

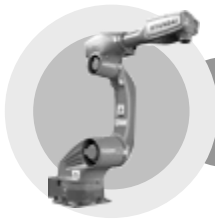


WARNING



**INSTALLATION SHOULD ONLY BE
PERFORMED BY QUALIFIED
INSTALLATION PERSONNEL AND MUST
CONFORM TO ALL NATIONAL AND
LOCAL CODES**





Manipulator Maintenance Manual

YP015-28

 **HYUNDAI ROBOTICS**

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1. Safety

YP015-28

1.1. Introduction

The main purpose of this chapter is to describe the safety precautions for users and operators who repair and manipulate the industrial robot.

This manual describes safety precautions for robot manipulator and controller, in compliance with the safety regulation of EU Machinery Directive 98/37/EC(2006/42/EC) and US OSHA. And the robot manipulator and controller is manufactured to comply with the safety standards EN ISO 10218-1:2006 and ANSI/RIA R15.06-1999.

Every operator, who installs, replaces, adjusts, manipulates, maintains, and repairs, must read thoroughly and fully understand the manipulation and maintenance manual, in particular, the special attention must be paid to the WARNING symbol, the most important marking related to the safety.

Installation, replacement, adjustment, manipulation, maintenance, and repair of robot system must be performed by the personnel who was duly trained for these purposes, following the indicated operating procedure.

This company is planning and carrying out the relevant training such as maintenance, repair, and manipulation for the above operations, so robot users make sure that robot operators should get the relevant training. And make sure that the robot handling work should be carried out only by the operators who completed this training course.

Hyundai Robotics user of industrial robot has responsibility to observe the safety regulation related to robot adopted in corresponding countries and responsibility to design, install and operate safety equipment well in order to protect workers who work at robot system.

In high-risk areas concerning robot systems in which robots, tools, and accessories operate, there must be a method of protection to stop the workers or objects from entering the area according to ANSI/RIA R15.06-1999.

The areas for which the robot can be applied and the environment in which it can be used are as follows.

Applicable areas

It is applied to the industrial robot used by installing on the surface of wall or plane (axes addable). It is also appropriate for controlling operation in the dotted section or consecutive section.

Major application is

- Coating
- Application such as Sealing

For the other use than the above emergency application, make a contact with our company to consult on the robot use and possible applications.

Disable environment

Our robot must not be used in a highly explosive environment and the areas contaminated by oil, flammable materials or chemical materials. (Prohibited to be installed and manipulated.)



1.2. Relevant Safety Regulations

The robot is designed as per ISO 10218-1:2006 safety standards for industrial robots, and furthermore in comply with ANSI/RIA R15.06-1999 regulations.

1.3. Safety Training

All the personnel who intend to teach, operate or inspect the robot must be trained in an approved robotic operation and safety training course before start-up. The safety training course includes the following details:

- Purpose and functions of safety devices
- Safety procedure to handle the robot
- Performance of robot or the robot system and possible hazards
- Tasks associated with any specific robot applications
- Safety concepts, etc.






1.4. Safety Related Nameplate

1.4.1. Safety Marking

For the purpose of effective safety instructions, the following safety symbols are used in this manual.

Table 1-1 Safety marking

Symbols		Descriptions
Warning		Indicate a highly dangerous situation, meaning that operating or handling in a wrong manner could result in death or serious injury to personnel, or damage to equipment. Attention should be paid to the operation and handling.
Mandatory		Indicate the compulsory measures that should be taken
Prohibited		Indicate the prohibited actions and/or operations that should not be performed.

1.4.2. Safety Nameplate

Identification plates, warning label and safety symbols are attached to the robot and to the inside and outside of control panel. The designation labels and cable Mark for wire harness between the robot and control panel, and the cables inside/outside of control panel are provided.

All of these plates, labels, symbols and marks constitute safety-relevant parts of the robot and the control panel. They must remain attached to the robot manipulator and control panel at their clearly visible positions all the time for the safety and their full performance.

The painted markings on the floor and signs indicating dangerous zones must be clearly distinguished in form, color, and style from other markings on the machine near the robot system or inside the plant facilities where the robot system is installed.



It is forbidden to remove, cover, or paint over by way of spoiling the clearly visible identification plates, warning labels, safety symbols, designation labels and cable marks.

1.5. Definition of Safety Functions

▶▶ Emergency Stop Functions – IEC 204-1,10,7

There is one emergency stop button on the controller and teach pendant respectively. If necessary, additional emergency buttons can be connected to the robot's safety chain circuit. The emergency stop function, which overrides all other robot controls, can bring the current operation to a halt by cutting off the power supply to the motors of individual axes. This function will also shut down the power supply to other dangerous functions, which are controlled by the robot, to prevent them from being used

▶▶ Safety Stop Function - EN ISO 10218-1:2006

A safety stop circuit needs to be configured, and, through this circuit, each robot should be connected with the safeguards and interlocks. The robot should have a number of electrical input signals which can be used to connect external safety devices, such as safety gates, safety pads, and safety lamps. These signals allow the robot's safety functions to be activated by all equipment, including peripheral equipment and the robot itself.

▶▶ Speed Limitation Function - EN ISO 10218-1:2006

In a manual mode, the maximum speed of the robot is limited to 250 mm per second. The speed limitation applies not only to the TCP (Tool Center Point), but to all parts of manual mode robot. The speed of equipment mounted on the robot should be possibly monitored.

▶▶ Restricting working Envelope - ANSI/RIA R15.06-1999

Operation area of each axis is restricted by soft limit and hardware limit. Axis 1, 2, and 3 can also be restricted by means of mechanical stopper.

▶▶ Operation Mode Selection - ANSI/RIA R15.06-1999

The robot can be operated either in the manual mode or auto mode. In the manual mode, the robot can be operated only by using the teach pendant.

1.6. Applicable Standards

IECEX	Ex ib [ib] pxb IIB T4 Gb
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Standards :

The electrical apparatus and any acceptable variations to it specified in the schedule of this certificate and the identified documents, was found to comply with the following standards:

IECEX Standards:

IEC 60079-0: 2011 Ed.6

**"Electrical apparatus for explosive gas atmospheres,
Part 0 : General Requirements"**

IEC 60079-2: 2014 Ed 6

**"Electrical apparatus for explosive gas atmospheres,
Part 2 : Equipment protection by pressurized enclosure 'p'"**

IEC 60079-11: 2011 Ed 6

**"Electrical apparatus for explosive gas atmospheres,
Part 11 : Equipment protection by Intrinsic safety 'i'"**

1.7. Installation

1.7.1. Safety Fence



Install safety fence against the possible collision between the robot and workers, so that no worker may approach the robot.

Install safety fence against the possible collision between the robot and workers, so that no worker may approach the robot. When operators or other personnel enter the robot's working envelope by accident, it may cause an accident. Install the safety fence to stop the robot when one, who intends to replace for TIP DRESSING or TIP changing replacement, or to inspect welding equipment, opens the fence gate and approaches the equipment during operation.

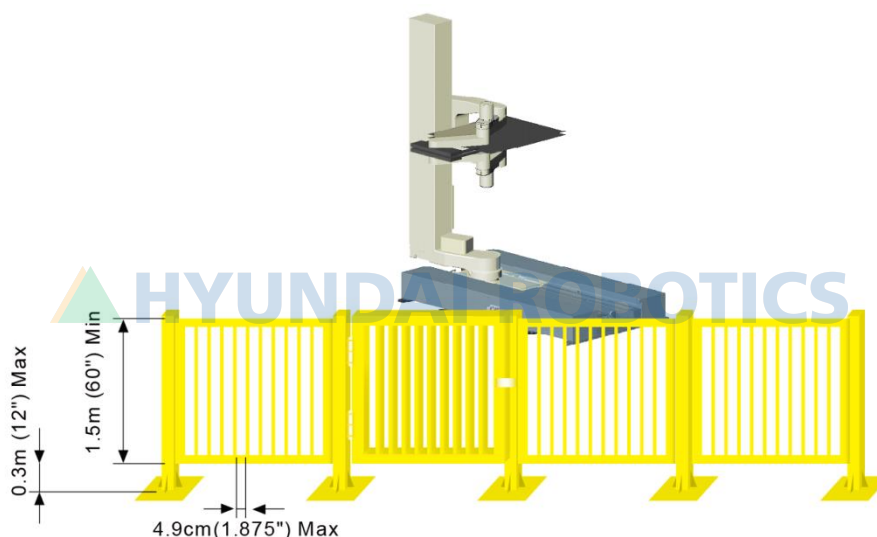


Figure 1.1 Recommended size for safety net and entrance gate (slot type entrance gate)

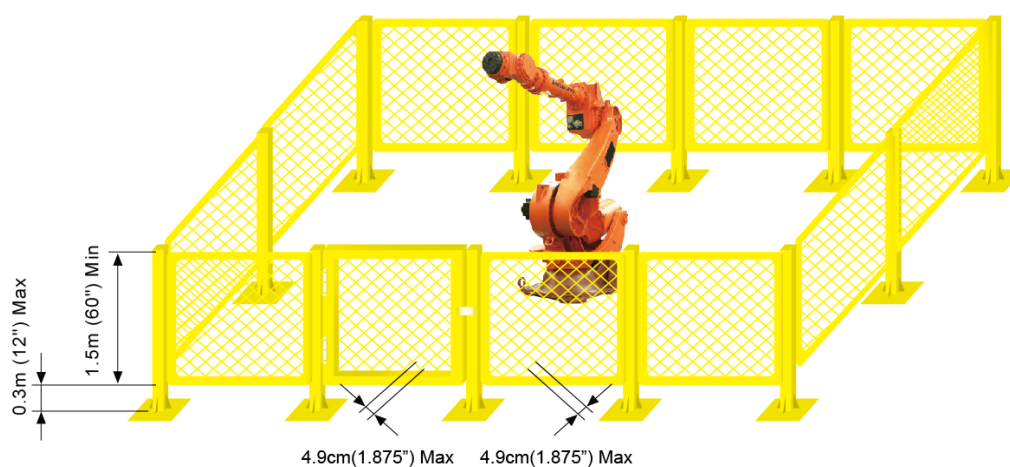


Figure 1.2 Recommended size for safety net and entrance gate (square type entrance gate)

- (1) Enough space for safety net should be secured by covering robot operating area so as that workers would not have difficulty in teaching work or repairing work, and the safety net should have solid structure in order that it would not move easily and man cannot enter over easily.
- (2) Safety net should be installed by static type in principle, and should not have hazardous parts such as prominence and depression or keen part, etc.
- (3) Install the safety fence with an entrance gate, and register the safety plug at the gate so that it does not open unless pulling the plug out. Wiring should be carried out in a way that the robot should be in the operation ready OFF status as well as in the motor OFF status when the safety plug is pulled out or safety net is open.
- (4) In order to operate the robot with the safety plug pulled out, wiring should be carried out in a way that will allow the playback to take place at a low speed.
- (5) The emergency stop button should be installed at a place where it can be pushed quickly by the operator.
- (6) If no safety net is to be installed, devices such as photoelectric switches, and mat switches, should be installed, instead of the safety plug, to cover the overall area within the robot's operation range in a way that the robot can be stopped automatically when a person enters the robot's operation range.
- (7) Operation area of robot (hazardous area) should be distinguished by the method like painting on floor.

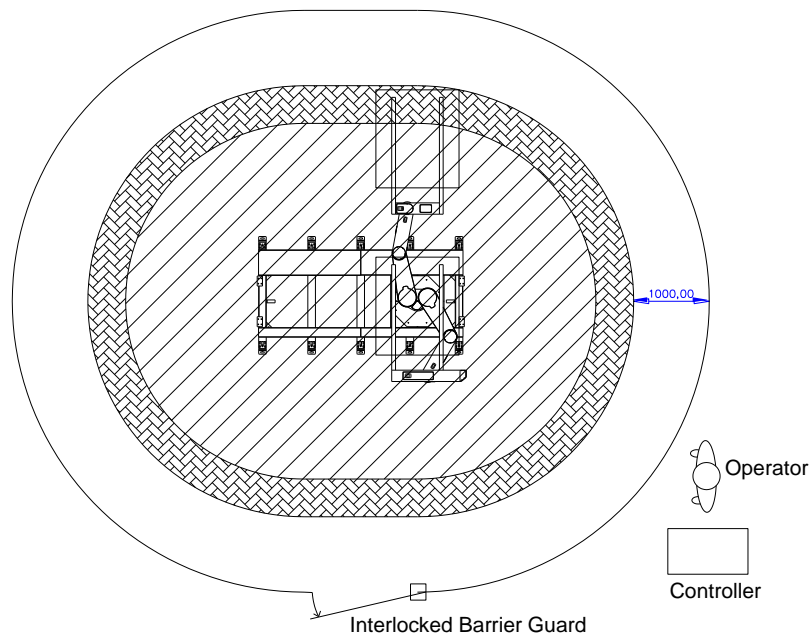


1.7.2. Placement of Robot & Peripheral Equipment



Please make sure that robot and peripheral equipment should be arranged by following method.

- (1) In case of connecting primary power of controller or peripheral devices, please work after checking whether supply power has been deleted. There is a possible danger of electric shock because the high voltage such as 220V and 440V is used as its primary power.
- (2) Post a sign [No enter during operation] up the safety fence gate, and inform the operators of its purport.
- (3) Arrange such devices as controller, interlock panel, and other manipulation panels to be handled outside of the safety fence.
- (4) When installing operation stand, install the emergency stop button on the stand. Make sure that stopping in an emergency situation can be initiated from any place from which the robot is operated.
- (5) Make sure that the robot manipulator and the wiring and piping of controller, interlock panel, and timer should not be placed in the way of operator's working range so that they would not be directly stepped on by FORK and LIFT. Otherwise, the operator may suffer electrocution or the wire may suffer disconnection.
- (6) Place the controller, interlock panel, and handling stand within the sight of robotic performance. It may cause a major accident to operate the robot while the robot is malfunctioning in an area where the robot's activity can not be observed, or while the operator is working on it.
- (7) Restrict the robot's working envelope by using the soft limits and the mechanical stopper if the necessary working envelope is narrower than the robot's workable envelope. When the robot is to move beyond the restricted envelop due to abnormal operation, such as the robot being handled in a wrong way, the robot will be stopped automatically in advance thanks to the function that restricts the workable envelop.
- (8) During the welding work, spatter could fall down to workers or the workers could be injured by burning, or fire could break out. Install such devices as a glare shield or a cover in the full sight of robot's working envelope.
- (9) Make sure that the device indicating the robot's running condition, whether automatic or manual mode, can be noticeable even from a slightly distant location. In the case of automatic start-up, a buzzer or a warning lamp will be useful.
- (10) Make sure that there is no projecting part in the robot's peripheral equipment. Cover it, if necessary. It usually could cause an accident if the operator comes in touch with it. And it may cause a major accident when the operator tumbles while being astonished at the sudden movement of the robot.
- (11) Don't make the system designed to allow the workers to carry the Work in and out using their hands through the safety fence. It could be a cause of accident associated with compressing or amputating.



(Cylinder type)

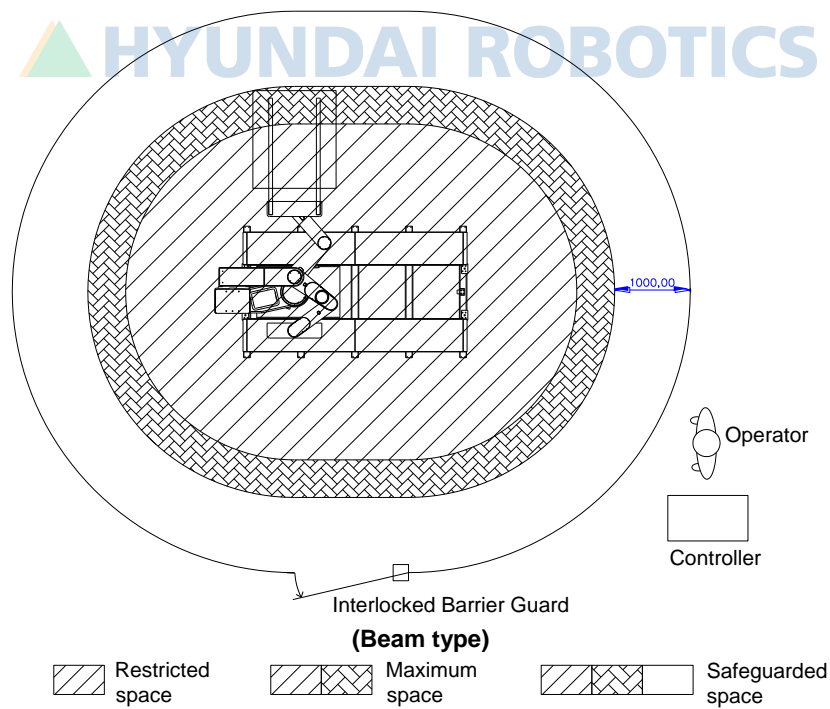


Figure 1.3 Arrangement of LCD robot peripheral devices and workers

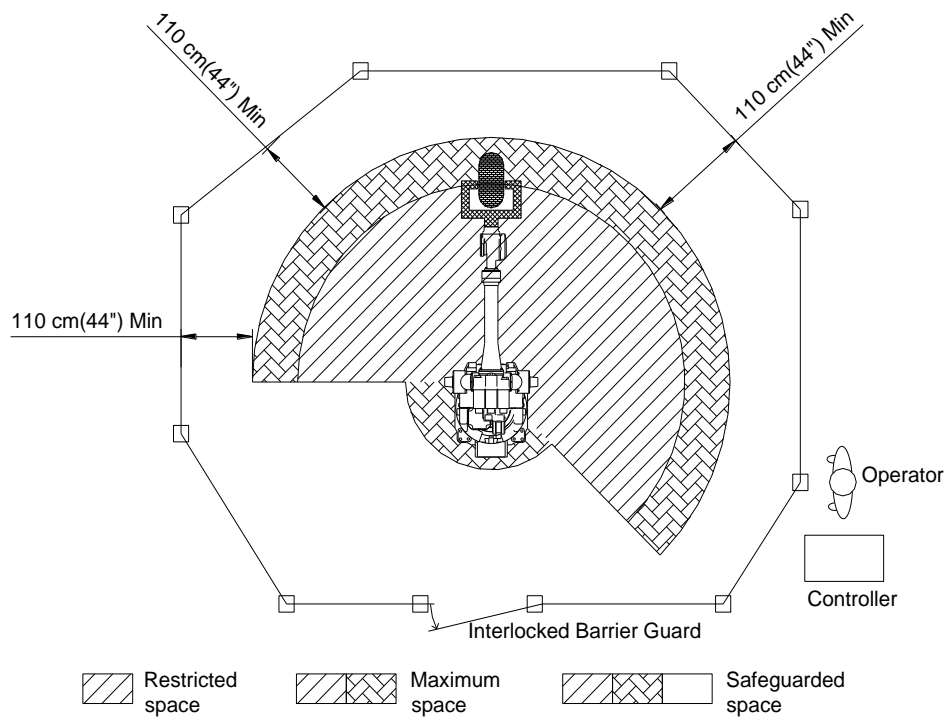


Figure 1.4 Arrangement of general robot peripheral devices and workers

 **HYUNDAI ROBOTICS**

1.7.3. Installing the Robot



Please install the robot in accordance with following method surely.

Install the robot as per the planning and layout which has been previously reviewed and studied for its optimized performance and functionality. In case of poor conditions for robot installation, the serious problems can take place, including error of relative position between robot and workpiece during operation, bad performance quality of robot caused by vibration, shortening lifetime, and cause of serious accidents. Thus, pay attention to the following precautions when installing the robot.

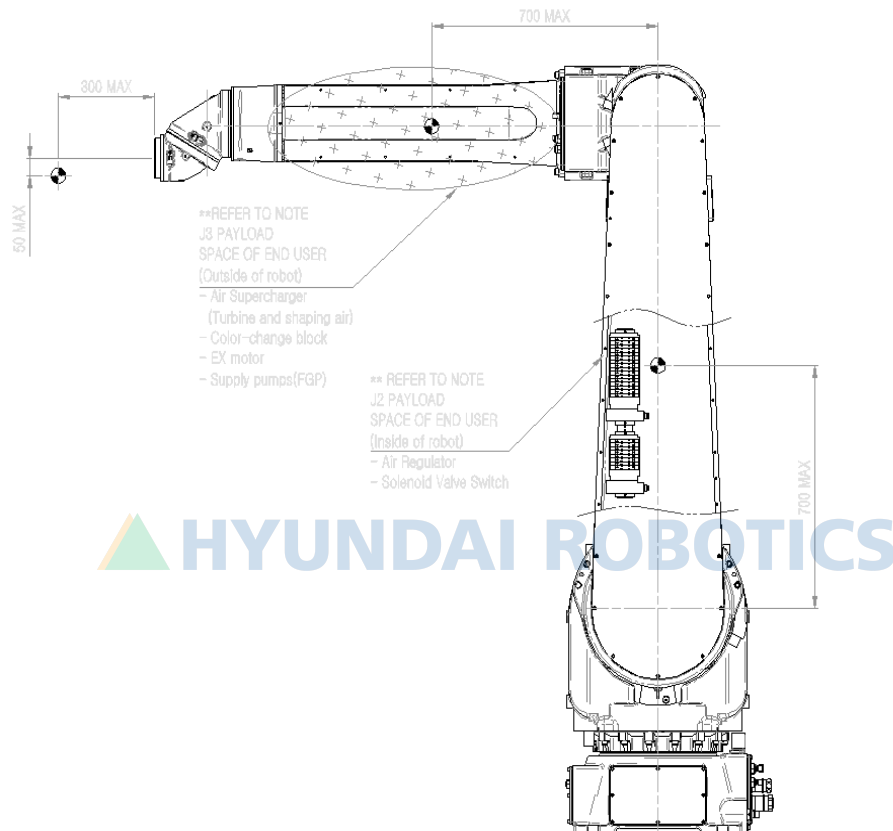
General Safety Precautions

- (1) Design and install the robot system properly in compliance with laws, regulations, and safety requirements enable in the country where the robot system is installed.
- (2) All the workers for the robot system must have the complete knowledge on the information specified in the application and supplementary manual, and proficiently operate and handle the industrial robot.
- (3) Installation workers of robot must follow the safety instructions and apply them to the installation when they face any safety problems.
- (4) System provider must ensure that all the circuits utilizing safety functions perfectly perform in a safe way.
- (5) Install main power supply to be disconnected from outside of the robot's working envelope.
- (6) System provider must ensure that all the circuits utilizing emergency stop function perfectly perform in a safe way.
- (7) For the immediate emergency stop, install emergency stop button within the accessible distance for the operator.

Technical Safety Precautions

- (1) Eliminate any interference with peripheral equipment considering the dimension and working envelope.
- (2) Avoid such place for installing which is directly exposed to the sun, extremely humid, contaminated by oil or chemicals, and containing a large amount of metal powder and explosive gas.
- (3) Install at the ambient temperature ranged 0~40℃.
- (4) Secure sufficient space for the easier disassembly and maintenance.
- (5) Install safety fence with a gate, and prohibit any person from entering the robot's working envelope.
- (6) Remove any obstacles out of the robot's working envelope.
- (7) Take a special measure, considering thermodynamics of controller, if the robot is installed near the heating elements or places exposed directly to the sun.
- (8) Take a special measure if the robot is installed in a place of abundant dust such as metal powder in the air.
- (9) Install the robot not to transmit welding electric current. In other word, insulate SPOT GUN with/from the robot's wrist.
- (10) Grounding is very critical in preventing electric shock and malfunction caused by noise, and thus install as following instructions.
 - ① Install an exclusive grounding terminal using class 3 or higher. (For the input voltage of 400V or higher, use special class 3 or higher.)
 - ② Connect grounding line into the grounding bus-bar inside of the control panel.
 - ③ In case of direct grounding on the floor by anchoring, two-point grounding both by robot manipulator and by controller can produce a "ground loop" and contrariwise cause abnormal operation. In this case, connect the grounding line to the base of robot manipulator and disconnect the second grounding point to the controller. If the robot vibrates even after stopping, double-check the grounding status because the possible main causes could be an incomplete grounding or "ground loop".
 - ④ In the use of internal transgun(GUN), there is a possible danger of dropping because the primary power cable is directly connected to the spot gun. In this case, directly connect the grounding line to the base of robot manipulator in order to prevent any electric shock and protect the control panel, but do not connect it to the controller.
- (11) This apparatus contains intrinsically safe circuit. The instructions detailed in section 2.8 shall be observed.
- (12) No batteries can be installed in payload areas without authorization.
- (13) All user electronics in the J2, J3 and wrist payload shall be IECEx Certified with an equipment protection level (EPL) of Ga or Gb.
- (14) The total internal volume of electronic devices installed in J2 can not exceed 1L.

