2202, MLPEN-221-015,001

NACHI

MANIPULATOR INSTRUCTION MANUAL

LP-01 series [AX20/FD11]

15th edition

- Before attempting to operate the robot, please read through this operating manual carefully, and comply with all the safety-related items and instructions in the text.
- The installation, operation and maintenance of this robot should be undertaken only by those individuals who have attended one of our robot course.
- When using this robot, observe the low related with industrial robot and with safety issues in each country.
- This operating manual must be given without fail to the individual who will be actually operating the robot.
- Please direct any queries about parts of this operating manual which may not be completely clear or any inquiries concerning the after-sale service of this robot to any of the service centers listed on the back cover.

NACHI-FUJIKOSHI CORP.

This manual explains the robot specifications, structure of each part and the basic handling precautions for inspection and maintenance to maintain function of the robot for a long period.
It is recommended that this manual is read by robot utilization planners and installation staff as well as inspectors and maintenance staff for robot operation and the robot is handled only after understanding this manual completely.

For safe use of the robot

Read this manual carefully prior to installation, operation, maintenance, or inspection and use equipment correctly. Use the robot only after fully understanding the equipment, all safety points, and comments/suggestions.

- Instruction manual “Precautions for handling industrial robots”
- Instruction manual “INSTALLATION” (for AX controller) “Chapter 1 Point on safety”
- Instruction manual “SETUP” (for FD controller) “Chapter 1 Point on safety”

The following table shows the importance of the following tags/marks in this Operation manual:

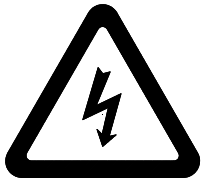
 DANGER	Case where a mistake made in handling is likely to cause the user to be exposed to the danger of death or serious injury and where the degree of the urgency (imminence) of the warning given for the danger to occur is at the high end of the scales (including high-level danger).
 WARNING	Cases where a mistake made in handling is likely to cause the user to be exposed to the danger of death or serious injury.
 CAUTION	Cases where a mistake made in handling is likely to cause the user to be exposed to the danger of minor injuries or of property damage only.

And, the other notes use a mark like the one shown as below.

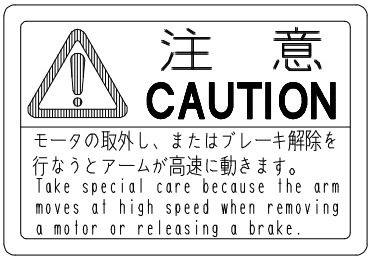
 IMPORTANT	This indicates the other special notes.

Labels and marks on manipulator

Following labels and marks are affixed on manipulator. Their location and their existence itself may vary according to the robot type.

	This mark indicates a power supply inlet for the robot. Motor power and detecting device power is supplied to connectors and terminal blocks under various connector covers on the robot baring this mark. Do not touch connectors or terminal blocks directly or indirectly with conductive items with mains power supplied, as electric shock may occur. If connectors or terminal blocks are removed with mains power on, electric shock or malfunction of the robot may result. Turn OFF main power on the controller when performing any maintenance.
	This mark indicates hot parts on the robot. Carelessly touching labeled hot parts may result in serious burns.
	This mark indicates area operators may get caught by the robot. Places bearing this mark should never be touched. Brakes can be released not only during teaching but also while the motors are OFF. Take adequate steps to prevent your hands or other parts of your body from being pinched when these areas are touched during maintenance work, etc.

Another caution and warning labels;
If these labels are ignored and, for example, some part is disassembled, this may cause fatal or serious accidents.



