kg	12 kg	15 kg
Degrees of freedom :	6 Axis	6 Axis	6 Axis
Operating radius :	916 mm	1,305 mm	963 mm
Weight :	27 kg	43 kg	41 kg

Controller	Hi6-H10	
Rated Voltage :	220VAC,	Single Phase
Rated Current :	10 A	
Rated Frequency :	50/60 Hz	
Protection Class :	I	
Weight :	27 kg	
Safety Level:	PLd, CAT3, SIL2	

This equipment has been evaluated according to ISO TS 15066.
This Technical Specification specifies safety requirements for collaborative industrial robot systems and the work environment, and supplements the requirements and guidance on collaborative industrial robot operation given in ISO 10218-1 and ISO 10218-2.

Tested according to:

EN ISO 10218-1:2011
EN ISO 12100:2010
EN 60204-1:2006/A1:2009
EN ISO 13849-1:2015

Page 2 of 2
Partly completed machines are designated to be assembled in a machine, which complies with the requirements set in the Machinery Directive 2006/42/EC and for which a Declaration of Conformity according to Annex II A of the Machinery Directive 2006/42/EC needs to be drawn up.

TÜV®

TÜV SÜD Product Service GmbH • Certification Body • Ridlerstraße 65 • 80339 Munich • Germany

NRTL certificate (1/2)

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

America

CERTIFICATE

No. U8V 071622 0088 Rev. 00

Holder of Certificate: **Hyundai Robotics Co., Ltd.**
50, Techno sunhwan-ro 3-gil, Yuga-eup, Dalseong-gun
Daegu 43022
REPUBLIC OF KOREA

Certification Mark:

C US

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

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

Test report no.: MAEA07221220

Date, 2020-11-24

(Ro-Hyun Park)

Page 1 of 2
TÜV SÜD America Inc. • 10 Centennial Drive • Peabody • MA 01960 • USA

TÜV®

NRTL certificate (2/2)

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

America

CERTIFICATE

No. U8V 071622 0088 Rev. 00

Model(s): **Manipulator: YL005, YL012, YL015**

Controller: Hi6-H10

Tested according to: UL 1740:2007/R:2018-01
CAN/CSA-Z434-14/R:2017-02
ANSI/NFPA 79:2018

Production Facility(ies): 071622

Parameters:

Manipulator	YL005	YL012	YL015
Payload :	5 kg	12 kg	15 kg
Degrees of freedom:	6 Axis	6 Axis	6 Axis
Operating radius :	916 mm	1,305 mm	963 mm
Weight :	27 kg	43 kg	41 kg
Controller	Hi6-H10		
Rated Voltage :	220VAC ,	Single Phase	
Rated Current :	10 A		
Rated Frequency :	50/60 Hz		
Protection Class :	I		
Weight :	27 kg		

Page 2 of 2
TÜV SÜD America Inc. • 10 Centennial Drive • Peabody • MA 01960 • USA

TÜV®

■ Autonomous safety verification reporting certificate (KCs) (YL005)

자율안전확인 신고증명서

신청인	사업장명	현대로보틱스주식회사	사업장관리번호	261-86-018210
	사업자등록번호	261-86-01821	대표자 성명	서유성
	소재지	(43022) 대구광역시 달성군 유가읍 테크노순환로3길 50현대로보틱스(주)		

자율안전인증대상 기계·기구명	산업용로봇		
형식(규격)	YL005	용량(등급)	6 axis
자율안전확인번호	20-AM1EQ-00548		
제조자	현대로보틱스주식회사		
소재지	(43022) 대구광역시 달성군 유가읍 테크노순환로3길 50현대로보틱스(주)		

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

2020년 09월 25일

한국산업안전보건공단 대구광역본부장

■ Autonomous safety verification reporting certificate (KCs) (YL012)

KCs

자율안전확인 신고증명서

신청인	사업장명	현대로보틱스주식회사	사업장관리번호	261-86-018210
	사업자등록번호	261-86-01821	대표자 성명	서유성
	소재지	(43022) 대구광역시 달성군 유가읍 테크노순환로3길 50현대로보틱스(주)		
자율안전인증대상 기계·기구명		산업용로봇		
형식(규격)		YL012	용량(등급)	6 axis
자율안전확인번호		20-AM1EQ-00546		
제조자		현대로보틱스주식회사		
소재지		(43022) 대구광역시 달성군 유가읍 테크노순환로3길 50현대로보틱스(주)		

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

2020년 09월 25일

한국산업안전보건공단 대구광역본부장

■ Autonomous safety verification reporting certificate (KCs) (YL015)