- (15) The temperature rating of Ex equipment installed in J2 payload shall be T4,T5,T6 with minimum ambient temperature of 60°C.
- (16) The temperature rating of Ex equipment installed in J3 and wrist payload shall be T4,T5,T6 with minimum ambient temperature of 40°C.
- (17) The rating of electronic devices installed in J2 → Max AC240V/DC60V, 9A.



- (18) Wiring between purge controller Hi5a-P10 and panting robot shall be in accordance with IEC 60079-14 or relevant installation standard.

1.7.4. Space for Robot Installation



To prevent explosion, please follow the instructions below to install the robot

The robot manipulator must be installed in “Zone1” or “Zone 2”. Do not installed in a zone that is classified as “Zone 0” or a more dangerous explosion hazard area. The Controller is not a pressure explosion-proof structure and must be installed outside the explosion-proof area such as outside the paint booth. (refer to KS C IEC 60079-10-1:2012)

Install robot after securing sufficient space for maintaining the robot manipulator, controller, and other peripheral equipment. to install the main body and controller, please secure the above mentioned installation area. Install controller outside of the safety fence in order to monitor the robot manipulator and to operate in a safe way.

When installing, be sure to make it easier to perform the maintenance when opening the Controller door. Secure the available space. The specifications of the controller can change according to the type of the controller. (For more details, please refer to the “Maintenance manual”.)



1.8. Safety Operation for Robot Handling

Follow the safety instructions to prevent any accidents. Don't modify nor ignore safety devices or circuits at any time, and be careful of electric shock.

All the normal operations in an automatic mode must be performed outside of the safety fence. Check the robot's working envelope if anyone is inside before operating.

1.8.1. Safety Precautions for Robot Handling



Please observe following countermeasures because safety is very important for the test operation of the robot.

- (1) Do not handle the robot other than such personnel as operators handling the robot and other possible operators and supervisors who were designated as whom duly trained in an approved robotic training course and become familiar enough with the proper operation of the safety and robotic functions.
- (2) Be sure to wear helmets, goggles, and safety shoes.
- (3) Perform the work in pairs. One person must be ready to press the emergency stop button in an emergency while the other must perform his work quickly but carefully within the robot's working envelope. Always check the escape route before working.
- (4) Make sure that there is no one in the working envelope when the power source is on.
- (5) Operations such as teaching must be performed outside of the robot's working envelope. However, if the operation is performed within the working envelope after stopping the robot, enter the envelope with safety plug or key switch for converting to automatic mode. Make sure that other operators do not change it into automatic mode by accident. Also, pay close attention to the specific direction of robotic movement in case of abnormal operation and malfunction.
- (6) Supervisors should follow the instructions below.
 - ① Be located at a place where you could take an entire view of robot, and commit yourself to monitoring.
 - ② Press the emergency stop button immediately when abnormality is found.
 - ③ Anyone is forbidden to be near the operating area other than those who are engaged in the operation.
- (7) In a manual mode, the speed of teaching is limited to 250mm/sec.
- (8) In teaching, post a sign [Under Teaching].
- (9) Operators must pull the safety plug out, and enter the safety fence with the plug.
- (10) Do not use any devices causing noise in and around the teaching area.
- (11) Handle the teach pendant button, while checking the teaching point with your naked eyes, and do not handle it just relying on your sense.



- (12) It is a repairing part to be prepared for when you buy many sets.

- (13) In teaching, check and examine carefully under your feet. In particular, in high teaching for more than 2M, secure a safe zone on which you may step before teaching.



- (14) Instructions for any abnormal operations.

- ① Press immediately the emergency stop button when any abnormal operations are found.
- ② Be sure to check if the relevant equipment is stopped when checking the abnormality in an emergency stop.
- ③ In case that the robot stops automatically due to power failure, investigate possible causes and take actions after confirming that the robot completely stops.
- ④ In case of malfunction of emergency stop devices, immediately disconnect the main power and investigate possible causes to take necessary actions.
- ⑤ Investigation of the failure must be conducted only by a designated person. For the re-operation after emergency stop, operators must clarify the cause of failure and take necessary actions, and then operate the robot again following the proper procedure.

- (15) Write out the operating rules proper to working details and installing location regarding the operation and handling method for the robot, and the necessary actions for robot's any failure. In addition, it is recommended to operate the robot in accordance with the operating rules.

- (16) Instructions when the robot stops

Make sure not to approach the robot even when it seems to be stopped. Most accidents occur from a sudden movement of robot which seemed to be stopped when one approaches it. The conditions that the robot stops are as follows.

Table 1-2 State of Robot Stop

No.	State of Robot	Drive Power	Access
1	Pause (Minor failure, Pause switch)	ON	X
2	Emergency stop (Major failure, Emergency stop switch, Safety gate)	OFF	O
3	Input signal standby of peripheral equipment (START INTERLOCK)	ON	X
4	Playback Completion	ON	X
5	Standby	ON	X

Even in the accessible state of robot, be watchful against any possible sudden movement of robot. Make sure to avoid approaching the robot without precautions for emergency under all circumstances.

- **During temporary halt, the entrance countermeasure same as entrance of teaching work should be considered at the case (nozzle contact, welded part detected, arc error, and so on) of opening entrance gate for simple management against error.**

- (17) Clean up any split oil, tools, and impurities in the safety fence after completing robotic operation. Accidents such as conduction may occur in the working envelope contaminated by oil, or scattered tools on its floor. Make a habit of organizing and cleaning things up.

1.8.2. Safety Precautions for Operating Test



Please observe following countermeasures because safety on robot operation is very important.

In case of operating test, errors in design or teaching and inferiority in manufacturing are possibly seen in the entire system such as teaching program, jig, and sequence. Thus, be more careful and safe in case of operating test. Accidents may occur by these combined causes.

- (1) Before handling, check the stop buttons and signal functions to stop the robot such as emergency stop button or stop button. And then, check the abnormality - detective movements. Above all, it is the most critical to check all the stop signals. It would be the most important to stop the robot when any possible accidents are predicted.
- (2) In case of operating test, start the robot at low speed(approximately 20%~30%) in the variable speed function, and repeat it more than one cycle to check the movements. If any errors are found, immediately correct them. After then, increase in speed (50% → 75% → 100%) gradually, and repeat more than one cycle respectively to check the movements. Operating at high speed from the very beginning may cause a serious accident.
- (3) In case of operating test, it is hard to predict what problems would happen. Do not enter the safety fence during operating test. Unexpected accidents are likely to occur because of its low reliability.

 **HYUNDAI ROBOTICS**

1.8.3. Safety Precautions for Automatic Operation



Please observe following countermeasures because safety on robot automatic operation is very important.

- (1) While posting a sign [Do Not Enter During Operation] up the safety fence gate, ask the operators not to enter during operation. If the robot stops, you may enter the safety fence under your full understanding of the situation.



- (2) Be sure to check if any operators are inside of the safety fence when starting the automatic operation. Operating without checking the presence of operators may cause a personal injury.
- (3) Before starting the automatic operation, check and confirm that the program number, step number, mode, and starting selection are in the possible state for automatic operation. If starting with the other programs or steps selected, the robot could move in an unpredicted way, and lead to an accident.
- (4) Before starting the automatic operation, check if the robot is properly located to get started. Check whether the program number or step number is identical with the location of robot. Even if it's all identical, accidents are still possible to occur due to an abnormal movement when the robot is differently located.
- (5) Be prepared to immediately press the emergency stop button when starting the automatic operation. Immediately press the emergency stop button in case of robot's unexpected movements or emergency.
- (6) Be sure to detect any abnormalities by checking the route, condition, or sound of robot movement. Sometimes the robot may be abnormally operated including a sudden break down. However, it will show a certain indication before the break down. Understand the robot's normal condition well in order to catch the symptom in advance.



- (7) When any abnormality is detected from the robot, immediately stop and take proper actions on it. Using the robot before any proper actions taken may cause an interruption of produce as well as serious failure leading to a very serious personal injury.



- (8) When checking the robot's movement after the proper actions taken for the abnormality, do not operate the robot with operators inside of the safety fence. Unexpected accidents are possibly to occur because its low reliability may cause another abnormality.

1.9. Safety Precautions for Access to Safety Fence



Please observe following countermeasures because safety on robot automatic operation is very important.

The robot is very heavy and strong, even at low speeds. When entering the safety fence, one must observe the relevant safety regulations of its pertinent country.

The operators always must be aware of the unexpected movements of robot. Robots are able to move fast shortly after being stopped. The operators should know that the robot is able to move in a different route, without any notice, by means of external signals. Thus, when trying to stop the robot during teaching or operating test, one should be able to stop the robot with a teach pendant or control panel.

When entering the working envelope through the safety gate, you must take the teach pendant with yourself so that other people can not operate the robot. Make sure to post up the control panel a sign indicating the state of robot handling.

People must understand the followings when they are to enter the robot's working envelope

- (1) Do not enter the working envelope other than teaching person.
- (2) Operation set-up mode of controller must be a manual mode in the control panel.
- (3) Always wear the approved working suite. (Do not wear a loose clothes as you please)
- (4) Do not wear gloves when handling controller.
- (5) Do not leave innerwear such as underwear, shirts, or necktie out of the working suite.
- (6) Do not wear personal accessories such as big earrings, rings, or necklaces.
- (7) Make sure to wear safety shoes, helmet, and goggles and if necessary, wear other self-protective outfit such as safety gloves.
- (8) Make sure that the emergency stop circuit is working correctly and in its proper function, turns MOTOR OFF when pressing the emergency stop button in the control panel and teach pendant before handling the robot.
- (9) Make your posture face-to-face with the robot manipulator when performing your work.
- (10) Follow the predetermined working procedure.
- (11) Be prepared for emergency exit or safe place considering that the robot may unexpectedly rush at you.

1.10. Safety Precautions for Maintenance and Repair

1.10.1. Safety Precautions for Controller Maintenance and Repair



Please observe following safety countermeasures on repair and check for robot controller.

- (1) Maintenance and repair of the robot must be performed by the personnel who was duly trained in the special maintenance training course and has a good knowledge of maintenance.
- (2) Perform your work following the maintenance procedures for controller.
- (3) Perform your maintenance and repair in a safe way by securing emergency exit or safe place.
- (4) Before the daily maintenance, repair, or changing parts, be sure to power down. In addition, post a warning sign [Do Not Input Power] up the primary power so that other operators may not input power by accident.
- (5) When changing parts, be sure to use the specified ones.
- (6) When you open the door of controller, you should turn off power, and please start working after 3 minutes.
- (7) Please do not touch heat radiating plate of servo AMP and recovery resistance because they are very hot.
- (8) After completing maintenance, be sure to close the door completely after checking if tools or other things are still remained in the controller.
- (9) Operators should be careful not to cause defects through periodic training, and all assembly and wirings should be done using prescribed specifications and tools.
- (10) Training shall be carried out so that personnel have adequate prior knowledge of explosion-proof equipment. Educational materials and records shall be maintained.
- (11) In order to verify the product, the personnel are required to be skillful, and the abilities shall be documented and suitably evaluated.

1.10.2. Safety Precautions for Robot System & Manipulator Maintenance



Please observe following safety countermeasures on repair and check for robot controller.

- (1) Refer to the safety precautions for Controller maintenance and repair.
- (2) Perform your maintenance and repair for the robot system and manipulator, following the indicated procedures.
- (3) Be sure to disconnect the primary power of controller. Post the warning sign [Do not input power] up the primary power to prevent other workers from connecting the power.
- (4) Make sure that the Arm is fixed and immovable before maintenance and repair since dropping or moving of the robot's Arm may cause a danger during maintenance and repair. (Refer to the 『Robot manipulator maintenance manual』 .)
- (5) Be careful not to cause static hazard by applying non-metallic paint on the manipulator surface during use. So periodically checked and removed the non-metallic paint.

1.10.3. Necessary Actions after Maintenance and Repair



Please install the robot in accordance with following method surely.

- (1) Check if the cables or parts of controller are properly connected.
- (2) After maintenance is completed, carefully check that no tools are left around or inside of the controller and manipulator. Make sure that the door is firmly closed.
- (3) Do not turn on the power if any problems or critical failures are detected.
- (4) Be sure that there is no one within the working envelope, and that you are in a safe place before turning on the power.
- (5) Turn on the main circuit breaker on the control panel.
- (6) Check the current position and status of robot.
- (7) Operate the manipulator at low speed.

1.11. Safety Functions

1.11.1. Operating a Safety Circuit

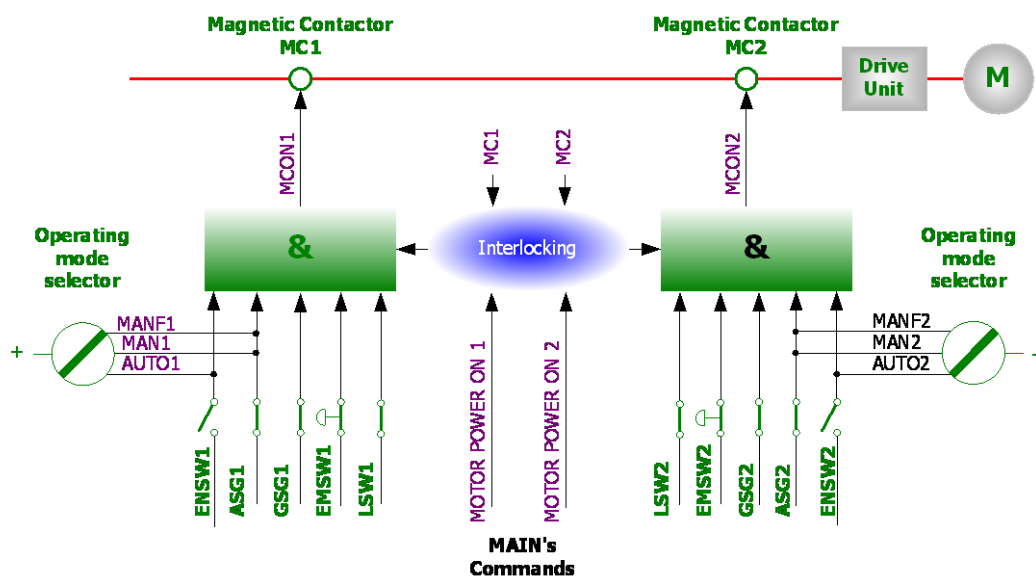


Figure 1.5 Configuration for safety chain

The robot's safety system is based on a two-channel safety circuit that is continuously monitored. If an error is detected, the power supply to the motors is disconnected and the motor brake is applied. To return the robot to MOTOR ON mode, the switches of two-channel circuit must be connected. If one of the two-channel circuit switches shorts, the contactor of motor will be disconnected leading to the application of brake, and finally the robot will be stopped. Furthermore, when safety circuit is disconnected, the interrupting call will be sent automatically to the controller to find out the possible reason for the interruption.

The safety control circuit of operation is based on dual safety electric circuit in which the controller and MOTOR ON mode are operated interactively. In order to be in MOTOR ON mode, the safety circuit consisted of several switches must be all connected. MOTOR ON mode indicates that drive power is supplied to the motors. If one of the contactors is disconnected, the robot will always return to MOTOR OFF mode.

MOTOR OFF mode indicates that drive power is removed from the robot's motors and the brakes are applied. The status of the switches is displayed on the teach pendant. (Refer to the I/O monitoring screen of "SERVICE" menu, 『Operation manual』.)

Safety circuit

The emergency stop buttons on the controller panel and on the teach pendant and external emergency stop buttons are included in the safety circuit of operation. Users may install the safety devices (safety plug, safety stop device for safe place) which are operated in the AUTO mode. In a manual mode, the signals of these safety devices are ignored. You can connect the general safety stop devices that is active in all operating modes. No one can enter the working envelope in an automatic operation mode due to the unconditional operation of the safety devices (door, safety mat, safety plug etc.). These signals are also generated in a manual mode, but the controller will keep the robot operating while ignoring the robot's teaching. In this case, maximum speed of robot is restricted to 250mm/s. Thus, the purpose of this safety stop function is to secure the safe area around the manipulator while one approaches the robot for maintenance and teaching.

When the robot is stopped with the limit switch, change the robot's position by operating it with the pendant key at the constant setting mode. (Constant setting mode refers to the state of entry into the menu 『[F2]: System』 menu)



The safety circuits must never be by-passed, modified or changed in any way.



1.11.2. Emergency stop

An emergency stop should be activated when people or equipment is located at the dangerous area. The emergency stop buttons are located both on the control panel and on the teach pendant. All safety control devices such as emergency stop buttons on the control panel must be located outside the working envelope and easily accessible at any time.

▶ Status of Emergency stop

When the button is pressed, the robot will operate as follows.
Robot stops immediately in any cases.

- Disconnect the servo system power.
- Motor brake is activated.
- Emergency stop message is displayed on screen.

For the emergency stop, the following two methods can be operated simultaneously.

- (1) Emergency stop for control panel and teach pendant (Basic)

Above the control and teach pendant console.

- (2) Emergency stop of external system

External emergency stop device (button etc.) can be connected to the safety electric circuit in accordance with applied standard for the emergency stop circuit.
(Please refer to system board in “basic configuration of controller”) At this time, the emergency stop must be connected to be “Normal On” and it must be check for proper operation during test run.

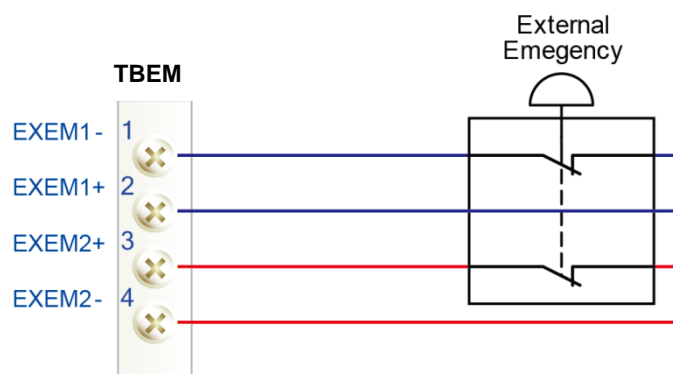


Figure 1.6 Connection with external emergency halt switch through system board terminal block TBEM

1.11.3. Operating Speed

To teach the robot, the operating mode switch must be in a MANUAL mode. Then the maximum speed of robot is limited to 250mm/s.

1.11.4. Connecting the Safety Devices

External safety devices such as light beams, light curtains, safety plug, and safety mats which can be adapted by the system builder execute interlocking the controller by way of connecting with safety circuit within the controller. These devices are used for safety device during execution of normal program in an automatic mode.

1.11.5. Restricting the working Envelope

When the robot is not necessary to reach certain area for specific applications, working envelope of the robot can be limited to secure the sufficient safety working area. This will reduce the damage or loss in case of robot's collision with external safety devices such as safety fence, etc. The movement of axes 1, 2, and 3 of HR, HX, HS and HA can be limited by means of mechanical stopper or electrical limit switches. In this case, the corresponding software limitation parameters must be also changed. If necessary, movement of wrist 3 axes can be restricted, too. Limitation of working envelope for all the axes could be carried out by the user. The robot is delivered to customer as the status of full working envelope setting.

- **Manual mode: Maximum speed is 250mm/s.**
In a manual mode, by means of worker's selection, workers may enter the safeguard area.
- **Auto mode : The robot can be operated via remote controller.**
All safety devices such as safety door, safety mats, etc. are activated.
No one may enter the safety device area of robot.

1.11.6. Monitoring Function

- (1) Motor monitoring function
Motors are protected against overload by means of onboard sensors.
- (2) Voltage Monitoring Function
For the protection of, the servo amp module turns off the power switch when the voltage is too low or too high.

1.12. Safety Related to End Effectors

1.12.1. Gripper

- (1) When a gripper is used to grip a workpiece, there should be safety precautions for unexpected dropping of the loaded workpiece.
- (2) When any end effectors or devices are installed on the robot arm, use the required size and piece of bolt, and securely fasten as per the required torque using torque wrench. Do not use the bolt which has rust or dirt on its surface.
- (3) End effector must be designed and manufactured not to exceed the maximum allowable load at the wrist of robot. Even though power or air supply stops, the gripped workpiece must not be dropped from the gripper. In order to remove any risks and problems which may cause personal injury and/or physical damage, the sharp edge and projecting part of end effector must be made dull and smooth.

1.12.2. Tool / Workpiece

- (1) It must be possible to replace tools such as milling cutters in a safe manner. Make sure that safety devices are working correctly until the cutters stop rotating.
- (2) Tool must be designed to keep in gripping workpiece securely even though a power failure or a control failure takes place. It must be possible to release workpiece from the gripper in a manual mode.

1.12.3. Pneumatic and Hydraulic Systems

- (1) The special safety regulations will apply to pneumatic and hydraulic systems.
- (2) Since residual energy of pneumatic and hydraulic systems can be still remaining even after the robot stops, particular care and attention must be paid by users. Internal pressure of equipment must be removed whenever starting the repair work for pneumatic and hydraulic systems.

1.13. Liabilities

The robot system has been built in accordance with the latest technical standards and approved safety rules. Nevertheless, the serious accidents such as death or personal injury still may take place due to the collision between the robot system and peripheral equipment.

The robot system must be used by operator who has a full technical knowledge on its designated use and also pay his close attention to the possible dangers and risks involved in its operation. The use of robot system is subject to compliance with these operating instructions and the operation and maintenance manual supplied together with the robot system. The safety related functions of robot system must not be used for any purposes other than safety.

When you use the robot system for any other or additional purposes than its designated usage, you must review whether it is enable in accordance with design criteria. The manufacturers cannot take any responsibility for any damage or loss which resulted from such misuse or improper use. The users shall have the full responsibility for the risks caused by such misuse or improper use. When you use and operate the robot system for its designated use, you must have a good command of all the information contained at these operating instructions as well as the maintenance manual.

The robot system may not be put into operation until it is ensured that the functional machine or plant into which the robot system has been integrated conforms to the specifications of the EU Machinery Directive 98/37/EC(2006/42/EC) and US OSHA.

The following harmonized standards in particular were taken into account with regard to the safety of the robot system.

- ANSI/RIA R15.06-1999
Industrial Robots and Robot Systems - Safety Requirements
- ANSI/RIA/ISO 10218-1-2007
Robots for Industrial Environment - Safety Requirements - Part 1 - Robot
- ISO 11161:2007
Safety of machinery - Integrated manufacturing systems - Basic requirements
- EN ISO 13849-1:2008
Safety of machinery - Safety-related parts of control systems - Part 1: General principles for design (ISO 13849-1:2006)
- EN 60204-1:2006
Safety of machinery - Electrical equipment of machines - Part 1: General requirements (IEC 60204-1:2005 (Modified))
- EN ISO 10218-1:2006
Robots for industrial environments - Safety requirements - Part 1: Robot (ISO 10218-1:2006)
- **IEC 60079-0: 2011 Ed.6**
"Electrical apparatus for explosive gas atmospheres,
Part 0 : General Requirements"
- **IEC 60079-2: 2014 Ed 6**
"Electrical apparatus for explosive gas atmospheres,
Part 2 : Equipment protection by pressurized enclosure 'p'"
- **IEC 60079-11: 2011 Ed 6**
"Electrical apparatus for explosive gas atmospheres,
Part 11 : Equipment protection by Intrinsic safety 'i'"

Users must take the full responsibility for any accident caused by their negligence or non-observance of these instructions. The manufacturer will not take any liabilities and responsibilities for any damages or losses caused by the misuse or malfunction of such equipment which is not included in the contract between manufacturer and user and provided by user, or such equipment which is installed around the robot system arbitrarily by the user. User must take the full liabilities and responsibilities for any risks and damages caused by such equipment.