Protection labels;

Chapter 1 Basic specifications

1.1 List of basic specifications

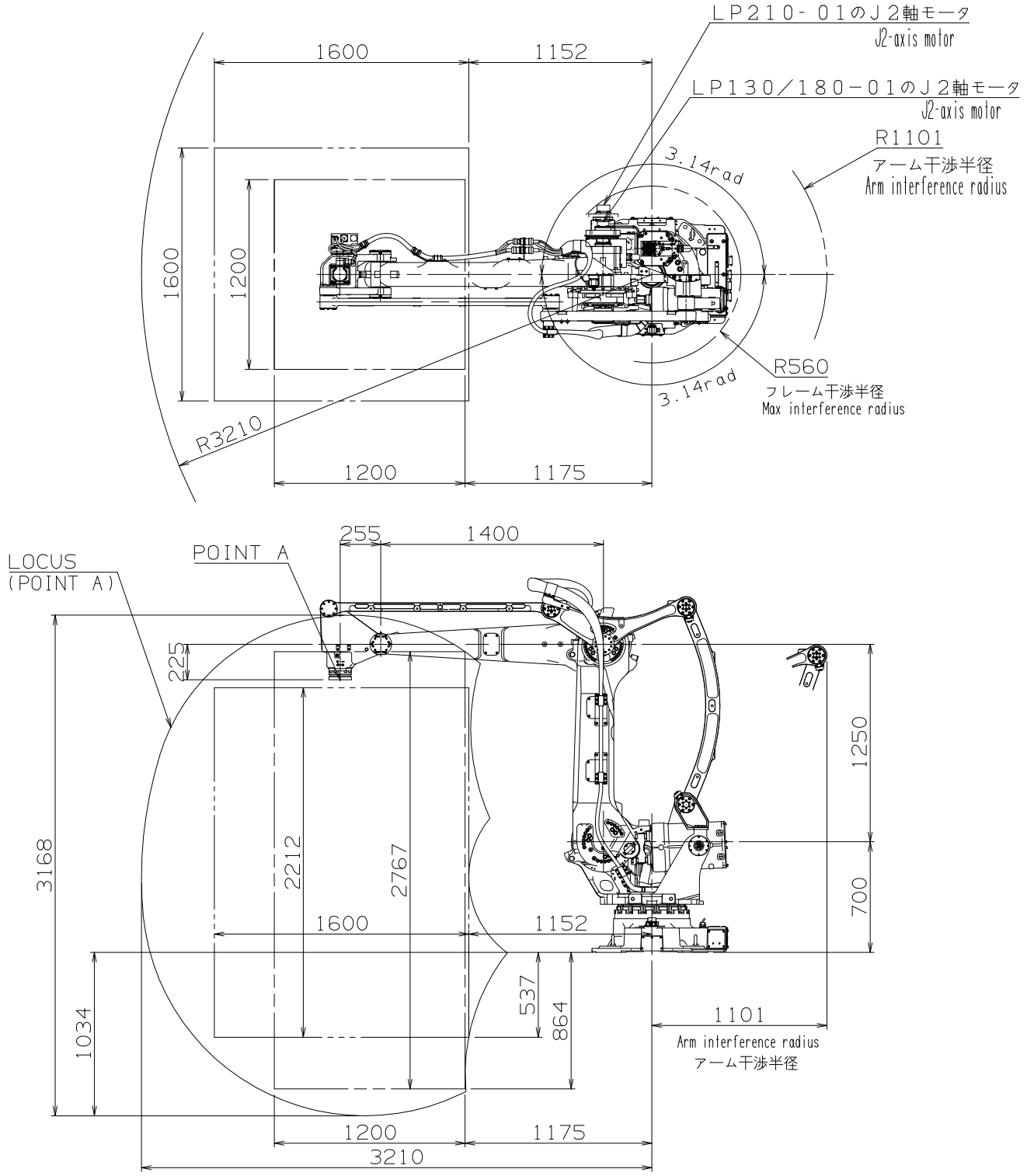
Item			Specifications		
Robot type			LP130-01	LP180-01	LP210-01
Structure			Articulated construction		
Degrees of freedom			4		
Drive system			AC servo system		
Maximum Motion range	Arm	Axis 1	±3.14 rad		
		Axis 2	+0.71 ~ -1.65 rad		
		Axis 3	+0.30 ~ -2.04 rad		
	Wrist	Axis 4	±6.28 rad		
Maximum Velocity	Arm	Axis 1	2.27 rad/s	2.01 rad/s	1.83 rad/s
		Axis 2	2.01 rad/s	1.75 rad/s	1.73 rad/s
		Axis 3	2.01 rad/s	1.83 rad/s	1.75 rad/s
	Wrist	Axis 4	6.98 rad/s	6.28 rad/s	5.24 rad/s
Maximum payload		Wrist	130 kg	180 kg	210 kg
		Upper part of Forearm *1	25 kg at maximum		
Maximum static load torque		Axis 4	50 kgm^2	69 kgm^2	100 kgm^2
Position repeatability *2			±0.3 mm	±0.4 mm	
Air pressure			-101.3 ~ 690 kPa		
Air			2-φ12×8 (to the wrist unit)		
Application signals			20 wires (to the wrist unit) 6 wires (to the fore arm)		
Mounting Condition			Floor		
Ambient conditions			Temperature: 0 ～ 45 ºC *3 Humidity: 20 to 85%RH (No dew, nor frost allowed) Vibration to the installation face: Not more than 0.5G (4.9 m/s^2)		
Protection class			IP50 equivalent		
Robot weight			1,150 kg		