자율안전확인 신고증명서

신청인	사업장명	현대로보틱스주식회사	사업장관리번호	261-86-018210
	사업자등록번호	261-86-01821	대표자 성명	서유성
	소재지	(43022) 대구광역시 달성군 유가읍 테크노순환로3길 50현대로보틱스(주)		
자율안전인증대상 기계·기구명		산업용로봇		
형식(규격)		YL015	용량(등급)	6 axis
자율안전확인번호		20-AM1EQ-00547		
제조자		현대로보틱스주식회사		
소재지		(43022) 대구광역시 달성군 유가읍 테크노순환로3길 50현대로보틱스(주)		

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

2020년 09월 25일

한국산업안전보건공단 대구광역본부장

Functional Safety certificate

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

Product Service

CERTIFICATE

No. Z10 071622 0110 Rev. 00

Holder of Certificate: **Hyundai Robotics Co., Ltd.**
50, Techno sunhwan-ro 3-gil, Yuga-eup, Dalseong-gun
Daegu 43022
REPUBLIC OF KOREA

Certification Mark:

Product: **Robot Safety Unit**

Model(s): **Safety Control Module BD6F1**

Parameters: Suitable for: ISO TS 15066:2016, ISO 10218-1:2011
Safety functions (SIL 2, PL d, CAT 3):
Safe Stop 1, Safe Stop 2, Emergency Stop, Safe Brake Control (SBC), Safety Output, Safety Input, Safe Operating Stop (SOS), Joint Angle Monitoring (Joint-SLP), Joint Angular Speed Monitoring (Joint-SLS), Joint Torque Monitoring (Joint- SLT), Collision Detection, Position Monitoring (TCP-SLP), TCP Orientation Monitoring, Speed Monitoring (TCP-SLS), TCP Force Monitoring, Momentum Monitoring. Power Monitoring, Protective Stop

Tested according to:
IEC 61508-1:2010
IEC 61508-2:2010
IEC 61508-3:2010
IEC 61508-4:2010
IEC 61800-5-1:2007
IEC 62061:2005/AMD2:2015
ISO 13849-1:2015
IEC 61000-6-7:2014
IEC 61800-5-2:2016

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

Test report no.: HD96641T
Valid until: 2026-03-30
Date, 2021-04-01

(Guido Neumann)

TÜV®

Page 1 of 1
TÜV SÜD Product Service GmbH • Certification Body • Ridlerstraße 65 • 80339 Munich • Germany

Attachment

The Rules on the Criteria for Occupational Safety and Health, and the Public Notice of Safety Inspections

The applicable industrial robots shall be installed in consideration of the inspection criteria specified in the Rules on the Criteria for Occupational Safety and Health, and the Public Notice of Safety Inspections (if the robots are subject to inspection).

■ The Rules on the Criteria for Occupational Safety and Health

Article 222 (Teaching, etc.) When the project owner carries out teaching (setting, modifying, or result verification of the operating sequence, positions, and speed of the manipulator) for the applicable robot within its operating range, he/she shall take the following actions for preventing hazards due to any unexpected operation or mal-operation of the robot: However, the actions provided in Paragraphs 2 and 3 may be omitted if the work is carried out while the driving source of the robot is disconnected. 〈amended on April 7, 2016〉

1. Specify instructions on the details of the following items, and ensure that the work is carried out according to the instructions.

   a. operating methods and sequence of the robot

   b. the speed of the manipulator during the work

   c. the signaling methods in case two or more workers carry out the work

   d. the actions to be taken in case anomalies are found

   e. the actions to be taken after the robot operation is stopped and resumed after anomalies are found

   f. other actions to be taken for preventing hazards due to unexpected operation or mal-operation of the robot

2. The workers and their supervisors shall take actions to stop the robot operation immediately upon finding any anomalies.

3. During the work, take necessary actions for ensuring that any persons other than the authorizes workers cannot activate the activation switch and the like of the robot by posting signs on the activation switch and the like of the robot indicating that work is in process.

Article 223 (Hazard prevention in operation) The project owner shall, in order to prevent hazards of injuries that might occur to the workers due to the robot operation (excluding the robot operation for the teaching specified in Article 222 and the robot operation under the proviso to Article 224), install a fence of no lower than 1.8 m (the height may be adjusted in case where no hazards are posed by the height in consideration of the operating range of the robot), and install sensing-type protective devices such as safety mats or optical-electronic protective devices in partial zones where fences cannot be installed due to presence of conveyor systems and the like. However, the actions provided herein may be omitted when it is deemed by the Minister of Employment and Labor that the robot's safety conditions meet the criteria specified in the Korean Standard under Article 12 of the Industrial Standardization Act or those commonly applicable internationally.