HYUNDAI ROBOTICS

2

Specifications



2. Specifications

YP015-28

2.1. Robot Machinery Part

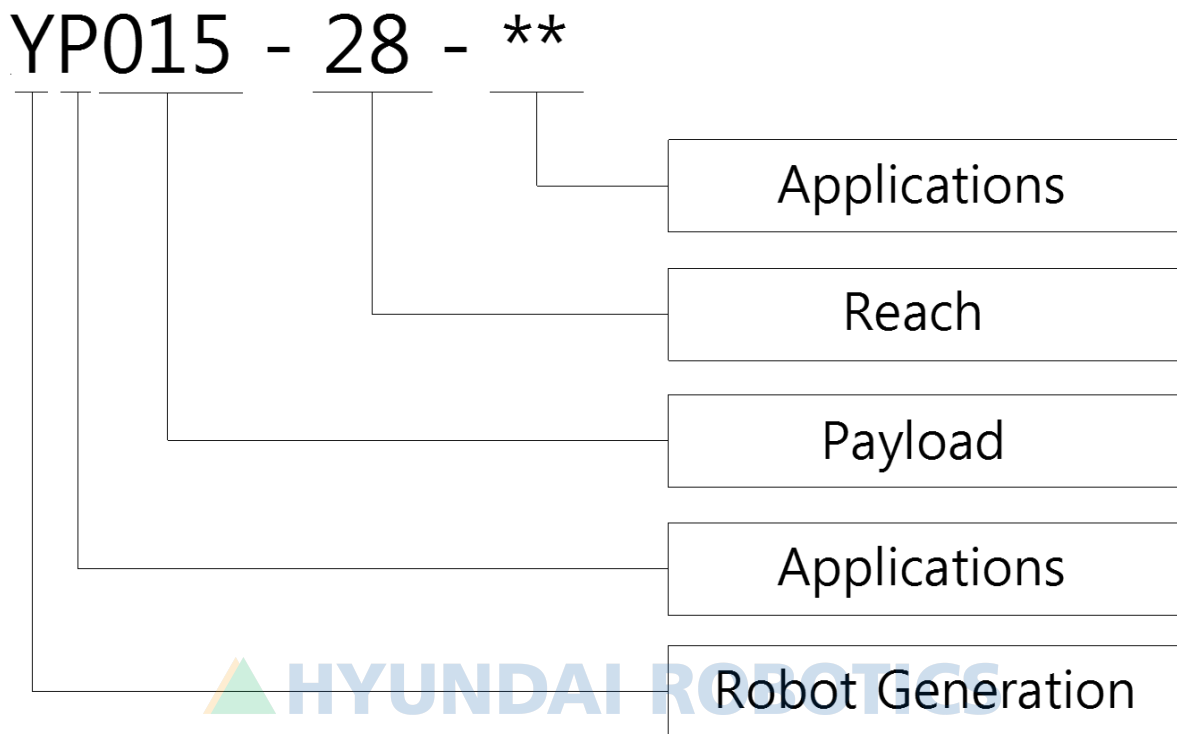
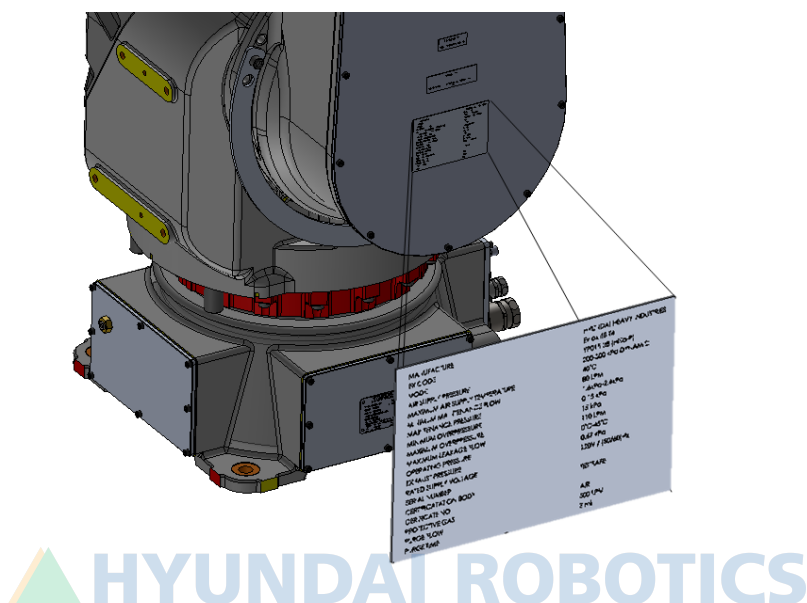


Figure 2.1 Robot Machinery Part

2.2. Location of Robot Identification Plate

The model name, serial number, and manufacturing date of robot are written down in the identification plate.

Identification plate is located at the bottom of the main body (Left or right side) as shown in the following figure.



MANUFACTURE	HYUNDAI ROBOTICS
EX CODE	Ex ib [ib] pxb IIB T4 Gb
MODEL	YP015-28 (Hi5a-P 10)
SERIAL NUMBER	
PRODUCT NAME	PAINTING ROBOT MANIPULATOR
PURGE FLOW	500 LPM
PURGE TIME	3 min
PROTECTIVE GAS	AIR
AIR SUPPLY PRESSURE	400-500 kPa DYNAMIC
MAXIMUM AIR SUPPLY TEMPERATURE	40°C
MINIMUM MAINTENANCE FLOW	50~105 LPM
MAINTENANCE PRESSURE	1.6kPa - 2.0kPa
MINIMUM OVERPRESSURE	0.15 kPa
MAXIMUM OVERPRESSURE	12 kPa
MAXIMUM LEAKAGE FLOW	50 LPM
OPERATING AMBIENT TEMPERATURE	0°C ~ 40°C
EXHAUST PRESSURE	0.67 kPa
RATED SUPPLY VOLTAGE	220V / (50/60)Hz
CERTIFICATION BODY	TESTSAFE
CERTIFICATE NO.	IECEx TSA 17.0001

Figure 2.2 The location of identification plate

2.3. Basic Specifications

2.3.1. Ex Part

Table 2-1 Specifications for Models

Item	Specification
Rating	AC220V 50/60Hz
Ex code	Ex ib [ib] pxb IIB T4 Gb
Pressurization	Leakage compensation
Enclosure Volume	204.5L (Floor type)
Min. Purge flow rate	500 NL/Min
Min. Purge duration	3Min
Protective Gas	Instrument air, (0.2~0.5) MPa
Normal flow rate	(50~105) L/Min
Min. overpressure	0.15 kPa
Max. overpressure	12 kPa
Normal internal pressure	(1.6~2.0) kPa
Max. leakage rate	50 L/Min
Protective gas Temperature	Max. 40℃
Operating Temperature	0~40℃

2.3.2. General Part

Table 2-2 Specifications for Models

Item				Specification
Structure				Articulated
Degree of freedom				6
Drive system				AC servo type
Max. Working envelope	Arm	S	Swivel	$\pm 2.793\text{rad}$ ($\pm 160^\circ$)
		H	Horizontal	$+4.014\text{rad} \sim -0.873\text{rad}$ ($+230^\circ \sim -50^\circ$)
		V	Vertical	$+1.571\text{rad} \sim -1.222\text{rad}$ ($+90^\circ \sim -70^\circ$)
		H/V	Interference	$+0.349\text{rad} \sim +5.585\text{rad}$ ($+20^\circ \sim +320^\circ$)
	Wrist	R2	Rotation 2	$\pm 6.283 \text{ rad}$ ($\pm 360^\circ$)
		B	Bending	$\pm 6.283 \text{ rad}$ ($\pm 360^\circ$)
		R1	Rotation 1	$\pm 6.283 \text{ rad}$ ($\pm 360^\circ$)
Maximum speed	Arm	S	Swivel	2.793rad/s ($160^\circ/\text{s}$)
		H	Horizontal	2.793 rad/s ($160^\circ/\text{s}$)
		V	Vertical	2.793 rad/s ($160^\circ/\text{s}$)
	Wrist	R2	Rotation 2	7.854 rad/s ($450^\circ/\text{s}$)
		B	Bending	9.425 rad/s ($540^\circ/\text{s}$)
		R1	Rotation 1	10.472 rad/s ($600^\circ/\text{s}$)
		Load Capacity		
Wrist torque		R2	Rotation 2	65.7 N·m (6.7 kgf·m)
		B	Bending	52.0 N·m (5.3 kgf·m)
		R1	Rotation 1	44.1 N·m (4.5 kgf·m)
Accuracy of position repeatability				$\pm 0.2 \text{ mm}$
Robot's Weight				600kg
Ambient Temperature				0~40℃ (273 ~ 318 K)
Relative humidity				20 ~ 85 %RH
Vibration				0.5G

2.4. Robot Dimension and Working Envelope

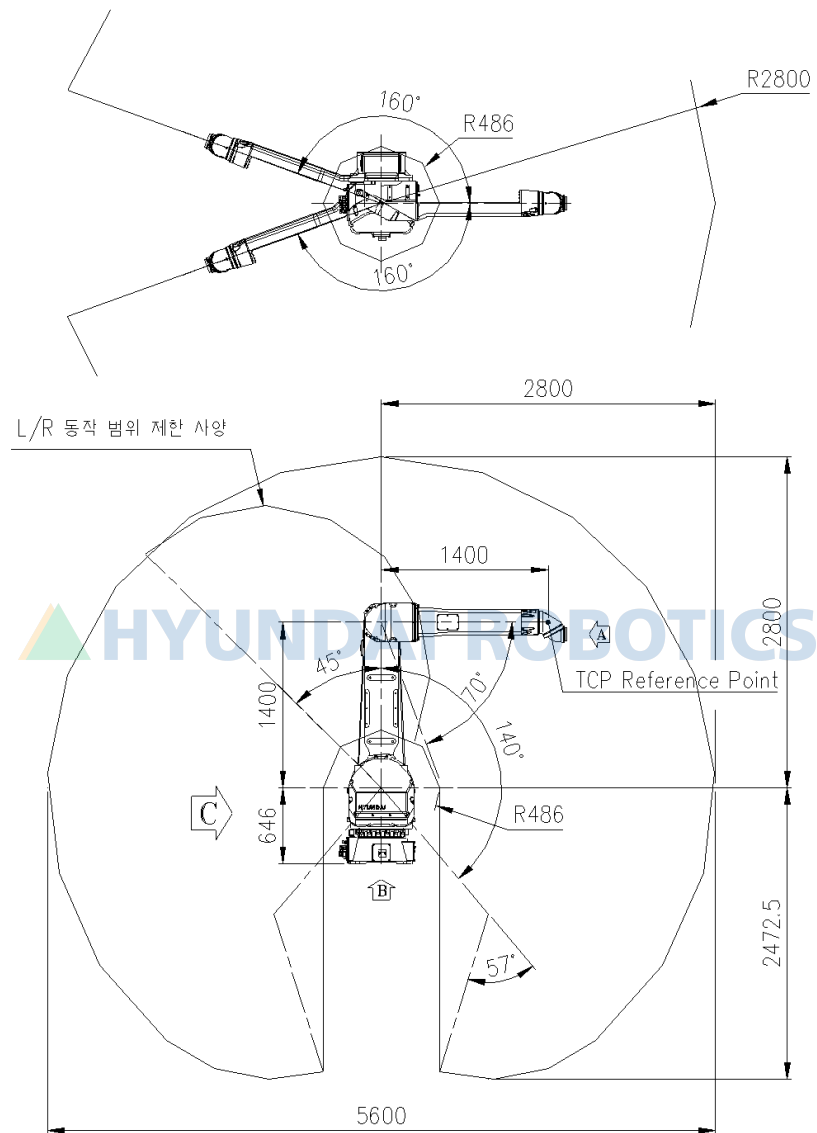


Figure 2.3 Robot Dimension and Working Envelope

2.5. Axis Identification

Table 2-3 Axis Motion

Axis Name	Operation	Teach Pendant Button	
S	Arm Swivel	X+(S+)	X-(S-)
H	Arm Forward and Backward	Y+(H+)	Y-(H-)
V	Arm Upward and Downward	Z+(V+)	Z-(V-)
R2	Wrist Rotation 2	RX+(R2+)	RX-(R2-)
B	Bending	RY+(B+)	RY-(B-)
R1	Wrist Rotation 1	RZ+(R1+)	RZ-(R1-)

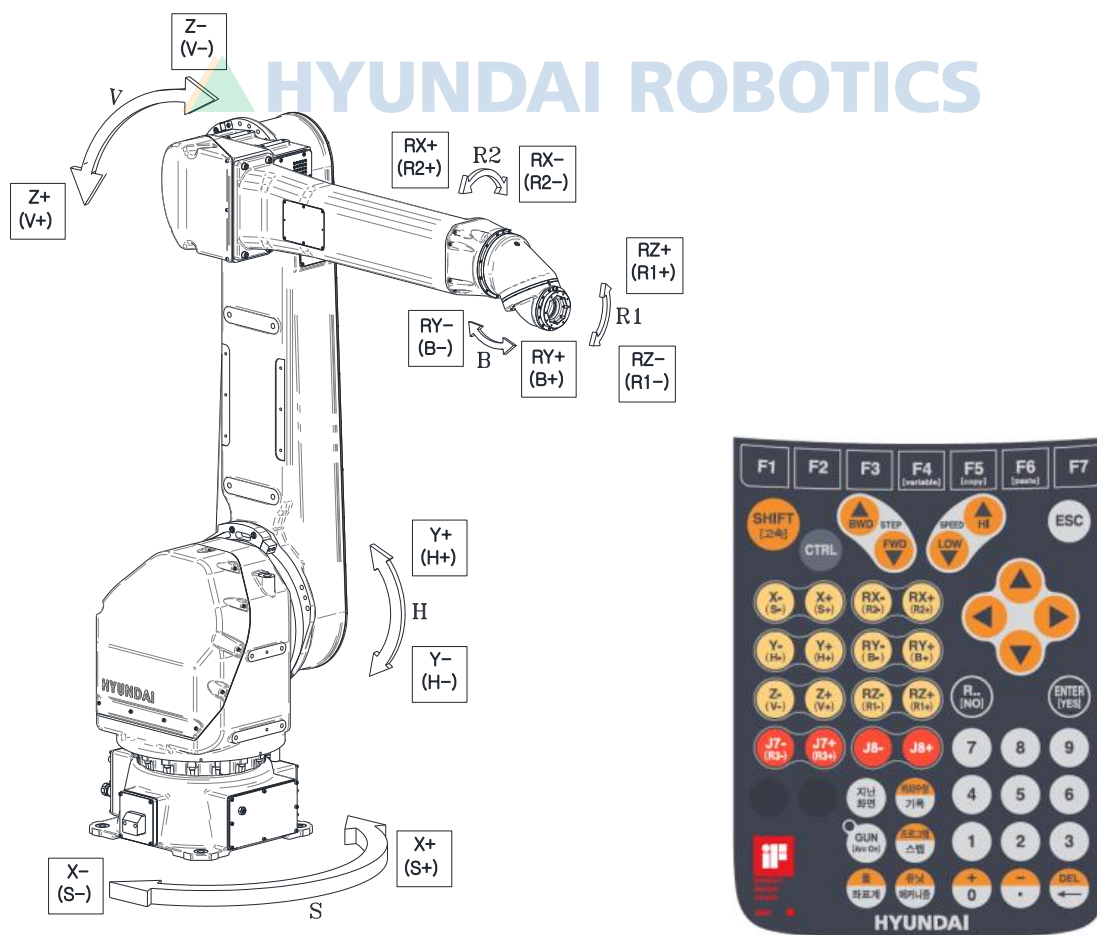


Figure 2.4 Robot Dimension and Axis

2.6. Details of Wrist Axis Attachment Surface

When attaching the work tool on the flange of the wrist end, use the bolt of the applicable model.

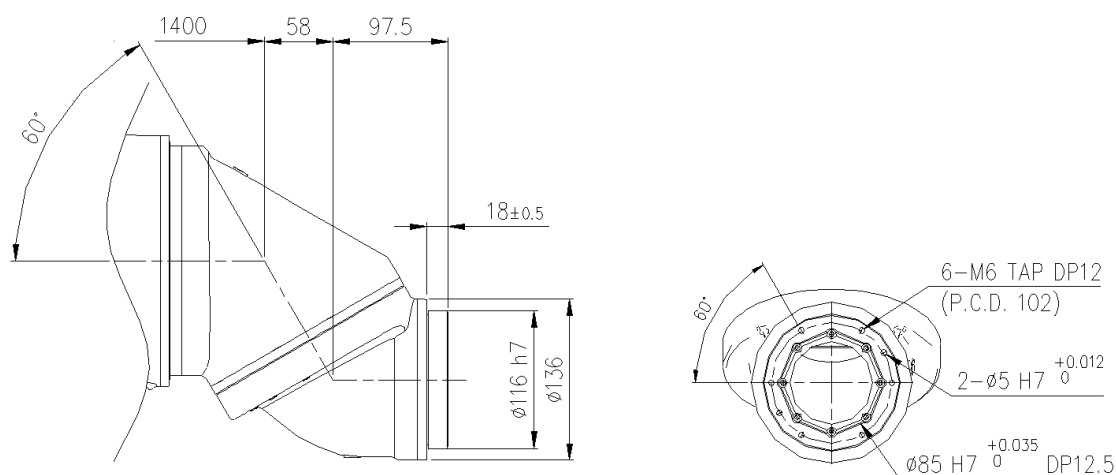


Figure 2.5 Details of Wrist Axis Attachment Surface



2.7. Detail diagram of attachment surface of Arm

There is a tap on the top of the arm pipe of the robot to attach any peripheral device.
When used with the arc welding, the wire supply device must be installed on the 1st arm.

[Handling precautions]

Attach so that the center of gravity is positioned within the allowable range.

- Maximum load of Arm Pipe/Upper Frame : each of 15kg

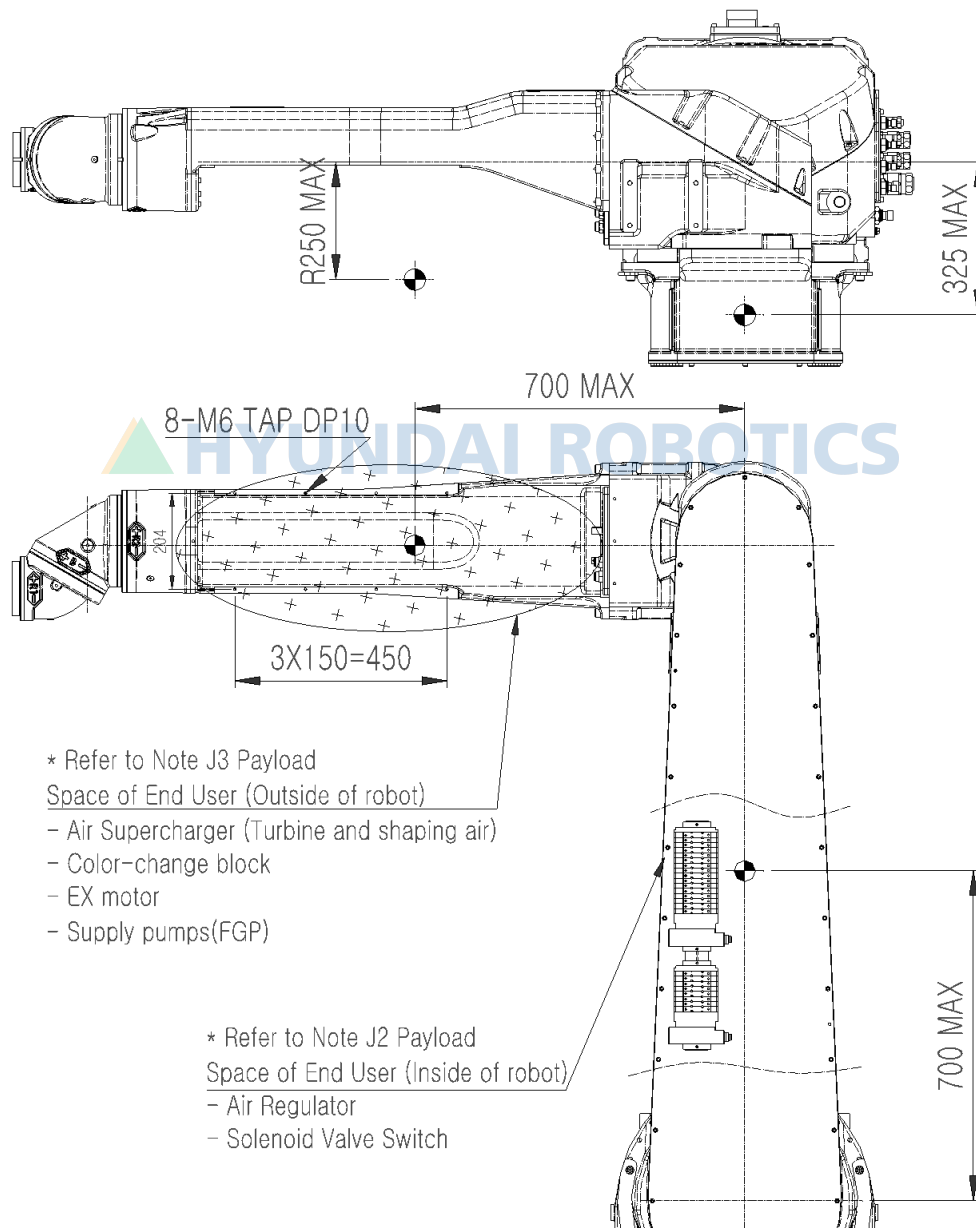
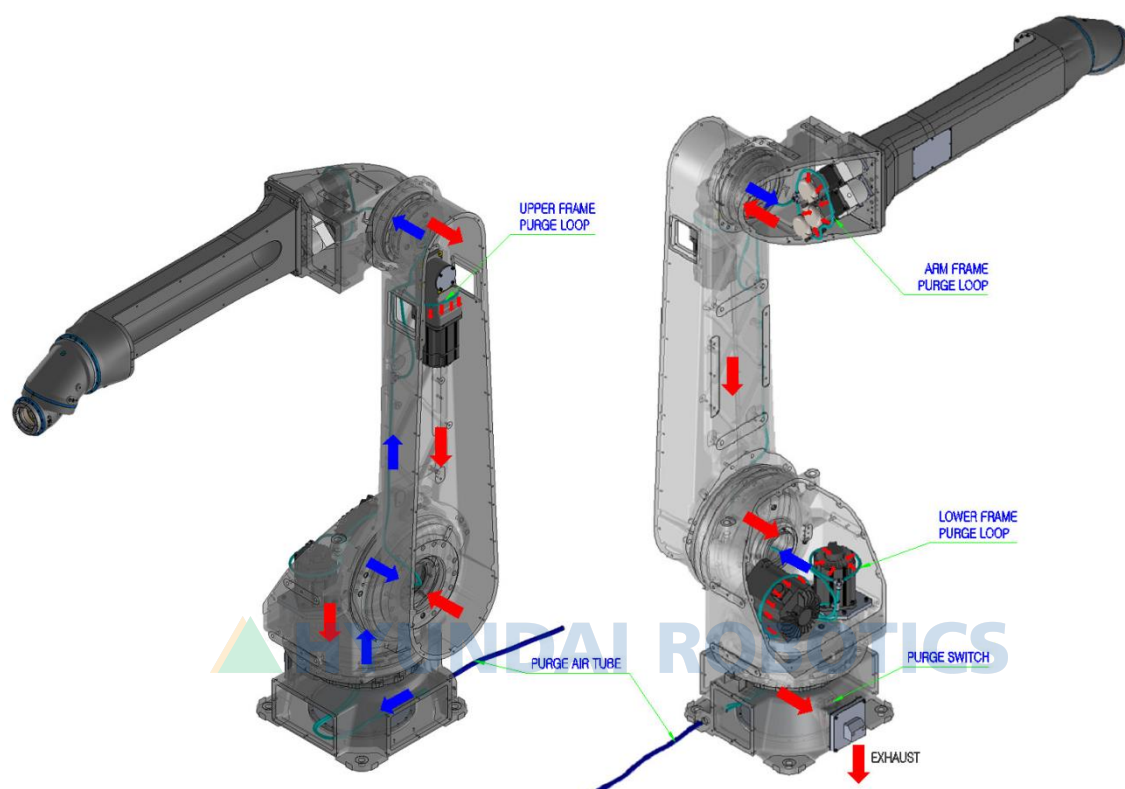


Figure 2.6 Detail diagram of attachment surface of arm

2.8. Purge System

2.8.1. Purge Flow



NOTE.