1[rad] = 180/π[°], 1[N-m] = 1/9.8[kgf･m]

*1: This load varies depending on its mounting position and the weight of wrist payload.
*2: This value is determined under the rule of JIS B 8432.
*3: Permitted height is not higher than 1,000m above sea level. If used in higher place, permitted temperature is affected by height.

1.2 Outline dimensions and motion range

[LP130-01] [LP180-01] [LP210-01]



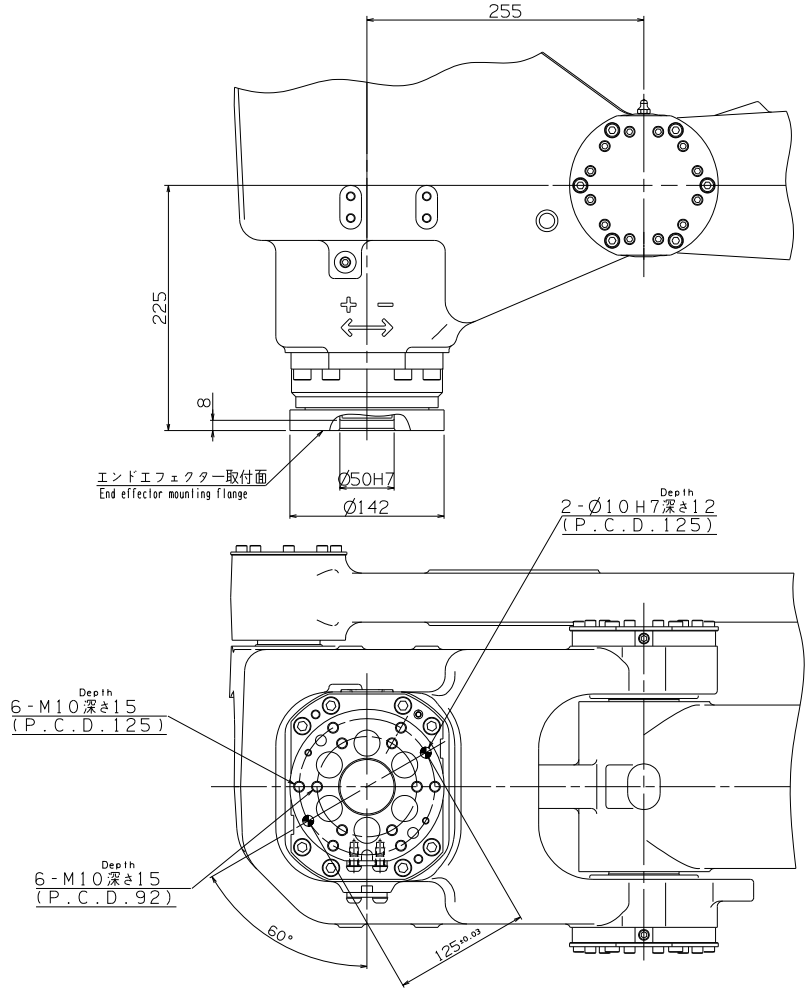
1.3 Details of load mounting face

■ **Wrist**

For the tool fixing bolts, use the mounting P.C.D. shown below.
Besides the mounting P.C.D. shown below, different P.C.D. (option) is available. For details, contact our Service Division.