Article 224 (Actions to be taken during work such as repairs) The project owner shall, in repairing, inspecting, adjusting (excluding those fall under the scope of teaching and the like), cleaning, lubricating, or verifying such results) within the robot's operating range, stop the robot operation, lock the activation switch of the robot by a key during the

work, manage the key separately, or take necessary actions for ensuring that any persons other than the authorizes workers cannot manipulate the activation switch by posting signs on the activation switch of the robot indicating that work is in process. However, this shall not apply to cases where it is inevitable to carry out the work while the robot is in operation and where the actions specified in Article 222 have been taken for preventing hazards due to unexpected operation or mal-operation of the robot

【Annex Table 14】 Criteria for Inspection of Industrial Robots (relating to Article 30)	
Automatic operation mode	a. In the automatic operation mode, the safety devices such as the protective fences shall maintain normal functionality, and the protective stop function shall run if any persons enter the protected space. b. The protective stop or emergency stop functions shall not be reset or invalidated upon the selection of the automatic operation mode. c. The automatic operation mode shall be cleared when any stop signals are given. d. When the automatic mode is selected, the automatic mode shall be activated only by a separate activation action from outside the protected space. e. The switching from the automatic operation mode to another operation mode shall be possible only when the driving part is stopped.
Pendant control	f. If the pendant has a string, its length shall be sufficiently long so that the teaching worker can carry out the work safely.
Electrical connection devices	The electrical connection devices such as electrical ports connected to the robot shall be of a type that cannot be disconnected easily.
Robot system layout design	The layout of a robot system for arranging working space, access and buffer space shall meet the following items: a. Limiting space and working space shall be set based on the maximum reach of the robot, and buffer space shall be arranged between the robot and any obstacle such as a building column. b. Safe passages including pedestrians' passages shall be arranged. c. The access and path to the control system shall be safe. d. Safe passages shall be arranged for accessing the robot for checkup, cleaning, repair, maintenance, and the like. e. No hazard of slipping, tripping, and stumbling due to wiring or other hazard source shall exist. f. No hazard due to cable trays and the like shall exist. g. Operation controllers and auxiliary equipment (such as welding controllers, pneumatic valves) requiring access during automatic operation shall be located outside the protected space.
Robot system stop function	Any robot system shall have a protective stop function and a separate emergency stop function. a. Emergency stop function 1) The robot system shall have a single emergency stop function for all the related parts of the system. 2) In the case of multiple robots or multiple cells, the control range may be divided, provided that the control ranges have clear indication in characters or symbols close to the emergency stop devices. 3) When there are two or more control locations, the emergency stop device installed at each control location shall maintain its functionality at all times. 4) The emergency stop function shall have priority over all the other robot controls. Upon any emergency stop, the driving power from the robot driver shall be removed, and retained at

【Annex Table 14】 Criteria for Inspection of Industrial Robots (relating to Article 30)	
	the stopped condition until it is reset. 5) Resetting shall be possible only manually, and the robot operation may not be resumed immediately after resetting, but shall be activated by a separate activation action. 6) The performance of the emergency stop circuit shall meet the performance requirements for the safety-related control systems specified in Paragraph 4. b. Protective stop function 1) The robot system shall have one or more protective stop circuits for being connected to external protective devices. 2) The protective stop circuits shall be such that their activation stops the robot operation, removes the power to the actuator, and enables control of all the hazard sources controlled by the robot. 3) The protective stop shall be actuated by manual operation or a control logic. 4) At least one protective stop functions shall be of the Stop 0 or Stop 1 type. Note 1) Stop 0 type: The system is stopped by an immediate disconnection of the power to the actuator. Note 2) Stop 1 type: The stopping is controlled so that the power is disconnected after the system is stopped while the power to the actuator is retained. 5) The performance of the protective stop circuit shall meet the performance requirements for the safety-related control systems specified in Paragraph 4.
Manual resetting, starting, and restarting	The robot system shall meet the following items for preventing unexpected actuation. a. Starting and restarting shall be possible only when all the safety functions and protective measures operate normally. b. When the power supply is stopped and resumed, a starting interface device shall be installed for preventing dangerous operations resume automatically, and resetting shall be possible only by manual operation. c. Starting and restarting controls shall be operated manually outside the protected space, and they may not be activated inside the protected space. d. The starting and restarting control devices shall be located where the operator can have a clear view of the protected space. However, if it is impracticable to secure view of the protected space, any of the following shall apply. 1) Install a detection device that can detect the presence of workers inside the protected space. 2) Install a means to fix the entrance door while it is opened. 3) Install an additional time limiting reset device inside the protected space. 4) Issue visual/audio alarm that can be clearly recognized inside the protected space, and provide sufficient time for escaping. e. When Item 4) of Paragraph d applies, install emergency stop devices of a sufficient number at places inside the protected space easily accessible by workers.
Protected space, fences, etc.	Protected space and fences shall meet the following paragraphs: However, partial exception may apply depending on the operating types of collaborative robots. a. Limiting spaces shall be located inside the protected space. b. The protected space shall be set by fences. However, at openings for moving in/out materials or parts, the protected space shall be set by sensing-type protective devices. c. The fences of a robot cell shall meet the following paragraphs:

【Annex Table 14】 Criteria for Inspection of Industrial Robots (relating to Article 30)	
	1) The fences shall be installed firmed so that they cannot be easily damaged by external force, and that they can be removed only by tools. 2) When a fence has an opening for moving in/out materials or parts, physical access by workers to hazardous points under, beside, or through the opening shall be prevented. If such measures are impracticable, additional actions shall be taken such as the installation of sensing-type protective devices. 3) The fences shall be no lower than 1,800 mm. However, the fences may be adjusted to no lower than 1,400 mm in case where no hazards are posed by the height in consideration of the operating range of the robot and the safety distance specified in KS B ISO 13857. 4) Movable fences (entrances) shall be such that they open sideways or in the direction moving away from hazard sources, and shall not have a structure in which they are opened toward the protected space. 5) Movable fences (entrances) shall have interlock devices, and the interlock devices shall be able to put hazard sources into safe conditions before workers approach them. However, in the case where it is probable that workers approach hazardous spaces before hazard sources are removed, entrance locking devices shall be installed in addition to the interlock devices. 6) The locking devices of movable fences (entrances) shall be such that the robot can be actuated only when the fences (entrances) are closed and locked.

Warranty

Hyundai Robotics (hereinafter “We”) provides warranty for raw material defects and manufacturing defects of this product according to the details specified in the Warranty Statement to protect the benefits of the customers who purchase robot systems manufactured by us and sold by us or our authorized sellers. This warranty is provided only for end users (hereinafter “Customers”) of our robots.

■ Warranty scope

The robot and its components (hereinafter the “Product”) are under our warrant in terms of material and manufacturing defects.

The only responsibilities of ours and the only remedial measures relating to any of our products will be limited to the repair or replacement of products deemed to have direct defects at our discretion. We will not compensate for any collateral damages or accidental, special, or consequential damages including the loss of income, loss of use, loss of production, or damages of other products or equipment caused by the defects of our products.

■ Warranty period

We provide a one-year warranty for product quality beginning on the date on which our product is delivered to a site after the customer purchase the product or the date on which the customer issues a letter of acceptance after the completion of commissioning. However, if the contract date and the delivery date (installation and commissioning completion date) do not match each other, the delivery date will be the beginning date of the warranty. When the product is replaced with a new finished product, the warranty period will be calculated from the replacement date.

■ Warranty limitations and exceptions

To maintain the warranty valid, the customer should comply with the maintenance procedure specified by us and keep the relevant records. If it is to be decided that the following are true because the customer does not comply with the maintenance procedure, the warranty will be void.

- Product faults and damages caused by the customer’s carelessness, unskillful operation, erroneous or arbitrary modification, disassembly, and repairing
- Product faults and damages caused by the installation and use of parts, consumables, software, etc. that are not authorized by us
- Product faults and damages caused by noncompliance with the instructions and precautions specified in the product manual
- Product faults and damages caused by its use for purposes other than its intended purposes
- Product faults and damages caused by the use of the product at inadequate environments, or dropping or giving impact to the product
- Product faults and damages caused by arbitrary installation, repair, or maintenance carried out by persons (customers, unauthorized persons, or non-licensed maintenance workers, etc.) than installation experts
- When the service life of consumable parts has elapsed
- When warranty service is filed after the warranty period has expired

We do not provide warranty for product damages caused by external situations that are not under our reasonable control, such as thefts, intentional sabotages, fires, natural disasters, wars, or terroristic behaviors. In addition, we will not take responsibility for any defects of products, functionality, and performance that are beyond the scope specified in the Warranty Statement.

Customer Support

- Representative phone number: 1670-5041 | Email: robotics@hyundai-robotics.com
- Working hours: Weekdays (Monday–Friday) 09:00–18:00 | Closed on weekends and holidays

For details and queries about products or services, please contact our Customer Support Team.

GRC: 477, Bundangsuseo-ro, Bundang-gu, Seongnam-si, Gyeonggi-do

Daegu: 50 Technosunhwan-ro 3-gil, Yuga-eup, Dalseong-gun, Daegu-si

Ulsan: Room 201-5, Automotive and Shipbuilding Engineering Hall, Maegoksaneop-ro 21, Buk-gu, Ulsan-si

Middle Region: Song-gok-gil 161, Yeomchi-eup, Asan-si, Chungcheongnam-do

Gwangju: Room 101, Building B, Pyeongdongsandan-ro 170-3, Gwangsan-gu, Gwangju-si

ARS 1588-9997 | 1 Robot Sales, 2 Service Sales, 3 Purchasing Consultation, 4 Customer Support, 5 Investment Queries, 6 Recruitment,

and Other Queries www.hyundai-robotics.com