1.  (BLUE ARROWS) : AIR FLOW IN
2.  (RED ARROWS) : AIR FLOW OUT
3.  (BLUE TUBING) : PURGE AIR

Figure 2.7 Detail diagram of Purge Flow

2.8.2. Operation Range Safety Device & Tolerance

Table 2-4 Safety Device and operation range

No.	Part Name	Operation range	Allowable error
1	Pressure Gauge	0.05 ~ 0.9 MPa	± 3% FS
2	Regulator R1000(3/8")	0.05 ~ 0.85 MPa	± 3%
3	Pressure Sensor	1.25 ~ 498 kPa	± 10%
4	Flow Sensor	3.7 ~ 14.9 kPa	± 10%
5	Relief Valve	1.6 kPa	± 10%
6	Purge Valve	0.2 ~ 0.9 MPa	

2.8.3. Routine Test

Table 2-5 Routine Test

No.	Test	Contents
1	Functional Test	The performance of Safety devices is tested
2	Leakage Test	With the air outlet valve closed and Robot internal pressure is set maximum overpressure, the leakage flow rate is measured at the inlet point

2.8.4. Purge Air Control Logic

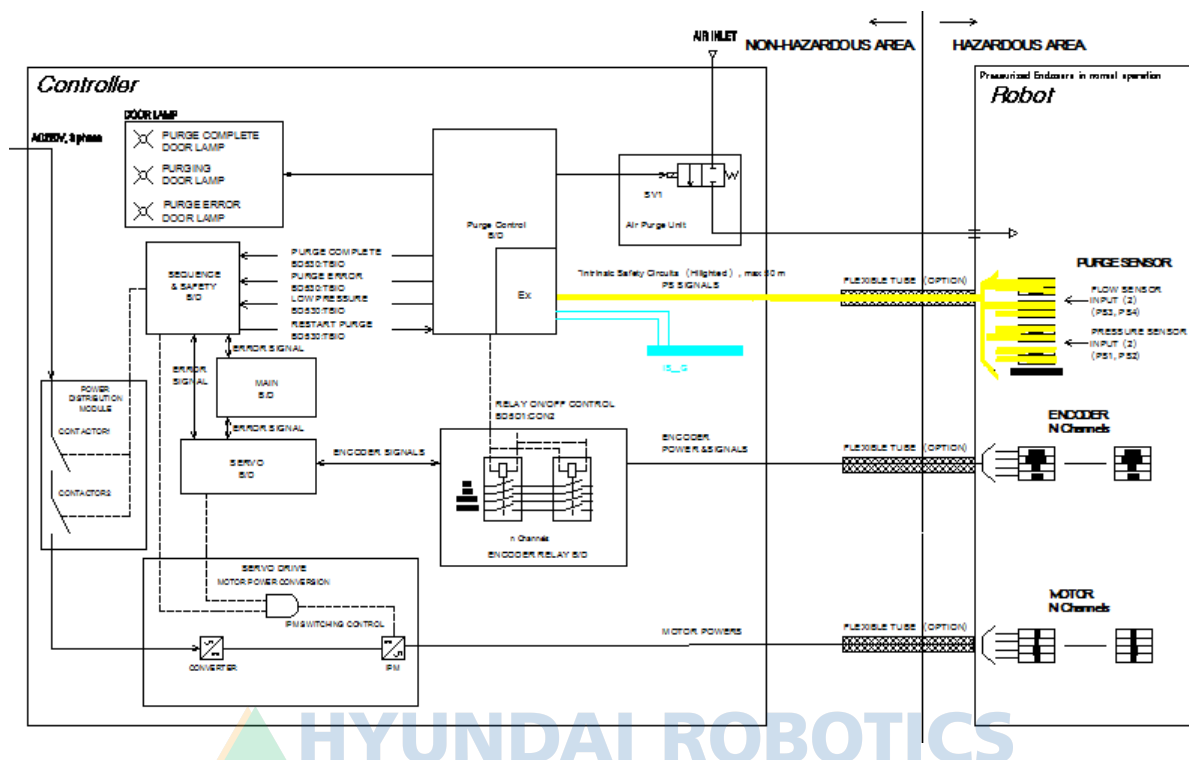


Figure 2.8 Purge Air Control Logic

2.8.5. Pneumatic Schematic

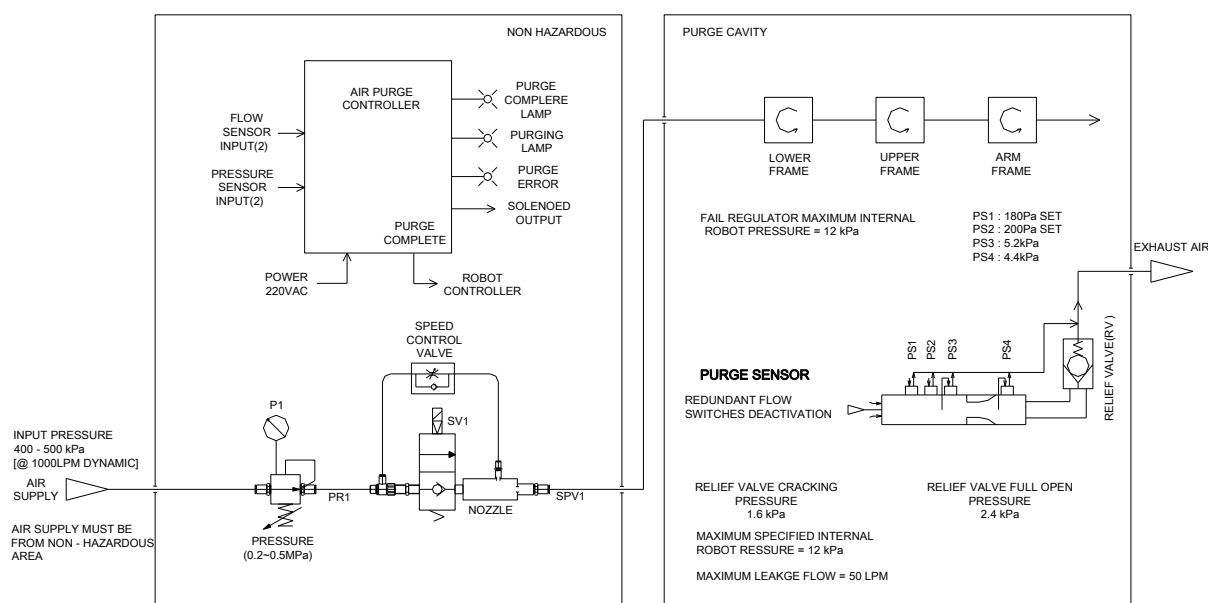


Figure 2.9 Pneumatic Schematic

2.8.6. Purge Flow Chart

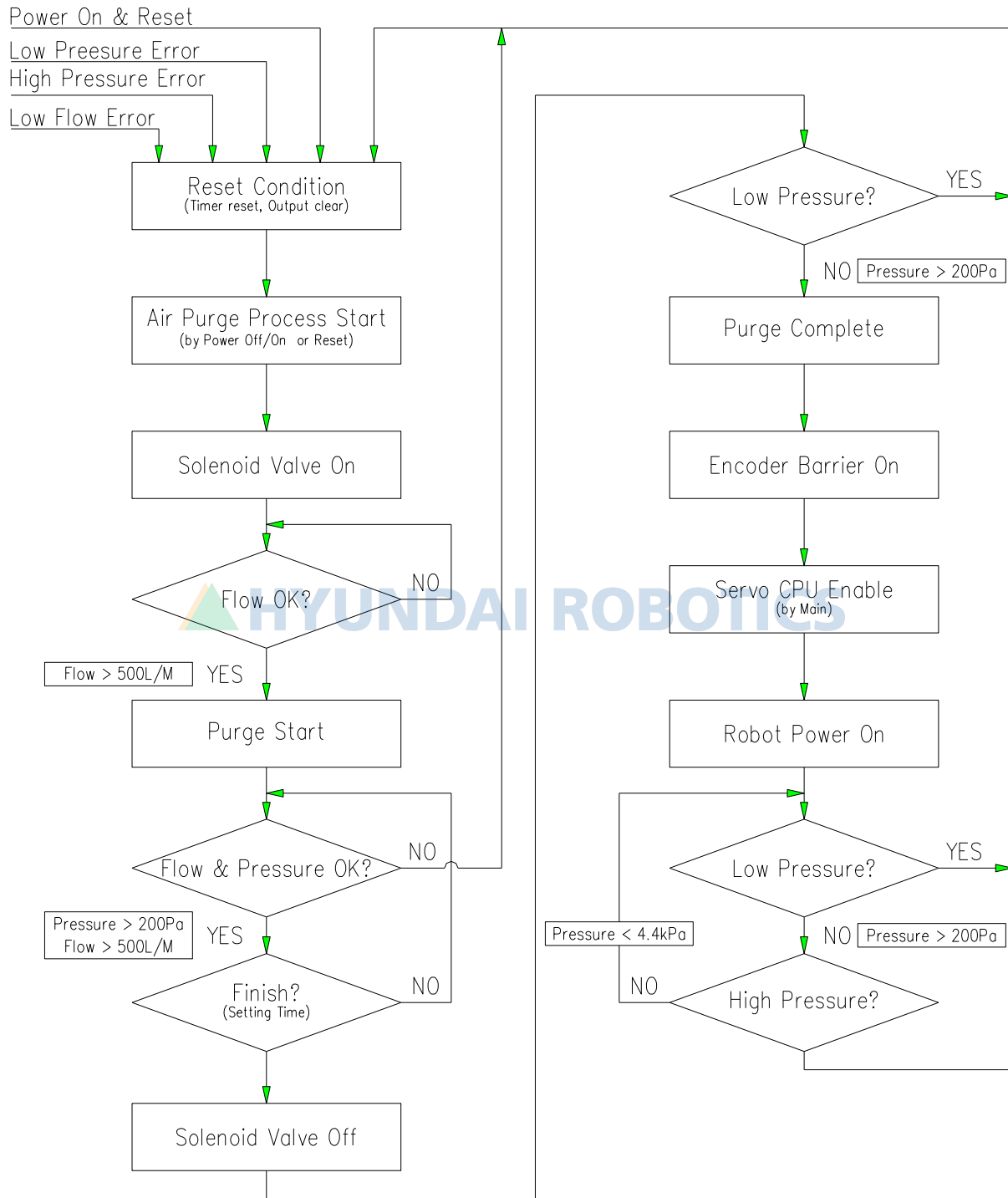


Figure 2.10 Purge Flow Chart

2.8.7. Calculation of Purge time

- Floor Type

* Internal Volume

204.6 ℓ

* 5 times of Internal Volume

$204.6 \text{ ℓ} \times 5 \text{ times} = 1023 \text{ ℓ}$

* Purge Flow

500NL/min

* Purge Time

$1023 \text{ ℓ} / 500\text{NL/min} = 2.04 \text{ Min}$

Minimum 3 minutes

Figure 2.11 Calculation of Purge Time

Table 2-6 Purge Flow Table

Supply Pressure	Purge		
	P3 (kPa)	P4 (kPa)	Flow(L/Min)
140kPa (1.4 Bar)	3.8	3.6	350
200kPa (2.0 Bar)	4.8	4.2	475
250kPa (2.5 Bar)	5.2	4.4	550
300kPa (3.0 Bar)	6.6	5.4	590
400kPa (4.0 Bar)	8.2	6.0	660
500kPa (5.0 Bar)	9.4	6.6	700

2.9. Air & Power Line Connection

There are air unit and connector to connect the additional equipment to the robot manipulator.
Application connectors are indicated as follows.

[Note] Max. Air Pressure : 5bar (5.1 kgf/cm², 72.5 psi)

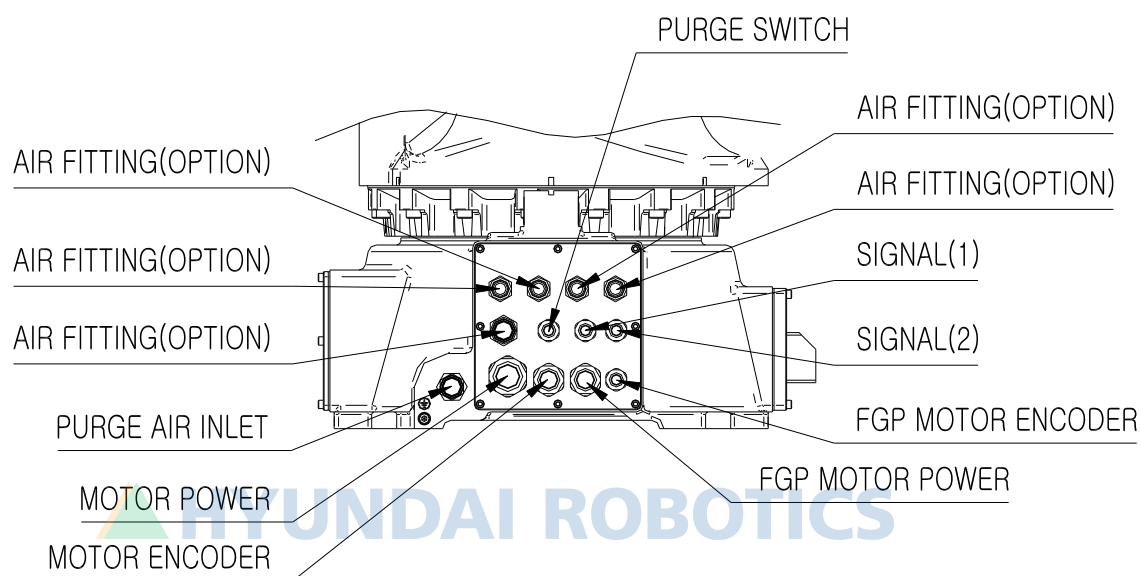


Figure 2.12 Air & Power Line Connection: [Standard]

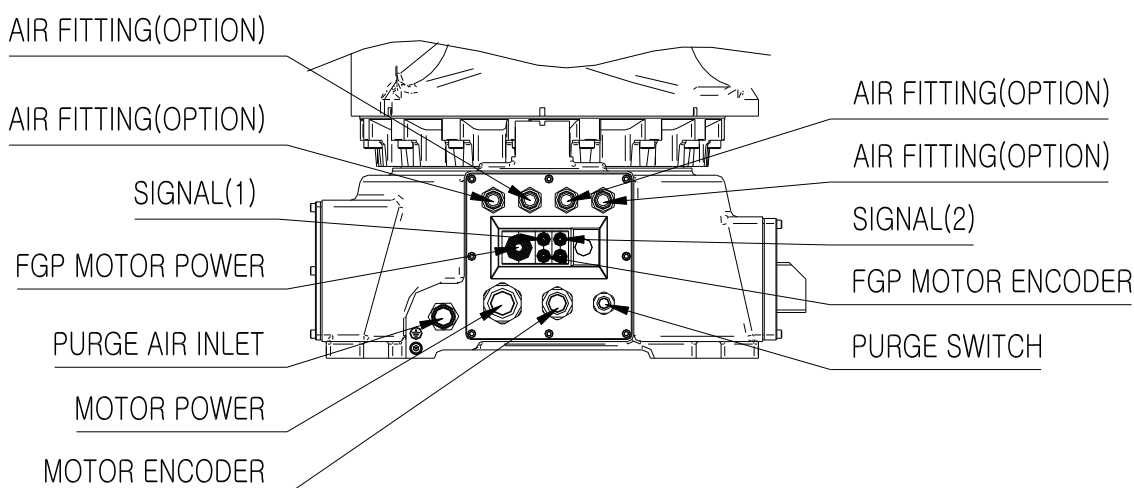


Figure 2.13 Air & Power Line Connection: [Option]

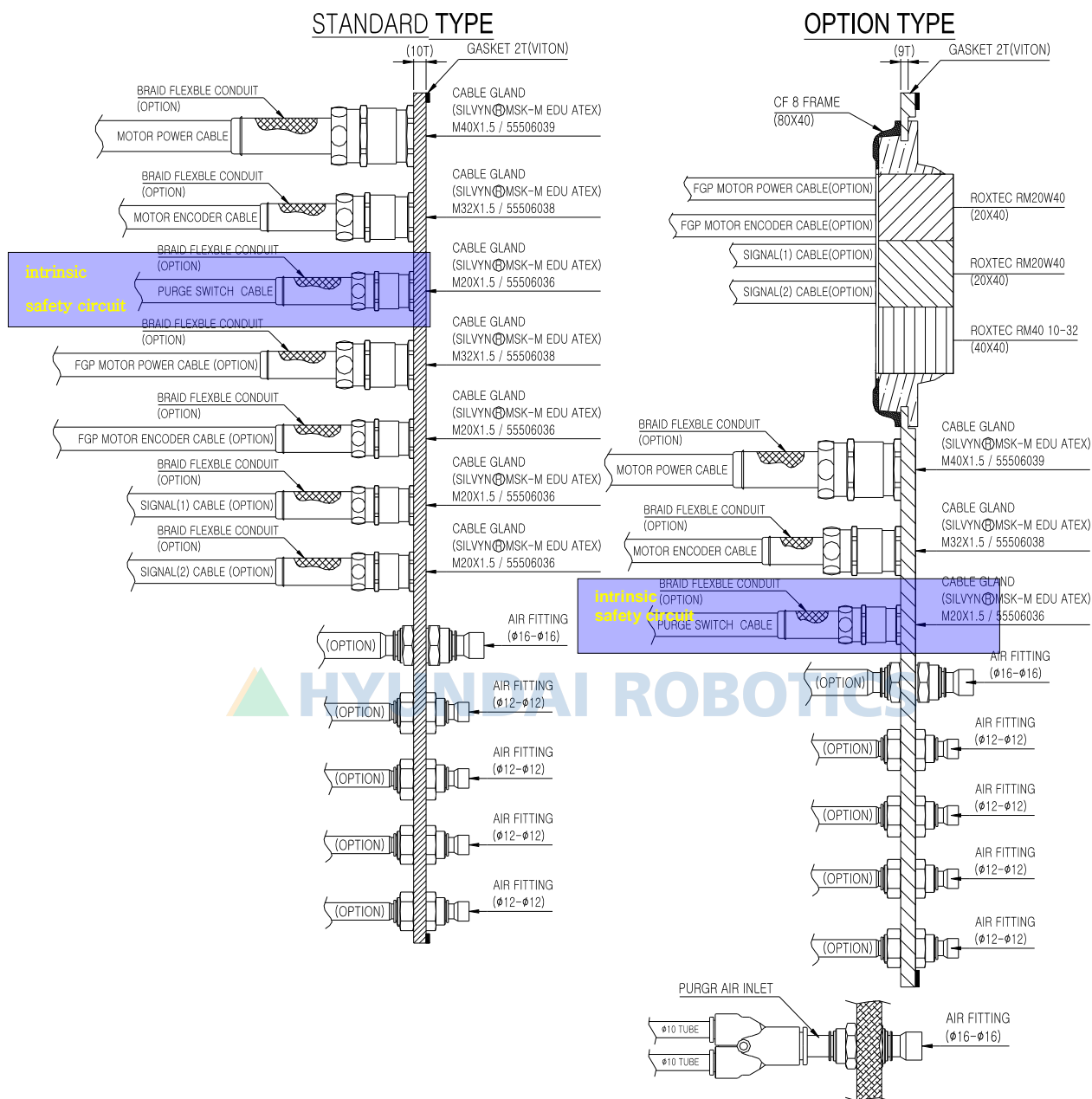


Figure 2.14 Air & Power Line

2.10. Intrinsic Safety Connection

The intrinsically safe pressure switch input circuits are monitored by the purge control B/D. When the robot body is pressurized, the purge control b/d activates the purge solenoid valve in the air purge unit.

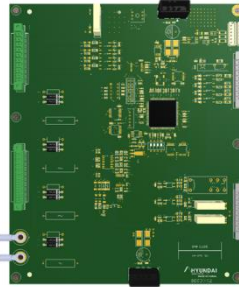


Figure 2.15 Purge Control B/D

For intrinsically safe signals, maintain 50.0 mm distance from all other cables and connections.

IS ground cable shall have a minimum thickness of 12 AWG (4mm²). Intrinsic safe ground connection shall be required to connect dedicated conductor (earth bar in below figure) run to the reference ground point. The resistance of this connection must be less than 1 ohm.

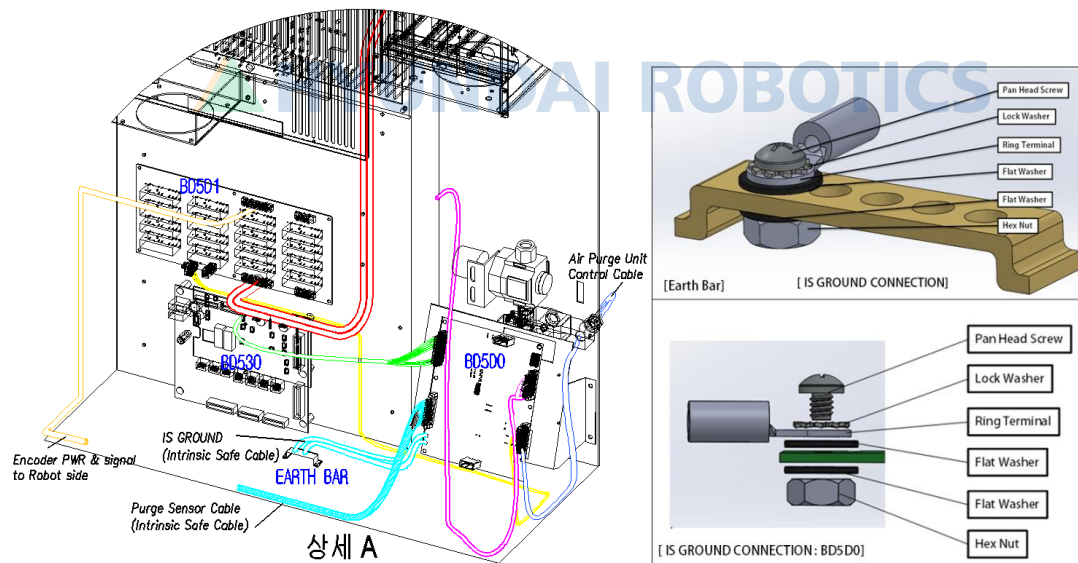


Figure 2.16 Controller Internal Wiring





3

Instructions



3. Instructions

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3.1. Robot Component Name

Name of each part of the main body is as shown in [Fig. 3.1].

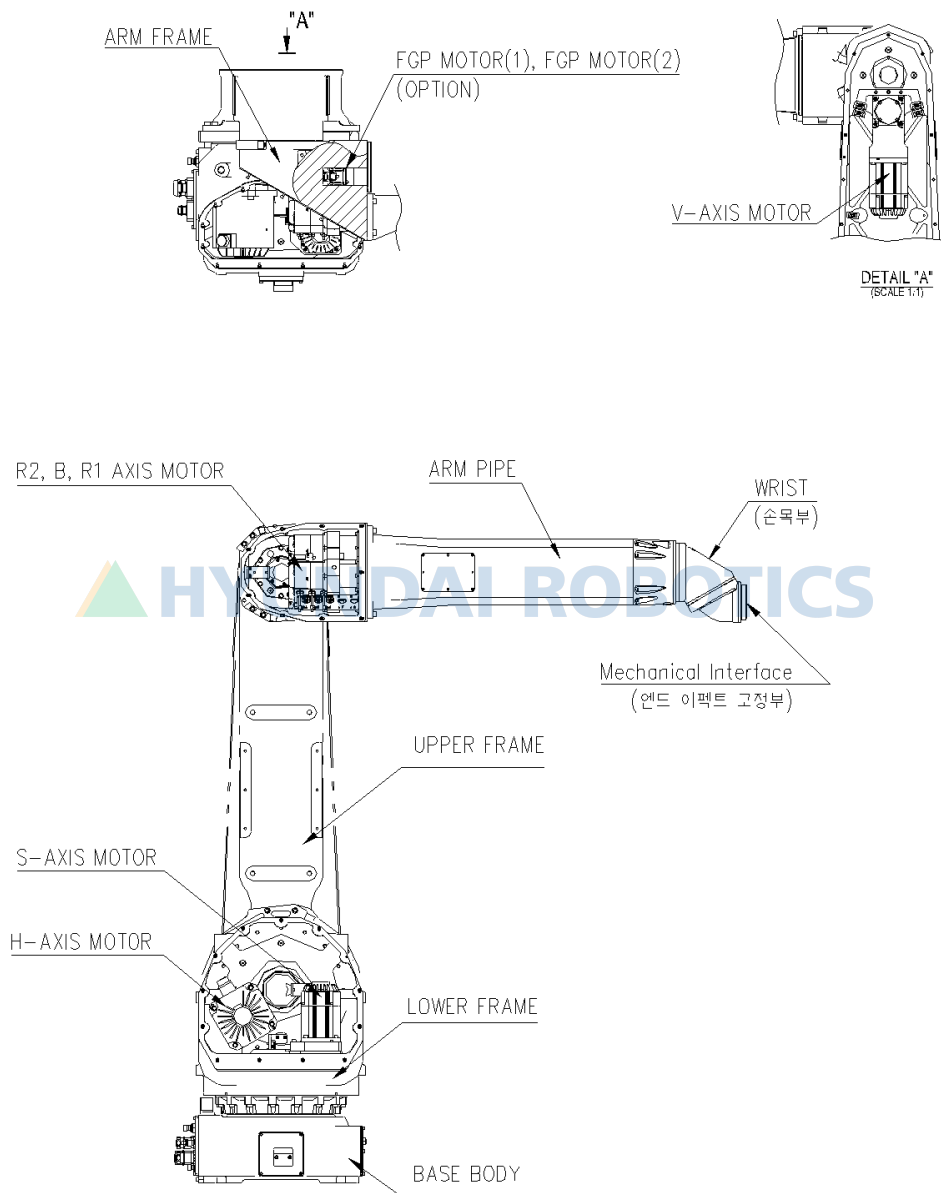


Figure 3.1 Name of Robot Components

3.2. Location of Safety Nameplate

In order to prevent any accidents, safety marking plates such as [Figure 3.2] are attached to the robot. Do not remove or replace it unnecessarily.

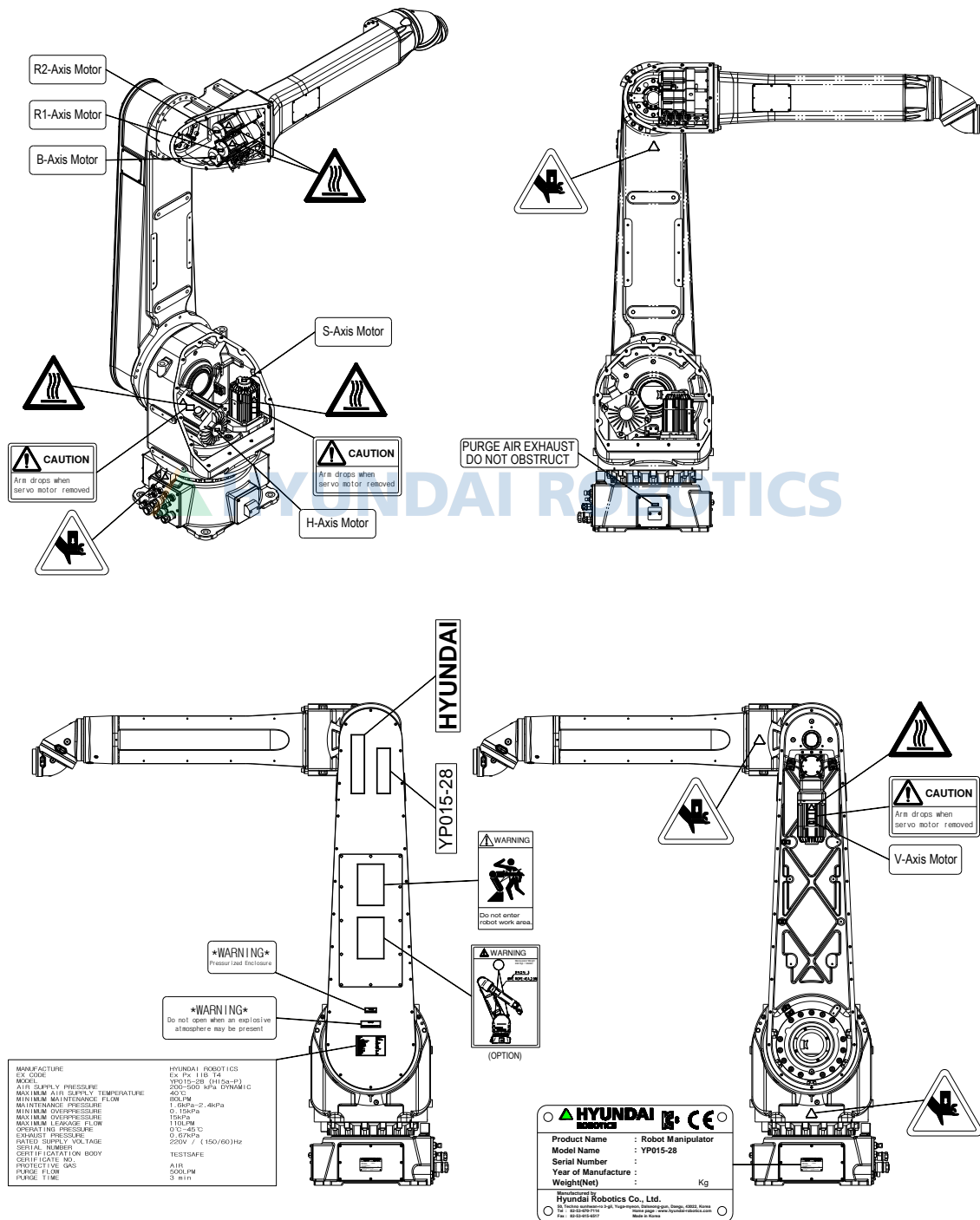


Figure 3.2 Location of Safety Nameplate

3.3. Transportation method

Robot transportation can be carried by using crane and forklift. When moving the robot, change it to a robot position suitable for each transportation situation as shown below and transport it using the eyebolt and designated transportation equipment.



- If you move or lower the robot, be very careful when moving slowly.
- When the robot is lowered on the floor, be careful not to cause strong collision with the bottom surface of the robot.
- Never transport this product by any means other than designated transportation equipment and methods.

3.3.1. Using crane

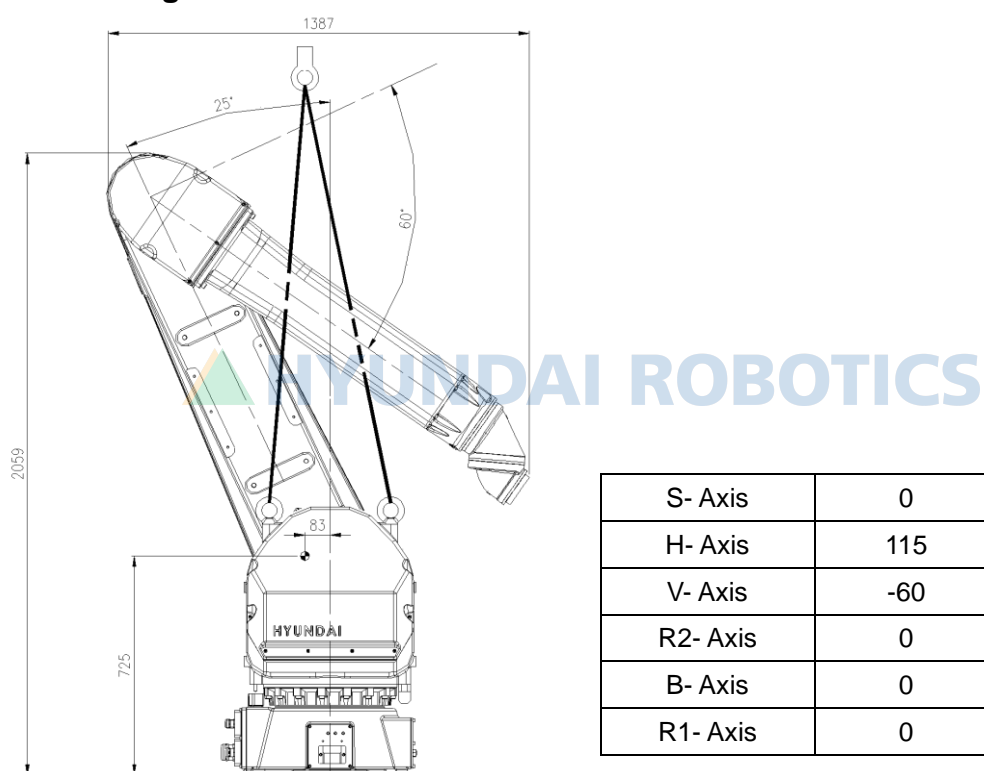


Figure 3.3 How to Transport: Using crane

The following lifting instructions are valid for a "naked" robot. If additional equipment is put on the robot, the center of gravity may change and make lifting dangerous.

- Never walk under the robot.
- Pose the robot as shown in the Figure.
- Install the 2-M24 eye bolt to the Lower Frame.
- Connect a wire rope to the EYE BOLTS.
- Minimum Crane Capacity : 2 Tone, Minimum rope Capacity : 1 Tone/each rope
- Attach the protective hose (50cm) to prevent the damage to the main body of the robot.
- Keep the safety regulations during lifting process.
- Secure the rope with care to avoid damaging the robot's motors, connectors, and cables.
- Weight of manipulator : 600kg

3.3.2. Use of forklift

When transporting the main body of the robot, you can use the forklift.

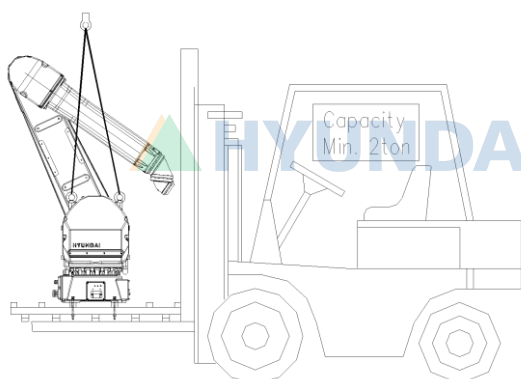
Follow the below procedure for safety purposes.

- Refer to the figure and take the basic pose for each model.
- Fixate the robot to the pallet and insert the fork of the forklift to transport the robot. The pallet must be able to sufficiently withstand the strength.
- Transport in low speed.
- Follow the safety regulations.



Caution

- Do not lean on the main body of the robot during the transportation work.
- When loading/unloading the main body of the robot, make sure that the robot does not collide with the floor.
- Follow the safety rules when operating the forklift.
- Make sure that the robot is fixed to the pallet before the work.



S- Axis	0
H- Axis	115
V- Axis	-30
R2- Axis	0
B- Axis	180
R1- Axis	0

Figure 3.4 Transportation method: Use of forklift

3.4. Robot storage

When storing the robot without installing the robot, keep the robot in the following position as shown in [Fig. 3.4].



[Caution]

If you store the robot in a different position, the robot can fall over. When storing the robot for a long period of time, take safety measures so that the robot does not fall over.

3.5. How to Install



NOTE:

Before starting to unpack and install the robot, read the safety regulations and other instructions very carefully.



Warning:

The installation shall be made by qualified installation personnel and should conform to all national and local codes.

When unpacking the robot, check if it has been damaged during transporting or unpacking. In addition, strictly keep the following installation instructions because installation method and foundation are very important to maintain a good robot performance.

3.5.1. Operating Conditions

- (1) Ambient temperature should range from 0°C to 40°C.
- (2) Ambient humidity should range from 20% to 85% RH, without dew condensation.
- (3) Less dust, oil, or moisture.
- (4) No flammable, corrosive liquid or GAS.
- (5) No impact and shacking.
- (6) No electrical noise generator near the robot.
- (7) If the robot is not immediately installed, keep it in a dry area at an ambient temperature between 0°C ~ and 40°C.

3.5.2. Installation the Robot Manipulator

The base floor where the robot will be installed must be designed to have hardness to minimize the dynamic effect of the robot.

When installing the robot on the concrete floor with thickness of 300mm or more, repair any uneven areas or cracks and fixate the mounting plate with M20 anchor bolts. And when installing the robot on the concrete floor with thickness of less than 300mm, make sure to review prior to the installation as it requires base construction.

The main body of the robot must be fixated firmly with 4ea M20 bolts. All 4 bolts must be used.

In particular, when installing on walls or ceilings, the bottom material should be constructed of steel or aluminum with a yield strength of at least 200 MPa.

- Bolt : M20X70(12.9) SOCKET HEAD BOLT
- Flate Washer : T=4mm or above, internal diameter = 24, hardness of HrC 35
- Assembly torque : $530 \pm 20\text{Nm}$ ($5,404 \pm 204 \text{ kgf-cm}$)

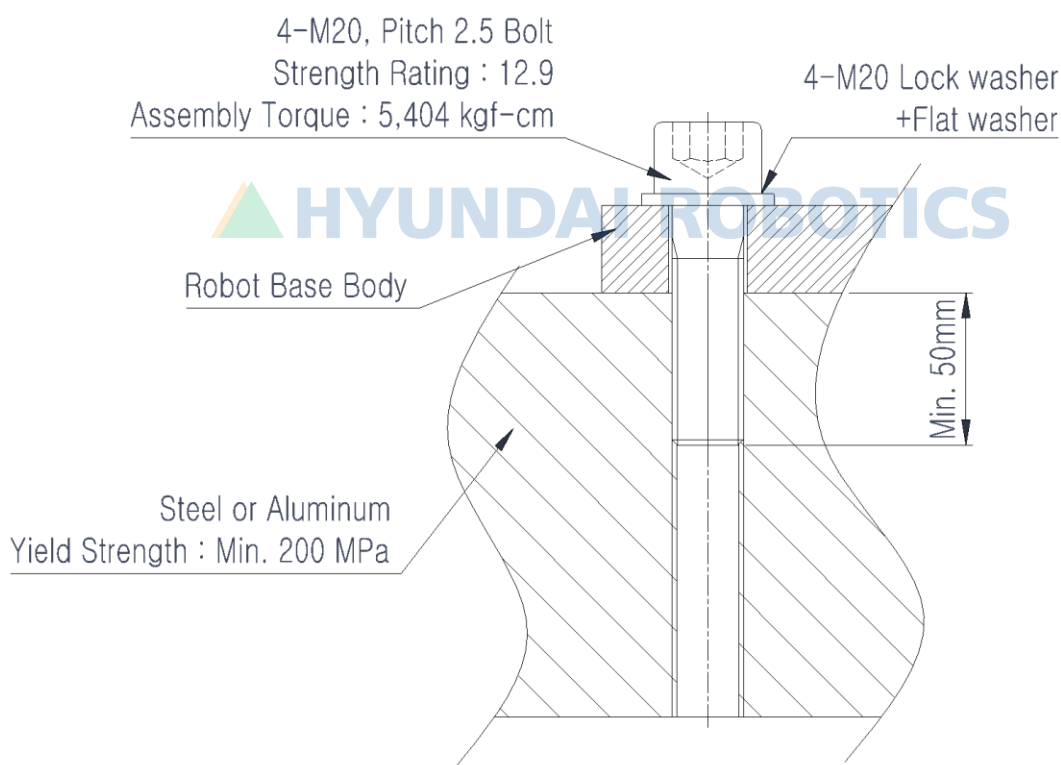


Figure 3.5 Section of Robot Installation(Floor, Wall, Ceiling)

3.5.3. Dimension of Installation Surface

Assemble the base body of the robot on the common base, Refer to the following dimensions.

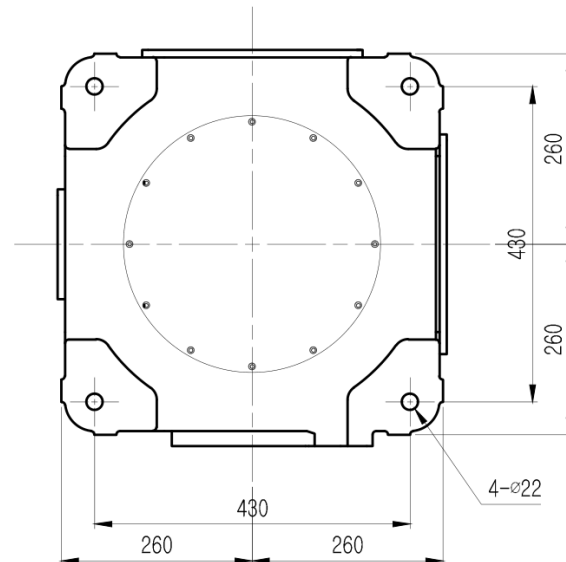


Figure 3.6 Dimension of Robot Installation

3.5.4. Accuracy of Installation Surface

The degree of flatness for the four attachment plate surfaces should satisfy the specification. Use a shim, if necessary. The rest of the surface must be flat within $\pm 2\text{mm}$.

■ Cautions

- ① The flatness of the 4 mounting plates must be within 1.0 mm.
- ② The flatness of the 4 areas of the plate for assembly must be within 1.0 mm ($\pm 0.5\text{ mm}$).

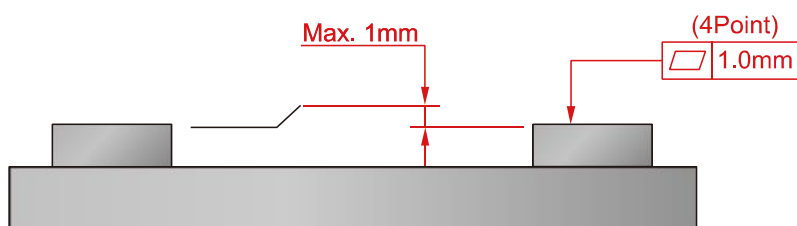


Figure 3.7 Robot installation surface accuracy

3.5.5. Robot Cable Connection

The robot is connected to the controller through a power cable and a signal cable.

Connect these cables to the connector on the back of the robot base.

(In the case of a painting robot, the robot and the cable are integrated.)

Connect the ground wire.

For pneumatic and optional cable connection, refer to 2.9 Air & Power Line Connection page.



Be sure to turn off the controller when connecting the cable.





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4

Inspection



4. Inspection

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This chapter provides the instructions for regular inspection and overhaul necessary for the prolonged lifetime of robot performance.

4.1. Inspection Schedule

Inspection is positively necessary to continue and maintain the high performance of robot for long-term operation.

There are daily inspection and regular inspection. [Table 4-1] shows basic periods for regular inspections, so inspectors should make an inspection according to the indicated periods.

And overhaul every 35,000 operating hours.

The inspection periods have been reviewed for SPOT Welding. In case of high precision work such as handling, it is recommended to inspect at the half intervals of that period as shown in [Table 4-1].

If you have difficulty in understanding the inspection and adjustment methods, please contact the Hyundai Robotics A/S Center (Customer Support).

Table 4-1 Inspection Schedule

Daily Inspection	Daily	MANIPULATOR, MOTOR, REDUCER
Regular Inspection	3months	WIRING, BOLTS, REDUCER
	1 year	LIMIT SWITCH / Dog, Brake

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4.2. Inspection Item and Period

Table 4-2 Inspection Items and Periods

No.	Inspection Intervals			Inspection Items	Inspection method	Standards	Remark
	Daily	3months	1year				
Robot Manipulator and Axes common							
1	○			Cleaning	Examine dirt and dust with naked eyes		
2		○		Inspection wiring	· Examine any cable damages · Examine cable fixing bracket tightening, paint marking with naked eyes · Examine any cable cover damages with naked eyes		
3		○		Main bolts	Examine paint marking with naked eyes		
4			○	Limit Switch/ Dog	Check the ON-OFF function of limit switch	Check if the emergency stop lamp is on when the limit switch is ON.	
5	○			Motor	Check the abnormal heating Check the abnormal sound		
6			○	Brake	Check the ON/OFF operation of brake release switch Note) Turn the switch off in a second because the ARM of working axis may be dropped when the brake release switch is on	When the brake release switch is OFF, ARM of End Effect will not be dropped.	
Axis S, H, V							
7	○			Reducer	Check the abnormal sound Check the shaking(vibrating)		
Axis R2, B, R1							
8		○		Reducer	Check the abnormal sound Check the shaking(vibrating)		
9		○		End Effect tightening bolts	Examine paint marking with naked eyes		

- If the robot is utilized in adverse condition(such as spot welding, grinding, etc.), perform the inspection more frequently to ensure proper reliability of the robot system
- Inspect all visible cabling, and replace them if damaged.
- Check the mechanical bumper devices for deformation and damage. If the bumper or Dog is bent, replace it immediately.
- Check the tightening torque of main bolts as shown in [Figure 4.1]
- Check the abnormal noise in an automatic or teaching mode in order to ensure the condition of power transmission (such as motor, reducer, etc).



4.3. Inspection of Main External Bolts

The recommended bolt torque is shown in [Figure 4.1].

Apply the appropriate torque, where required, using the torque wrench and place the paint marking where the check-up is completed.

Table 4-3 Inspection part for main bolts

No.	Inspection parts	No.	Inspection parts
1	S axis reducer seal bolt	5	V axis reducer seal bolt
2	S/V axis motor seal bolt	6	R2/B/R1 axis motor seal bolt
3	H axis reducer seal bolt	7	Arm Pipe assembly seal bolt
4	H axis motor seal bolt	8	Wrist Base Seal Bolt

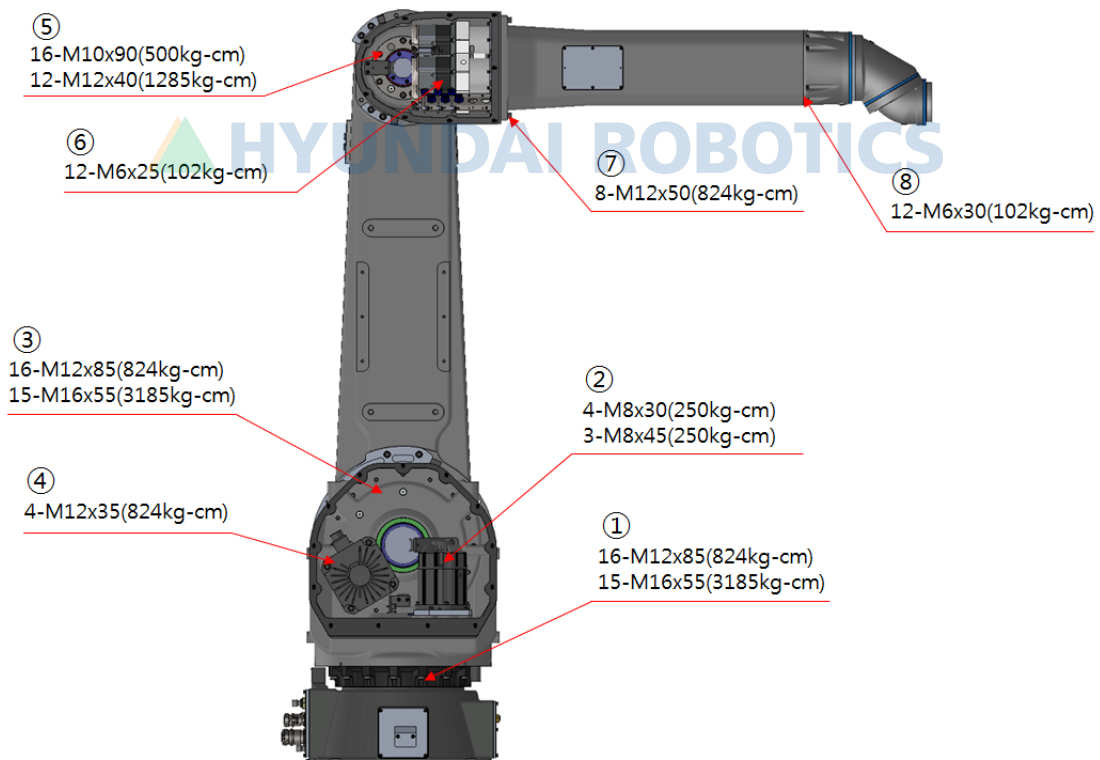


Figure 4.1 Inspection part for main bolts

4.4. Bolt Specification and Quantity of each Cover part

Bolt specification and quantity are shown in [Table 4-4].
Apply the appropriate bolts refer to Figure 4.2

Table 4-4 Bolt spec. & Qty

No.	Cover name	Bolt spec.	Bolt Qty
1	ARM FRAME COVER	M6X20, DACRO-COATING	9EA
2	LOWER FRAME COVER	M6X20, DACRO-COATING	13EA
3	BJ3 COVER(1)	M6X16, DACRO-COATING	8EA
4	BJ2 COVER	M6X25, DACRO-COATING	4EA
5	FGP MOTOR PLATE(2)	M6X16, DACRO-COATING	8EA
6	PLUG PLATE	M6X20, DACRO-COATING	2X4EA
7	UPPER FRAME COVER(2)	M6X16, DACRO-COATING	12EA
8	UPPER FRAME COVER(1)	M6X20, DACRO-COATING	26EA
9	BJ1 COVER(1)	M6X20, DACRO-COATING	8EA
10	BJ3 COVER(2)	M6X16, DACRO-COATING	8EA

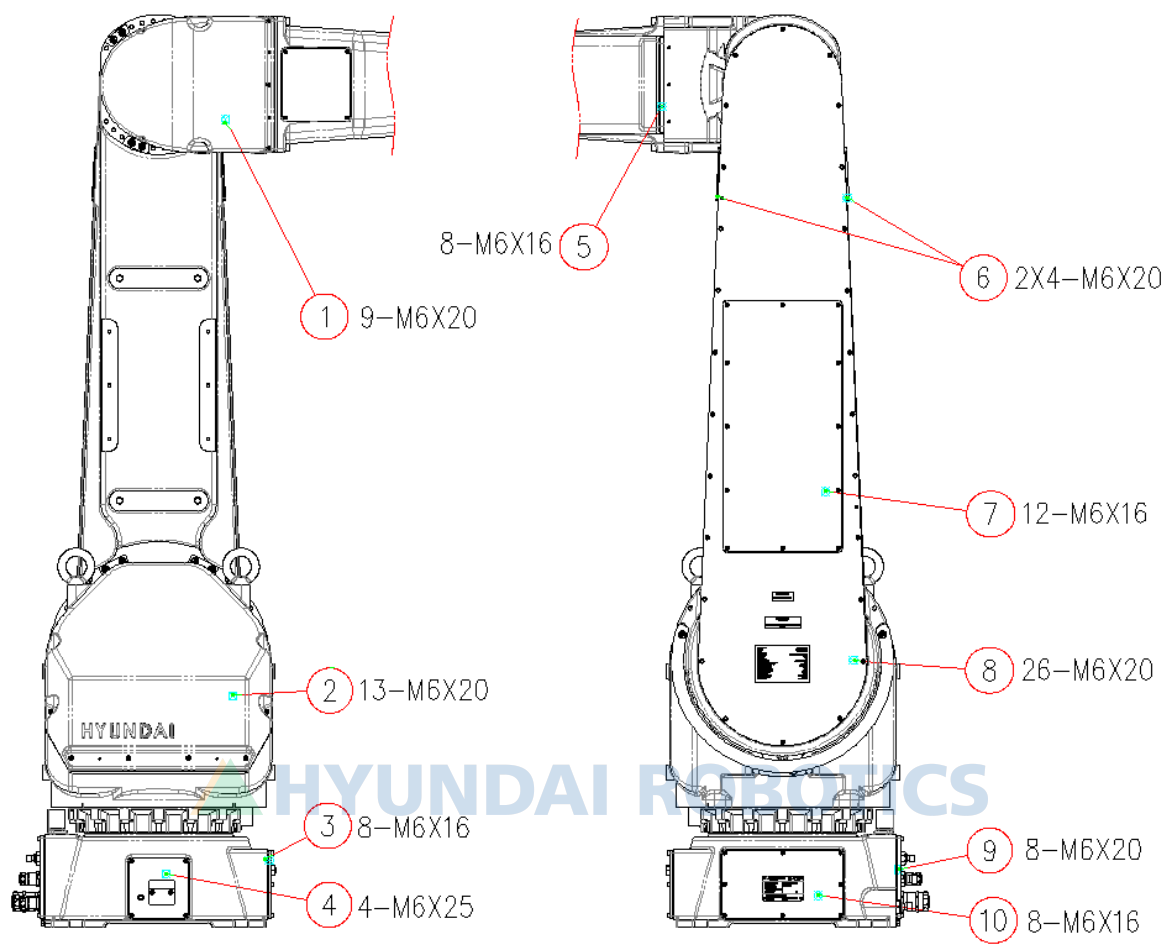


Figure 4.2 Bolt position of each cover part





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5

Maintenance



5. Maintenance

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5.1. Grease replacement & Injecting grease after replacing the reducer



Attention

If greasing is performed incorrectly, the internal pressure of the grease bath may suddenly increase, possibly causing damage to the seal, which would in turn lead to grease leakage and abnormal operation. When performing greasing, therefore, observe the following cautions.

- (1) Make sure to wear safety glasses before injecting grease and inspection.
- (2) Before starting to grease, remove the plug from the grease outlet.
- (3) When loosening a plug, grease and the plug could be discharged. Block the outlet with a thick cloth to prevent injuries caused by discharged grease or plug, and keep a distance away for safety. (Do not look into the grease outlet.)
- (4) Whenever possible, avoid using a compressed-air pump, powered by the factory air supply. If the use of a compressed-air pump is unavoidable, restrict the greasing pressure less than 1.5bar(1.5kgf/cm², 0.15MPa)
- (5) Use grease only of the specified type. If not, may damage the reducer or lead to other problems.
- (6) After greasing, confirm that no grease is leaking from the grease outlet and that the grease bath is not pressurized, then re-attach the plug in the grease outlet.
- (7) To prevent accidents caused by slipping, completely remove any excess grease from the floor or robot.
- (8) When an ambient temperature is more than 35°C, be sure to shorten the period of replenishment in half.

■ Grease Replacement Cycle

Replacement Cycle

- ✓ Grease Replenishment : 6,000 hours
- ✓ Grease Replacement : 12,000 hours

If there is still noise in the reducer even after using specified grease, check the state closely for 1-2 days during operation. Generally, the noise will go away.
(The noise will go away if you run the axis at a high speed for 5-10 minutes).

The noise may be caused by following reasons

1. Operation after greasing or replacing the reducer
2. Operation after long-term storage
3. Operation at a low speed
4. Operation at a low temperature

5.1.1. S-Axis Reducer

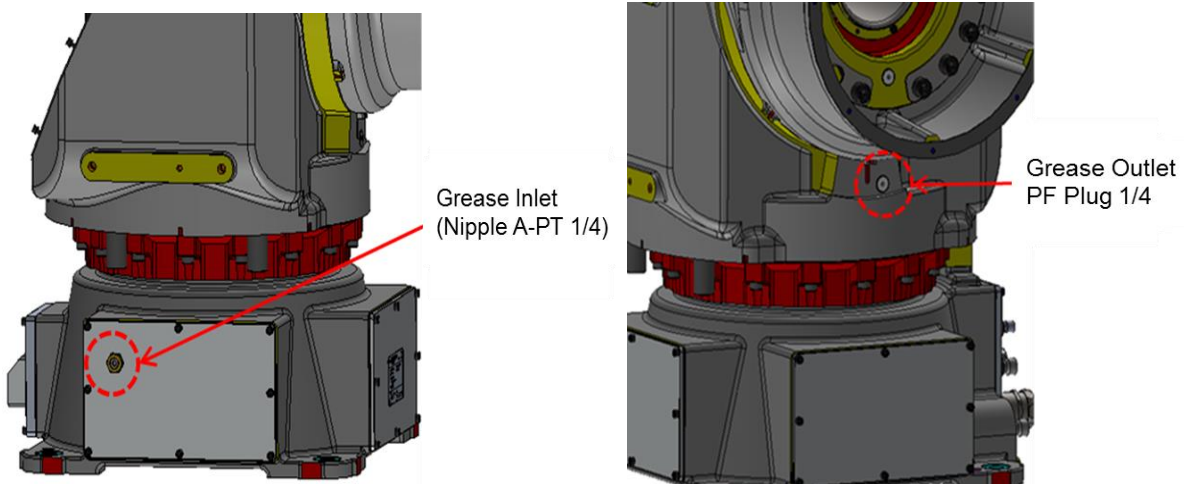


Figure 5.1 Position of Grease Inlet/Outlet on S axis



Attention

If grease is added without removing the outlet plug, the grease will go inside the motor and may damage it. It is absolutely necessary to remove the plug.

■ Grease Replacement

- (1) Remove the grease outlet plug.
- (2) Inject the grease into the grease inlet using a grease gun.

- ✓ **Grease type : VIGO GREASE RE0**
- ✓ **Amount of grease : 3,456cc(3.8kg)**

- (3) The grease replacement is complete when new grease appears in the outlet port. The new grease can be distinguished from the old one by color.
- (4) Move the S-Axis for a few minutes to eject the old grease and then add grease until the new grease appears in the outlet port.
- (5) Clean the greased around the outlet and assemble the seal-taped plug into its original state.

5.1.2. H-Axis Reducer

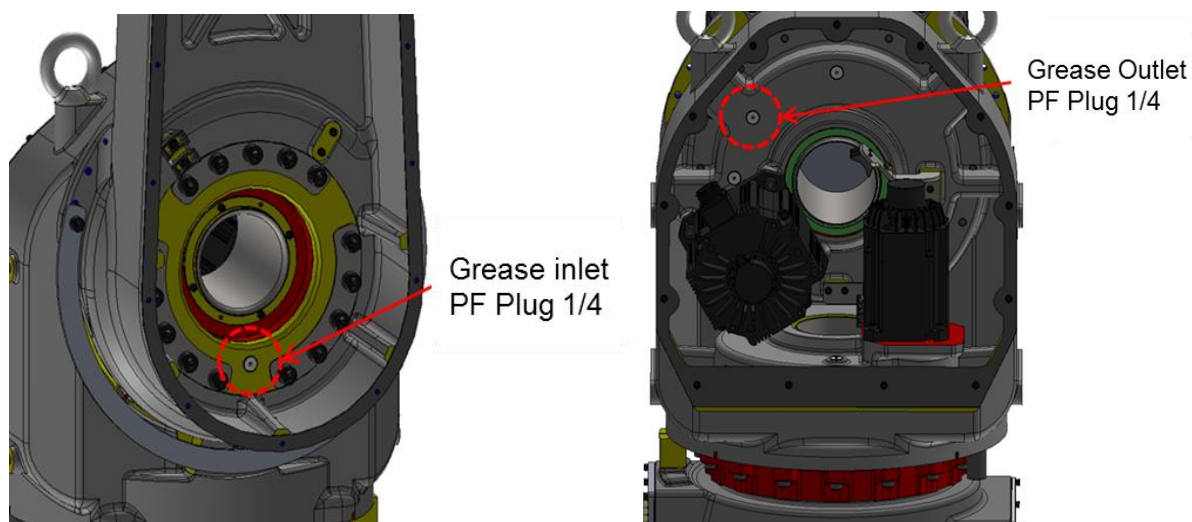


Figure 5.2 Position of Grease Inlet/Outlet on H Axis



Attention

If grease is added without removing the outlet plug, it cause damage to the seal of reducer and grease will go inside the motor and may damage it. It is absolutely necessary to remove the plug.

■ Grease Replacement

- (1) Make the H-Axis arm vertically(H:90°)
- (2) Remove the grease outlet plug.
- (3) Inject the grease into the grease inlet using a grease gun.

- ✓ Grease type : VIGO GREASE RE0
- ✓ Amount of grease : 3,312cc (3.7kg)

- (4) The grease replacement is complete when new grease appears in the outlet port. The new grease can be distinguished from the old one by color.
- (5) Move the H-Axis for a few minutes to eject the old grease and then add grease until the new grease appears in the outlet port.
- (6) Clean the greased around the outlet and assemble the seal-taped plug into its original state.

5.1.3. V-Axis Reducer

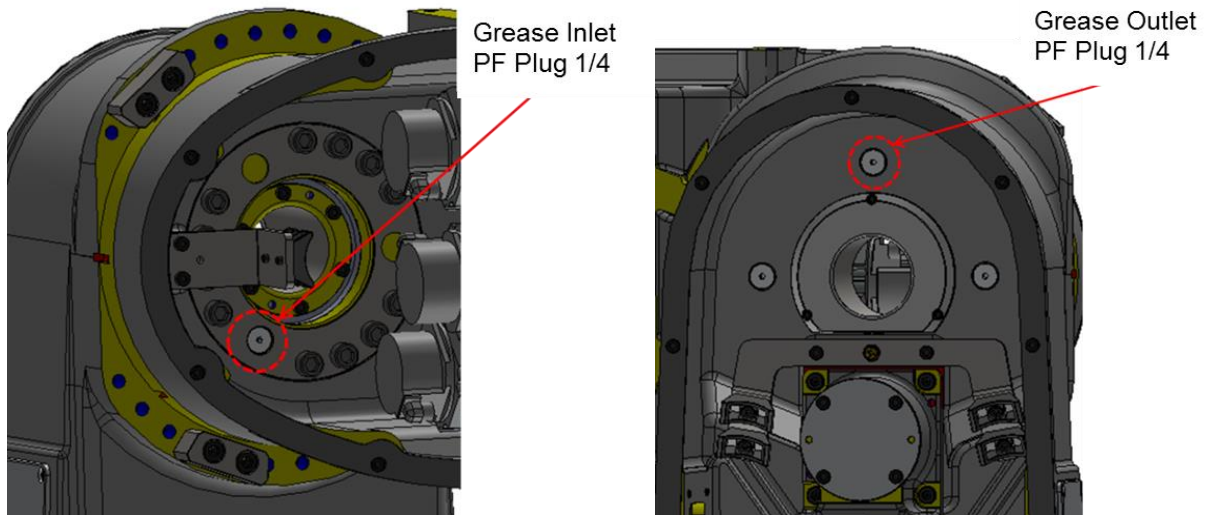


Figure 5.3 Position of Grease Inlet/Outlet on V Axis



Attention

If grease is added without removing the outlet plug, it cause damage to the seal of reducer and grease will go inside the motor and may damage it. It is absolutely necessary to remove the plug.

■ Grease Replacement

- (1) Make the V-Axis arm horizontally(V:0°)
- (2) Remove the grease outlet plug.
- (3) Inject the grease into the grease inlet using a grease gun.

- ✓ Grease type : VIGO GREASE RE0
- ✓ Amount of grease : 792cc (0.9kg)

- (4) The grease replacement is complete when new grease appears in the outlet port. The new grease can be distinguished from the old one by color.
- (5) Move the V-Axis for a few minutes to eject the old grease and then add grease until the new grease appears in the outlet port.
- (6) Clean the greased around the outlet and assemble the seal-taped plug into its original state.

5.1.4. R2, R1-Axis Reducer

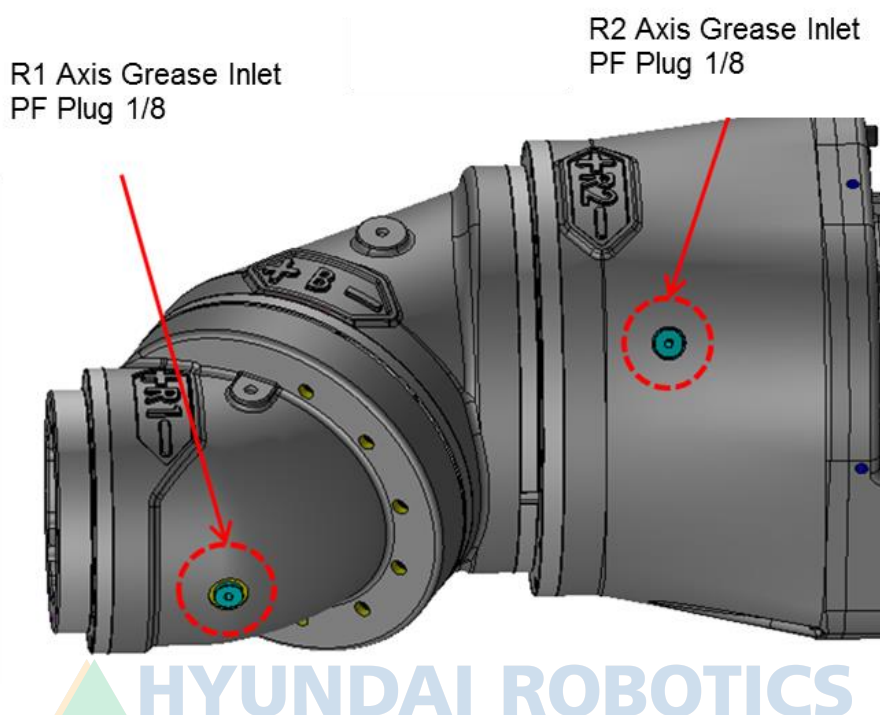


Figure 5.4 Position of Grease Inlet/Outlet on R2,R1 Axis



Attention

If grease is added without removing the outlet plug, it cause damage to the seal of reducer and grease will go inside the motor and may damage it. It is absolutely necessary to remove the plug.

■ Grease Replacement

- (1) Prepare grease nipple A-PF 1/8.
- (2) Remove the grease outlet plug.
- (3) Inject the grease into the grease inlet using a grease gun.

R2 axis

- ✓ Grease type : GADUS
- ✓ Amount of grease : 220cc (198g)

R1 axis

- ✓ Grease type : GADUS
- ✓ Amount of grease : 160cc (144g)

- (4) Clean the greased around the outlet and assemble the seal-taped plug into its original state.

5.1.5. B-Axis Reducer

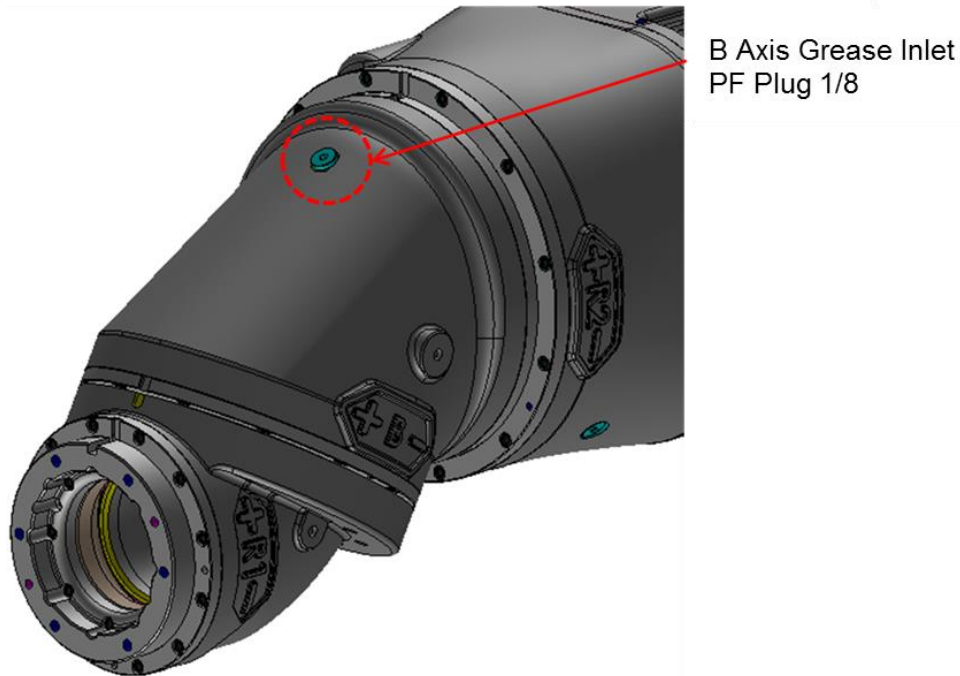


Figure 5.5 Position of Grease Inlet/Outlet on B Axis



Attention

If grease is added without removing the outlet plug, it cause damage to the seal of reducer and grease will go inside the motor and may damage it. It is absolutely necessary to remove the plug.

■ Grease Replacement

- (1) Prepare grease nipple A-PF 1/8.
- (2) Remove the grease outlet plug.
- (3) Inject the grease into the grease inlet using a grease gun.

- ✓ Grease type : GADUS
- ✓ Amount of grease : 190cc (180g)

- (4) Clean the greased around the outlet and assemble the seal-taped plug into its original state.

5.2. Internal Wiring

Replacement cycle of internal wiring depends on follows.

- Continuous operation
- Operating speed
- Atmosphere/environment

Inspect on a regular basis, every three months and check any damage on the cables or cable protect spring. If any damage, replace it.

Replace the cable every 24,000 operating hours regardless of working condition.



Attention

- ✓ As all the wires are flexible type, do not use any wires other than specified one.
- ✓ Wiring replacement must be done by unit.
- ✓ Do not use any Cable, protective spring, and Hose that have external damage as they may cause future problems.
- ✓ When purchasing robot cables, make inquiry of our service office about wiring type.
- ✓ Specify the length of wiring for connecting the robot with the controller.
- ✓ Do not pull out power connector part when connecting each motor cable of R2/B/R1 Axis as they easily loose due to the wearing of connector fixing part using excessive force or tool

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6

Troubleshooting



6. Troubleshooting

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6.1. Troubleshooting Procedure

If a failure occurs during robot's operation, but it does not stem from the controller, it must be caused by damage on machine parts. The way to troubleshoot as quick and easy as possible should be to diagnose the problem. In addition, it is necessary to determine which parts cause the problem.

- (1) Step 1: Which axis occurs the problem?
First of all, check which axis causes the malfunction. In case that it is hard to detect the problem, check the following possible mechanical defaults,
 - Is there any parts making noise?
 - Is there any parts generating an overheating?
 - Is there any parts have a play or backlash?
- (2) Step 2: Which parts have been damaged?
If the abnormal axes are determined, investigate which parts cause trouble. There could be many causes for one phenomenon. Refer to [Table 6-1] for the cause and phenomenon of the trouble.
- (3) Step 3: Dealing with malfunction parts
If the malfunction parts are confirmed, conduct relevant repair procedure based on the chapter 6.3 Diagnostics and Resolutions for Major Parts Failure. Contact our service office if you have any difficulties in dealing with problems.



6.2. Trouble Symptoms and Possible Causes

As shown in [Table 6-1], there may be many parts as the cause of one phenomenon.
Refer to next page to determine which part is malfunction.

Table 6-1 Trouble phenomenon and cause

Defect parts Trouble phenomenon	Reducer	Brake	Motor	Encoder	Backlash	Grease
Overload [Note 1]	○	○	○			
Displacement	○		○	○		
Abnormal sound occurrence	○	○	○			○ [Note 5]
Noise in operation [Note 2]			○		○	
Staggering at stop [Note 3]			○	○		
Irregular twitching [Note 4]			○	○		
Abnormal deviation			○	○		
Free fall of an axis	○	○				
Overheating	○	○	○	○		○
Incorrect action and out of control movement			○	○		

[Note 1] Overload ----- Phenomenon occurring when a load exceeds the rated motor load.
In specific, thermal relay of circuit protector is tripped.

[Note 2] Noise in operation ----- Phenomenon which occurs vibration on operation.

[Note 3] Staggering at stop ----- Phenomenon which gives oscillating motion when the robot stops

[Note 4] Irregular twitching ----- Phenomenon which gives sporadic twitching when the robot is not in motion.

[Note 5] If there is noise from the greased part of reducer at reduced-speed operation, check the state closely for 1-2 days during operation. Generally, the noise will go away.

(The noise will go away if you run the axis at a high speed for 5-10 minutes).

The noise may be caused by following reasons.

1. Operation after greasing or replacing the reducer
2. Operation after long-term storage
3. Operation at a low speed
4. Operation at a low temperature

6.3. Diagnostics and Resolutions for Major Parts Failure

6.3.1. Reducer

Vibration and abnormal sound will be occurred when a reducer is damaged. In this case, it causes overload and abnormal deviation disturbing normal operation. Sometimes overheating may result. The robot may also become completely immovable, or a position offset error may occur.



[Main Axes (S, H, V)]

When turning [ON][OFF] the brake release switch of axis H and axis V, be sure to take necessary precautions to prevent the ARM from dropping, and then switch the brake release [ON][OFF].

■ Diagnostics

- ① Check out any vibration, abnormal sound, or overheating of the reducer when the robot is in operation.
- ② Check out any play and abrasion in the reducer. And check if any abnormality is felt by hand when shaking 1st ARM back and forth with the brake release switch of axis S [ON]
- ③ Check if peripheral equipment has been contacted with the robot before the abnormality. (Damage may occur to the reducer due to the contacting impact)

■ Resolution

Replace the reducer. A chain block is needed to lift and hang the robot ARM. Contact our service office for any difficulties



[Wrist Axes (R2, B, R1)]

When turning [ON][OFF] the brake release switch, be sure to take necessary precautions to prevent the ARM from dropping, and then switch the brake release [ON][OFF].

■ Diagnostics

- ① Check out any vibration, abnormal sound, or overheating of the reducer when the robot is in operation.
- ② Check out any play in the reducer by shaking the End Effector (such as spot gun and hand devices, etc.) back and forth.
- ③ Turn motor off, with the brake release switch [ON], and check that the axis can be rotated by hand. If not, the reducer is in bad condition.
- ④ Check if peripheral equipment has been contacted with the robot before the abnormality. (Damage may occur to the reducer due to the contacting impact)

■ Resolution

- ① Replace the reducer.
- ② Replace the entire wrist section.
(The replacement of entire wrist should be a quick and reliable resolution as it takes time and necessary equipment for reducer replacement)

6.3.2. Brake

In case of brakes failure, each axis possibly drops with the motors [OFF]. Or, in reverse, brakes possibly operate even with the motors [ON]. The latter causes overload and noise.



When intending to operate the entire robot without the motors [ON], operate it with the brake release switch [ON]. Before turning the switch [ON], take necessary precautions to prevent the ARM from dropping as the robot ARM will drop by gravity.

- **Diagnostics**
Check if the brake can be heard in operation, by turning the brake release switch [ON] [OFF] alternately with the motors [OFF]. If not heard, the brake cable may be broken. (When operating the brake release switch [ON] [OFF], be careful of ARM dropping. The brake release switch is located on the panel in the controller cabinet door.)
- **Resolution**
If cables turn out to be good condition, replace the motor.

6.3.3. Motor

Motor failure causes abnormal operation of robot such as staggering at stop, irregular twitching and noise in operation. Besides, It may cause overheating and abnormal sound.

Check the reducer and fulcrum bearing as well in order to determine which part causes the abnormality. It is because that similar phenomenon is observed when the reducer is damaged.

- **Diagnostics**
Check for overheating and abnormal sound.
- **Resolution**
Replace the motor.

6.3.4. Encoder

Position offset, malfunction, and out of control movement as well as staggering at stop, irregular twitching may occur when the Encoder is in bad condition. This case has nothing to do with such phenomena as mechanical abnormal sound, overheating, and vibration.

- **Diagnostics**
 - ① Check for any encoder data failure.
 - ② Use reference pins and blocks to check the positional data is correct at pin position.
 - ③ Check for any irregular variations in the encoder data when moving each robot axis.
 - ④ Replace the servo amp board(BD542) to check errors.
- **Resolution**
 - ① If cabling turns out to be in good condition without any damage, replace the encoder.
 - ② If there is no error after replacing the servo amp board(BD542), replace the servo amp board.

6.4. Possible purge cycle problem

Table 6-2 Possible purge cycle problem

Problem	Cause	What to check for
Inadequate air flow through the robot	Air supply capacity inadequate	The air supply is inadequate. Check the air pressure at the pneumatic air supply.
Air leakage from robot	Bad seal	look for leakage around cover gaskets and bearing seals at the cable entrance to the robot , holes where plugs or screws are missing through unsealed conduit.
Pressure switch or air flow switch does not appear to work	Defective pressure switch or air flow switch	Perform the pressure switch test and air flow switch test to check components.
Inconsistent readings on the pressure gauge	Air leaks or other problems with the pneumatic air distribution	Check continuity of the pressure switch and air flow switch during dynamic test conditions. Check pressure gauge

6.5. Air Pressure Verification

A low pressure gauge can be used to check the air pressure within the robot. Simply remove the plug from the test port and insert a gauge. The air pressure should be in the normal pressure specified in the identification plate.

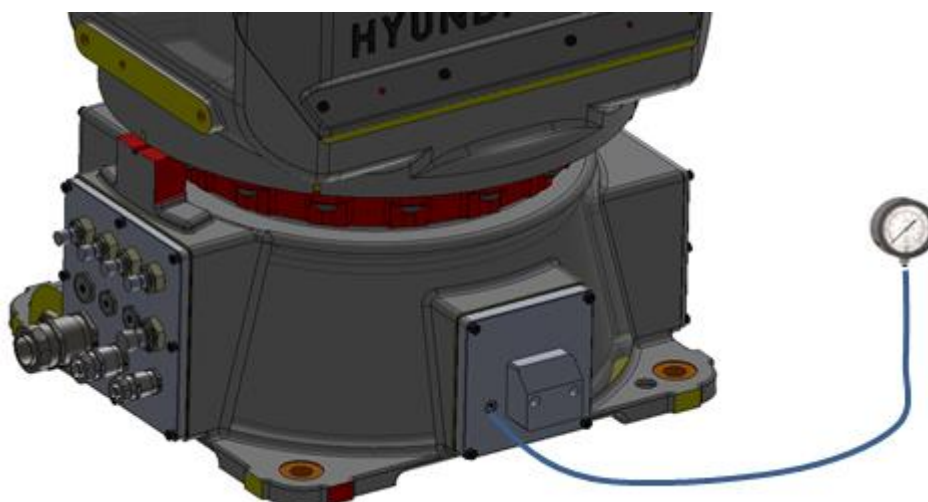


Figure 6.1 Test Port

6.6. Motor and reducer replacement



Caution:

This robot has a brake installed on the motor to maintain the position of the arm and when the motor is disassembled, the arm will fall. To prevent this, hang the arm with the crane or insert a fixating pin to keep the 1st and 2nd arms fixed.

When touching the motor immediately after the robot stops, check the temperature of the motor. The weights of the motor and reducer are as follows. When transporting the motor, be careful.

Table 6-3 Weight (motor)

Axis	S	H	V	R2	B	R1
Weight(kg)	11.9	23.9	11.9	3.1	3.1	3.1



Warning:

In this work, there is a part performed with the motor [ON]. Therefore, perform the work in pairs. An observer must always be ready to activate an emergency stop. The other performs the work quickly and carefully. An escape route should be determined before starting work.

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6.6.1. Necessary Tools and Parts

Table 6-4 Necessary Tools (motor)

Tool Name	Axis	Part No.(Model)	Remark
Torque wrench (prepared by user)	S, H, V	M8 Torque wrench (Long type) M12 Torque wrench (Long type)	Use torque wrench and extension on the market
	R2, B, R1	M6 Torque wrench (Long type) M8 Torque wrench (Long type)	

(When overhauling the robot, you can use the leveler to set the zero point precisely. If you need to calibrate the zero point precisely, please consult with Hyundai Robotics.)



6.6.2. How to Replace Motor

- (1) Set the controller to teaching mode and set the robot to standby [ON] condition. If the robot is not in standby [ON] condition, check whether the arm is sufficiently fixated to avoid it from dropping. And then proceed to (4).
- (2) The axis requiring motor replacement takes basic posture.
- (3) For S, H, V axis: Refer to [Fig. 6.2 ~ 6.3]
For R2, B, R1 axis: Set the zero point for each axis by using the key and V-groove.
- (4) Turn the main power [OFF] with the controller power [OFF].
- (5) Disconnect the connector from the motor.
- (6) Upon disconnecting the motor wire, remove the motor bolts to detach the motor from the robot body.
- (7) Detach the gear from the motor shaft.
Be careful to avoid excessive impact to the motor.
- (8) Assemble the gear after lightly applying grease to the shaft.
The bolt used to attach the gear to the shaft should be cleaned and removed of grease before using. Apply Loctite 243 to the screw part of the bolt, and then tighten it using a torque wrench in a regular torque. Besides, slowly tighten the bolt in a symmetrical order.
- (9) Assemble the motor on the robot after applying a moderate amount of grease to the teeth of gear.
- (10) Connect the connector to the motor.
- (11) After you have replaced the H and V axis motor, newly refill the grease.
- (12) Reset the encoder of the axis whose motor is replaced.



Warning

Before encoder correction, check motor connections, with motors [ON], while pressing the Enable switch for 2~3 seconds.

- (13) Perform the encoder calibration about the axis whose motor is replaced. Refer to the chapter [Encoder Calibration] in the controller operating manual.
- (14) Confirm that there is no error in robot's motion.

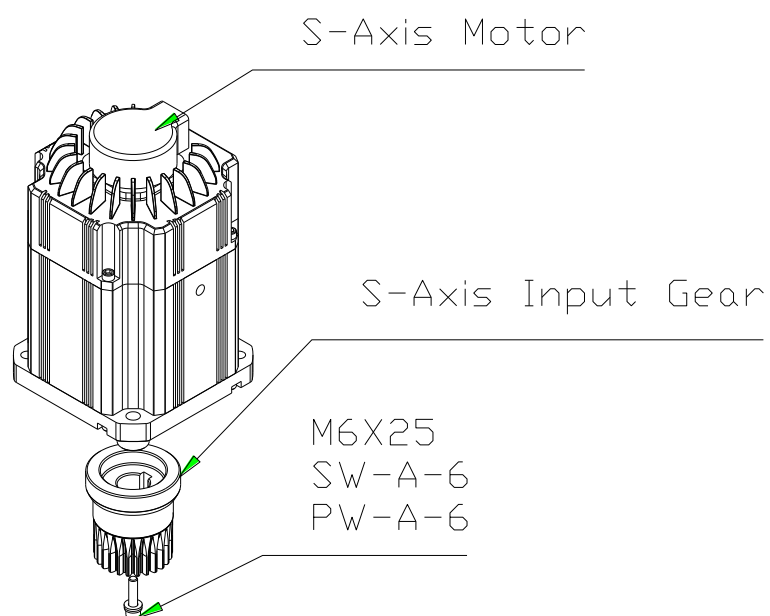


Figure 6.2 S axis motor replacement



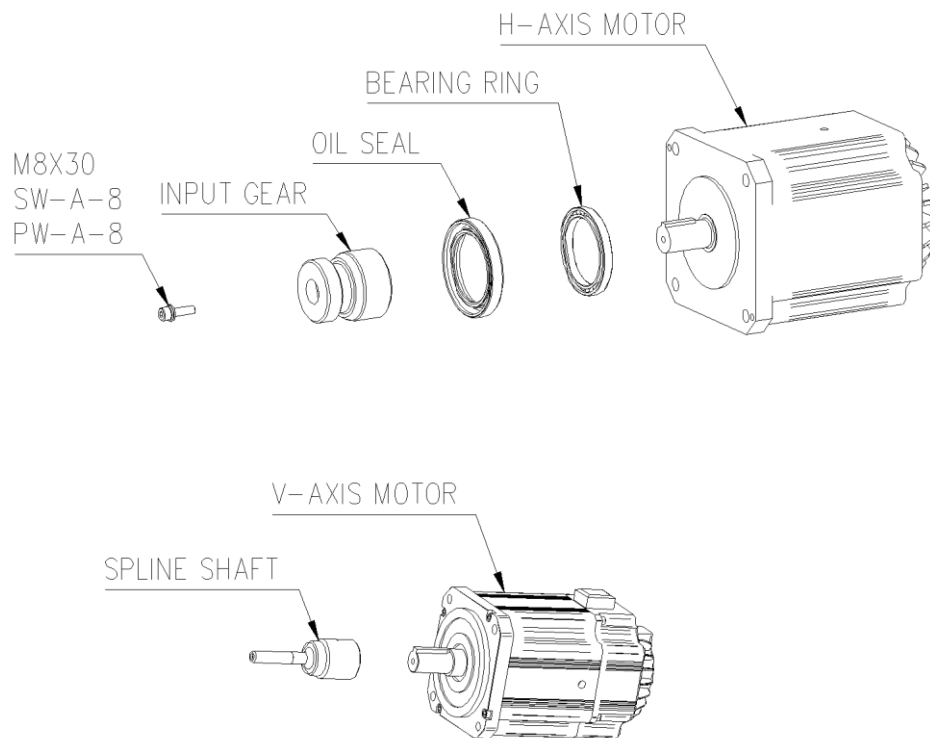


Figure 6.3 H/V axis motor replacement



Caution

When replacing the H/V axis motor, the upper arm must accurately be aligned to the direction of gravity to the mechanical stopper so that the upper arm does not rotate.

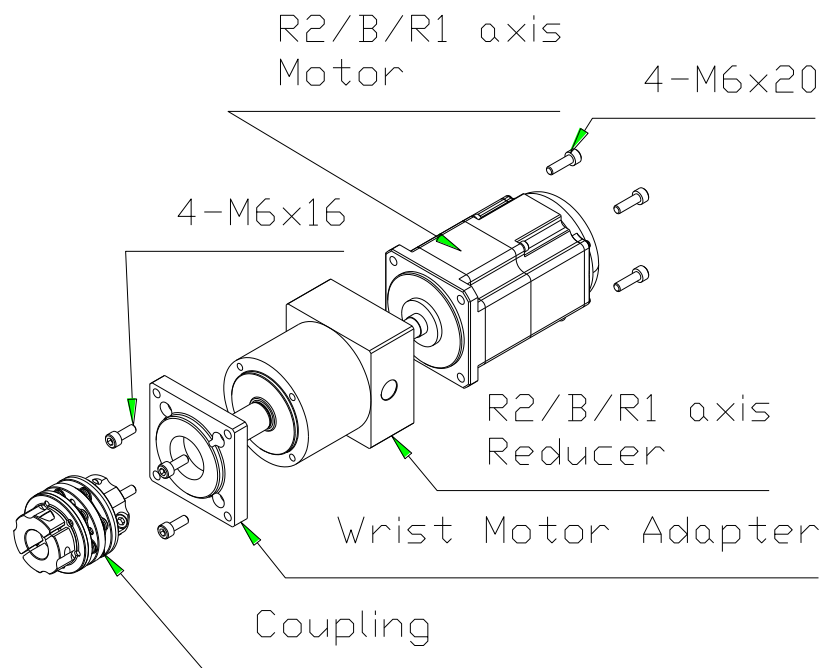


Figure 6.4 Wrist axis motor replacement

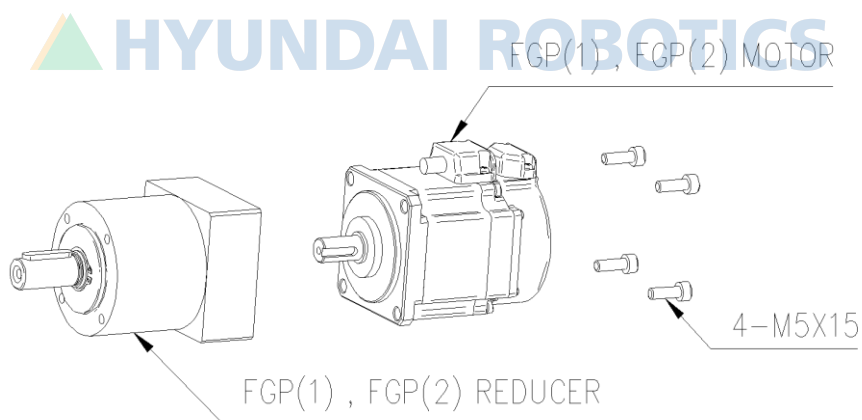


Figure 6.5 FGP motor replacement (Option)

6.7. Encoder Zero Setting

It is necessary to reset the origin when encoder data has been corrupted due to some problems and when the motor is replaced.

A key groove is used to determine the standard posture position for each axis of the robot. When the motor is replaced by the user, set the encoder using the key to have each axis at its original point.



Warning

In this work, there is a part performing in the state of motor [ON]. Therefore, this work must be performed in pairs. One must always be ready to activate an emergency stop. The other must perform the work quickly but carefully.

An escape route should be determined before starting work.

6.7.1. Zero Setting

- (1) Set the controller to teaching mode and set the robot to standby [ON] condition.
If the robot cannot be set to standby [ON] condition due to issues, use the brake cancel switch to set the reference location of the robot.
- (2) Move each axis to the basic posture to align it with the scale or V-groove.
- (3) Reset the Encoder. Refer to 『6.7.2 Encoder Reset』 for the method of encoder reset.
- (4) Correct the encoder. Refer to 『Controller Operation Manual 7.5.4 Serial Encoder Reset』.
- (5) Confirm that there is no problem in robot motion.

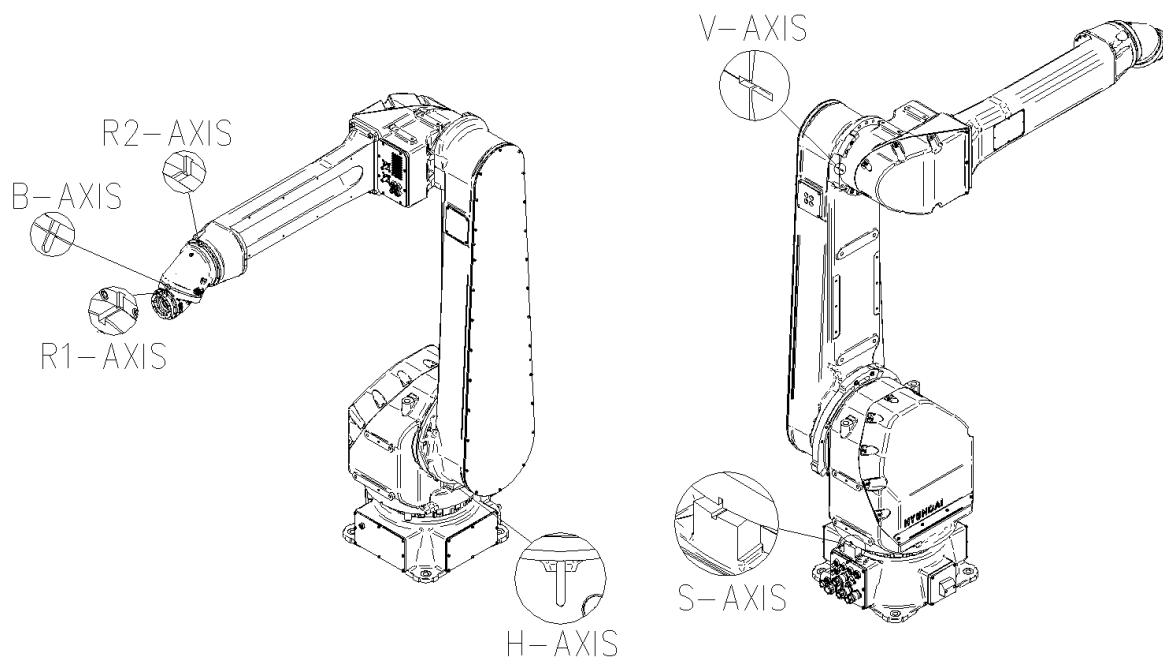
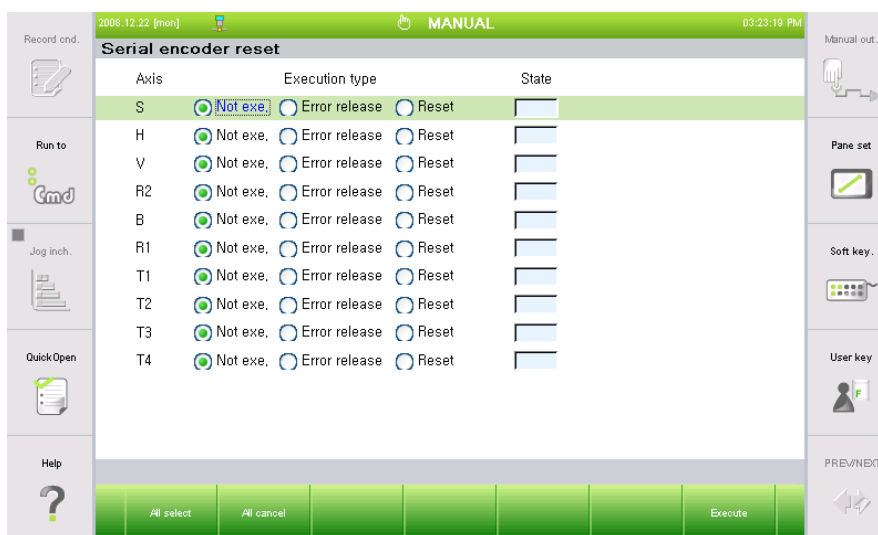


Figure 6.6 Zero Setting Position

6.7.2. Encoder Reset

- (1) Turn off the motor.
- (2) Open the serial encoder reset window. (『F2』: System』 → 『5: Initialize』 → 『4: Serial encoder reset』)



- (3) Use keys like [↓], [↑], [SHIFT] + [←][→] to move to a desirable axis, then press the [Execute] key.
- (4) After the encoder is reset, please make sure the controller power is turned on.

6.7.3. Encoder offset and Selection

- It is necessary to compensate encoder data for the basic position of each axis.
- Refer to 『Encoder offset』 in the Controller Manual for details.

[Encoder offset Screen]

	Adjust[%s]	Current[%s]	Angle[deg]
S	FFC00A28 [hex]	003FF5DD [hex]	0.708 [deg]
H	FFC00803 [hex]	003FF7FD [hex]	91.230 [deg]
V	FFC01223 [hex]	003FEDDD [hex]	1.452 [deg]
R2	FFC00020 [hex]	003FFFE0 [hex]	0.225 [deg]
B	FFC0054B [hex]	003FFAB5 [hex]	-90.740 [deg]
R1	FFC01EFE [hex]	003FE102 [hex]	3.487 [deg]
T1	0008843A [hex]	FFF77BC6 [hex]	-1886.396 [mm]
T2	FF6F1683 [hex]	0090E97D [hex]	-2104.792 [mm]
T3	FFC002FA [hex]	003FFD06 [hex]	-0.116 [deg]
T4	FFC00EBT [hex]	003FF14F [hex]	-0.660 [deg]

Table 6-5 Data range after reset.

Axis	Data range after reset	Pulse/
All	0 ~ 8,191	8,192

- (1) Select the axis, move the axis to a standard position using the [Axis operation] key, and press the 『[F1]: Apply』 key.
- (2) Place the robot's entire axis as the standard position using the [Axis operation] key and press the 『[F2]: Apply all』 key to carry out encoder offset correction for the entire axis.
- (3) To save the set data, press the 『[F7]: Complete』 key. The [ESC] key will prevent the changes being saved.



Warning

In case of encoder DATA compensation after replacing motor, check if the motor power is on with the power 『ON』.





HYUNDAI ROBOTICS

7

Recommended
Spare Parts



7. Recommended Spare Parts

YP015-28

The recommended spare parts for robot are as follows. Please check robot serial number and manufacturing date when purchasing, and contact our service office.

[Category]

A: Regular maintenance parts (what is replaced regularly)

B: Essential spare parts (what is of high frequency)

C: Essential component parts

D: Machine parts

Table 7-1 Spare Parts List

Category	PLATE No.	Item	Quantity	Application
A	R7900004400	VIGO GREASE (1CAN=16KG)	1CAN	Reducer
A	R7900054781	GADUS GREASE (1CAN=15KG)	1CAN	Gear, Bearing
B	R3412-7112-P01	MOTOR	2EA	S,V Axis
B	R3412-7212-P03	MOTOR	1EA	H Axis
B	R3412-7312-P01	MOTOR	3EA	R2,B,R1 Axis
B	R3412-7312-P02	MOTOR	2EA	FGP(1), FGP(2) (OPTION)
C	R3412-7112-P02	REDUCER	2EA	S, H Axis
C	R3412-7212-P02	REDUCER	1EA	V Axis
C	R3412-7312-P03	REDUCER	3EA	R2,B,R1 Axis
C	R3412-7312-P04	REDUCER	2EA	FGP(1), FGP(2) (OPTION)

7. Recommended Spare Parts

Category	PLATE No.	Item	Quantity	Application
C	R3412-7412-001	Wrist Assembly	1EA	
C	R3412-7512-001	CABLE Assembly	1EA	
D	R3412-7112-P03	BEARING	1EA	S AXIS CENTER GEAR
D	R3412-7112-P04	BEARING	1EA	S AXIS INPUT GEAR
D	R3412-7112-P05	OIL SEAL	1EA	LOWER FRAME
D	R3412-7112-P06	OIL SEAL	1EA	S AXIS INPUT GEAR
D	R3412-7112-P07	O-RING	1EA	S AXIS REDUCER
D	R3412-7112-P08	O-RING	1EA	S AXIS CABLE HOLLOW
D	R3412-7112-P09	O-RING	1EA	S AXIS MOTOR
D	R3412-7212-P05	BEARING	1EA	H AXIS CENTER GEAR
D	R3412-7212-P06	BEARING	1EA	H AXIS INPUT GEAR
D	R3412-7212-P07	BEARING	1EA	V AXIS CENER GEAR

Category	PLATE No.	Item	Quantity	Application
D	R3412-7212-P08	BEARING	4EA	V AXIS BEVEL GEAR INPUT
D	R3412-7212-P09	OIL SEAL	1EA	V AXIS CABLE HOLLOW
D	R3412-7212-P10	OIL SEAL	1EA	H AXIS CABLE HOLLOW
D	R3412-7212-P11	OIL SEAL	1EA	V AXIS BEVEL GEAR OUTPUT
D	R3412-7212-P12	OIL SEAL	1EA	V AXIS SPLINE SHAFT
D	R3412-7212-P13	OIL SEAL	1EA	H AXIS INPUT GEAR
D	R3412-7212-P14	O-RING	1EA	V AXIS CABLE HOLLOW
D	R3412-7212-P15	O-RING	1EA	V AXIS GEAR BOX
D	R3412-7212-P16	O-RING	2EA	H AXIS CABLE HOLLOW
D	R3412-7212-P17	O-RING	1EA	V AXIS BEARING HOUSING
D	R3412-7212-P18	O-RING	1EA	H AXIS REDUCER
D	R3412-7212-P19	O-RING	1EA	V AXIS REDUCER

7. Recommended Spare Parts

Category	PLATE No.	Item	Quantity	Application
D	R3412-7212-P20	O-RING	1EA	V AXIS MOTOR
D	R3412-7212-P21	O-RING	1EA	H AXIS MOTOR
D	R3412-7312-P05	BEARING	6EA	R2,B,R1 AXIS PINION GEAR
D	R3412-7412-P01	BEARING	2EA	R1 AXIS SHAFT
D	R3412-7412-P02	BEARING	1EA	R2 HOLLOW SHAFT
D	R3412-7412-P03	BEARING	1EA	BEVEL GEAR B 2 ND
D	R3412-7412-P04	BEARING	1EA	B AXIS SHAFT
D	R3412-7412-P05	BEARING	2EA	BEVEL GEAR(R1 4 TH)
D	R3412-7412-P06	OIL SEAL	1EA	R2 HOLLOW SHAFT
D	R3412-7412-P07	OIL SEAL	1EA	B-BASE FLANGE
D	R3412-7412-P08	OIL SEAL	1EA	MECHANICAL INTERFACE
D	R3412-7412-P09	OIL SEAL	5EA	WRIST HOLDER

Category	PLATE No.	Item	Quantity	Application
D	R3412-7412-P10	O-RING	1EA	CRB COVER(B)
D	R3412-7412-P11	O-RING	1EA	WRIST BASE
D	R3412-7412-P12	O-RING	1EA	R1 AXIS SHAFT
D	R3412-7412-P13	O-RING	1EA	MECHANICAL INTERFACE
D	R3412-7412-P14	O-RING	1EA	WRIST HOLDER





HYUNDAI ROBOTICS

8

Decommission



8. Decommission

YP015-28

The robot is made up of several materials as shown in [Table 8-1]. Some of them should be properly arranged and sealed up to eliminate any bad influence on the human body or environment.

Table 8-1 Materials of each part

Parts	Materials
Wiring, Motor	Copper
Base body	Cast Iron
Brakes, Motors	Samarium Cobalt(or Neodymium)
Wiring, Connectors	Plastic / Rubber
Reducers, Bearings	Oil / Grease
Lower Frame, Wrist Base etc.	Aluminum alloy cast





HYUNDAI ROBOTICS

9

Internal Wiring
Diagram

Internal wiring is shown in a connection diagram per unit, and thus utilize it to inspect and replace the wiring.

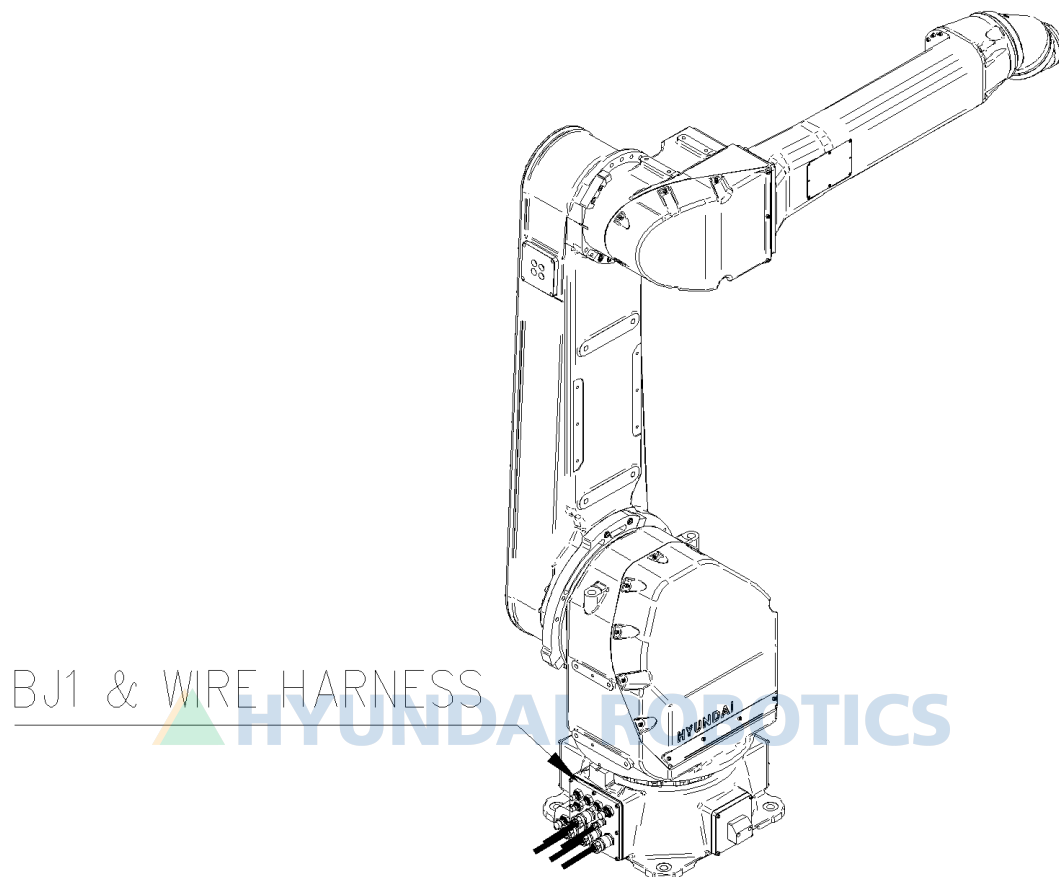
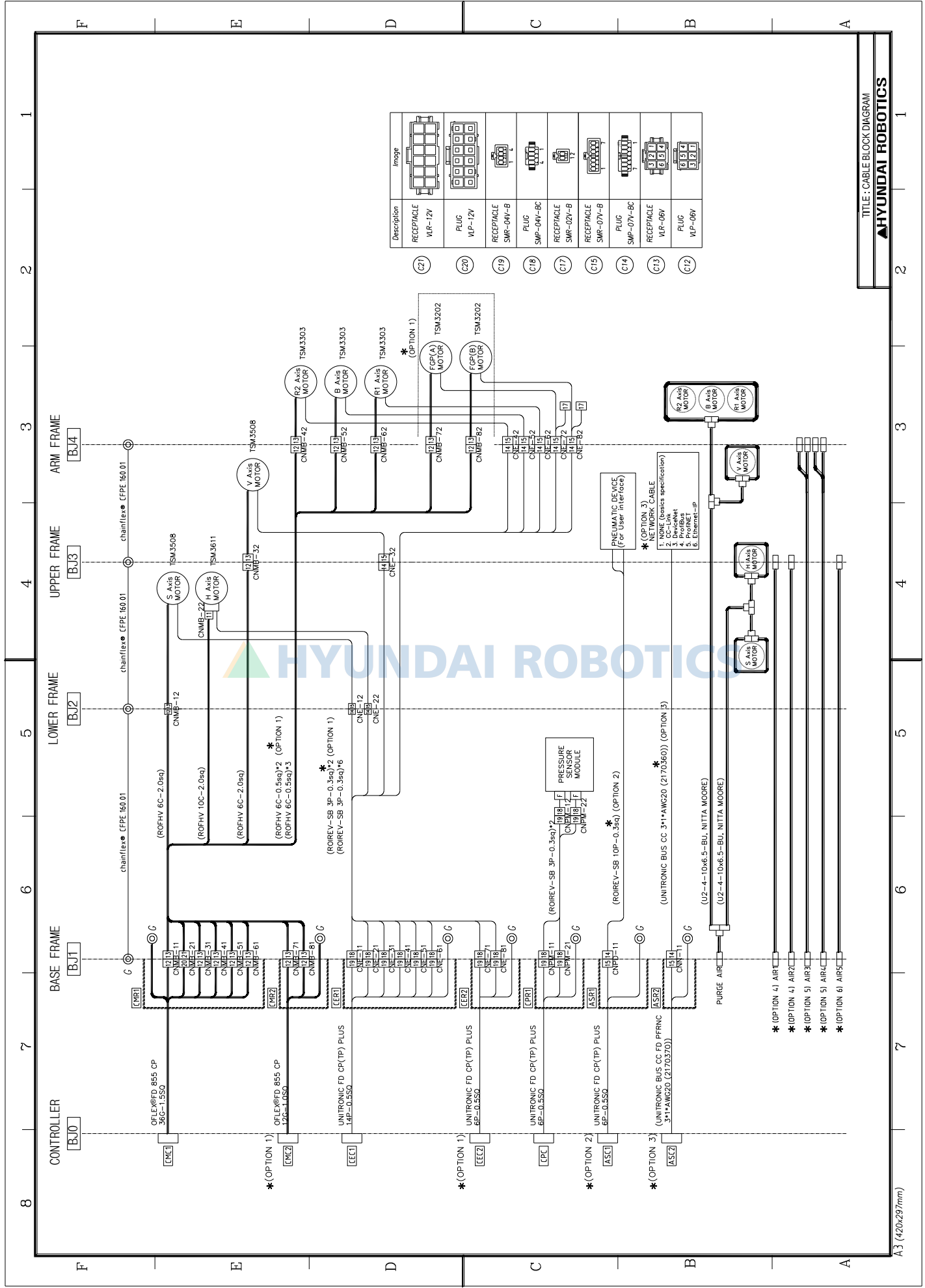
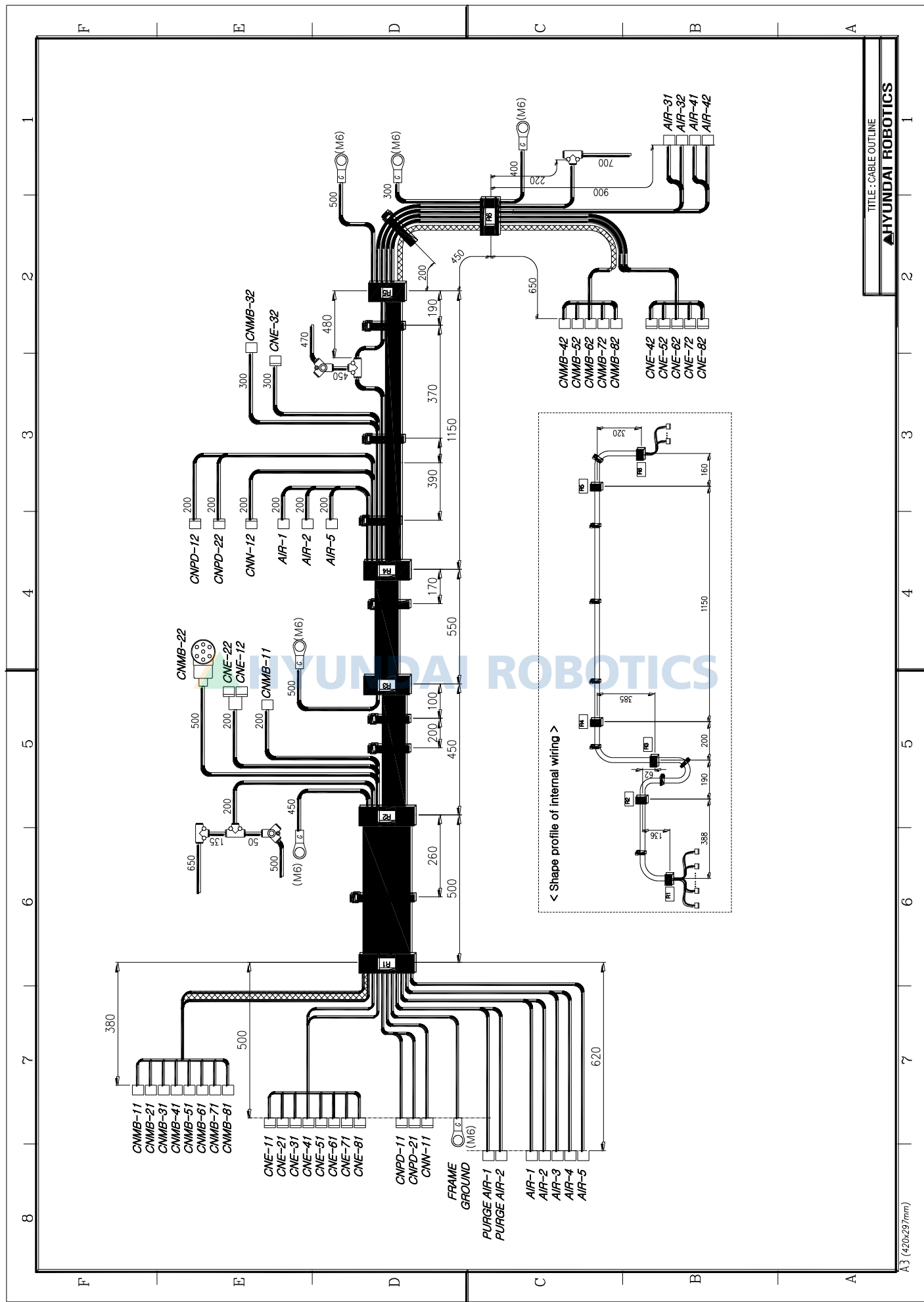


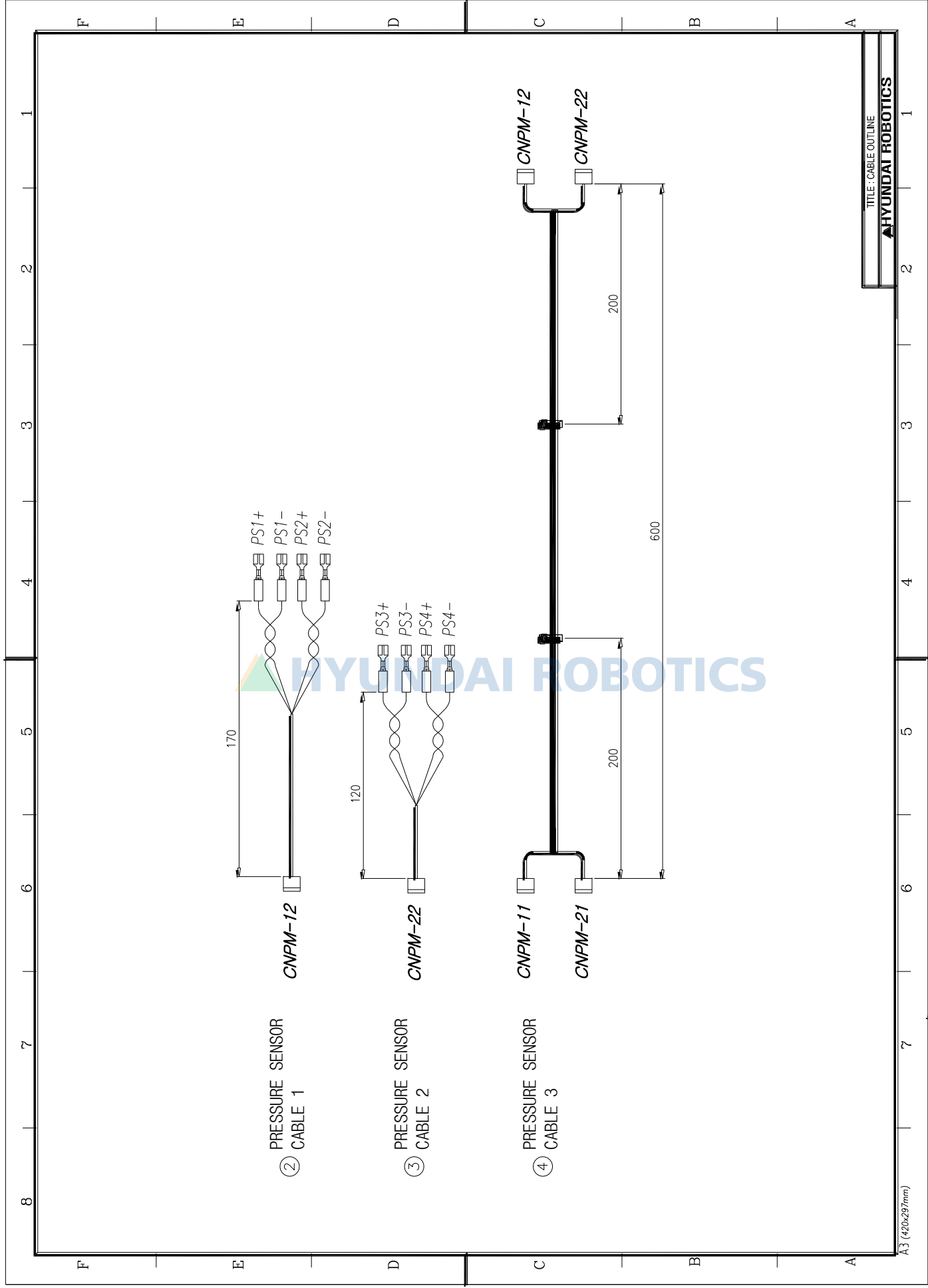
Figure 9.1 Manipulator Configuration

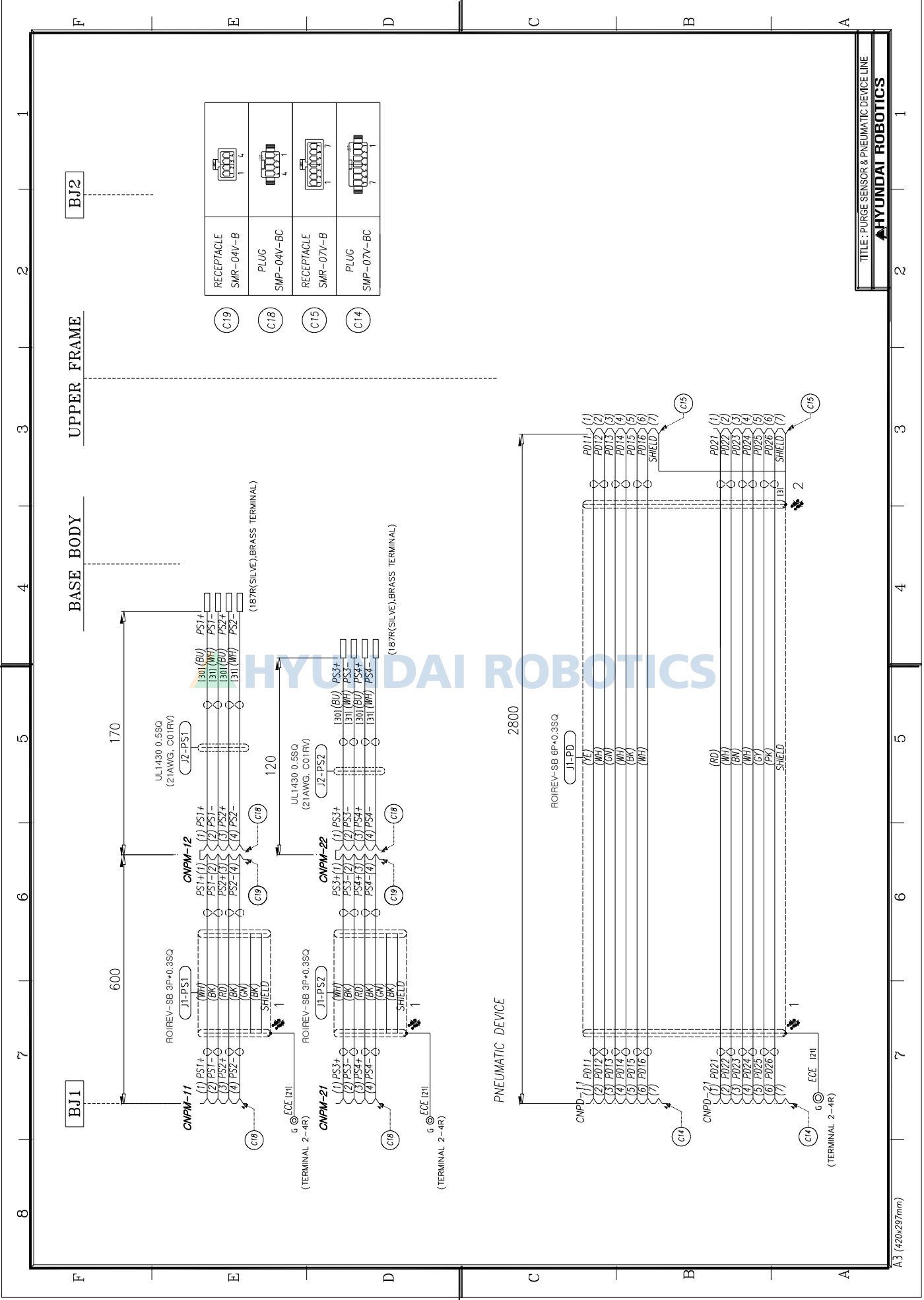
YP015-28 Internal wiring diagram

PAGE NO	CONTENTS
1	CABLE BLOCK DIAGRAM
2	CABLE OUTLINE(1/2)
3	CABLE OUTLINE(2/2)
4	PURGE SENSOR & PNEUMATIC DEVICE LINE
5	MOTOR POWER CABLE CONNECTION FOR S,H,V AXIS
6	MOTOR POWER CABLE CONNECTION FOR R2,B,R1 AXIS
7	MOTOR ENCODER CABLE CONNECTION FOR S,H,V AXIS
8	MOTOR ENCODER CABLE CONNECTION FOR R2,B,R1 AXIS
9	USER APPLICATION CONNECTION
10	GROUND & AIR TUBE





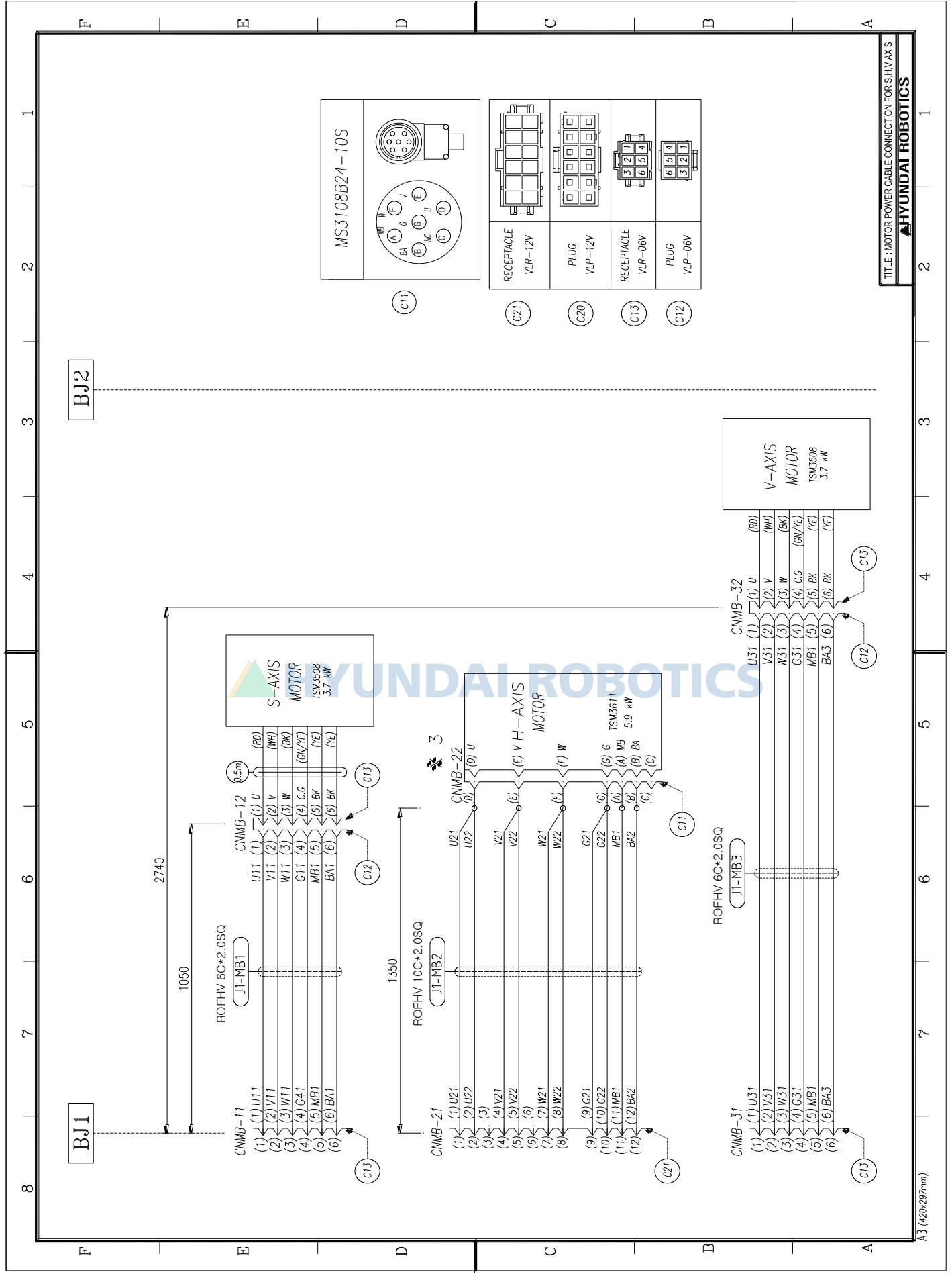




TITLE : PURGE SENSOR & PNEUMATIC DEVICE LINE



A3 (420x297mm)



TITLE: MOTOR POWER CABLE CONNECTION FOR S,V, H AXIS

HYUNDAI ROBOTICS

A3 (420x297mm)