CAUTION	Be sure to screw the M10 tool fixing bolts in the wrist not deeper than the screw depth in the mounting face. Screwing the bolts deeper than the screw depth may damage the wrist.
CAUTION	Be sure to use P.C.D.125 when the weight of end effecter is 100kg or higher or the moment of inertia is larger than 25kgm^2. (But if the stiffness of attachment bolt was considered inside tool, above size is unnecessary.)
CAUTION	When installing the end effecter (gripper etc.), please insert a positioning pin using the hole of φ10H7 to avoid rotation.

[LP130-01] [LP180-01] [LP210-01]

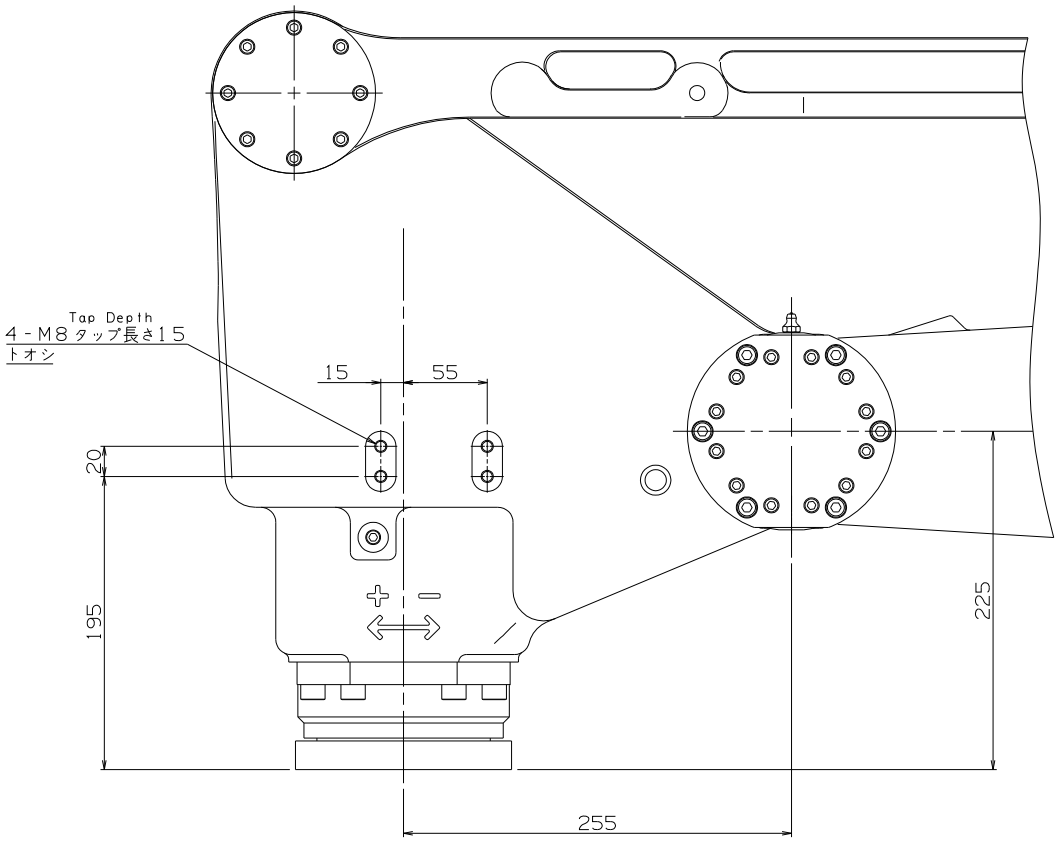


■ **Left side of wrist unit**

Ancillary equipment can be mounted on the left side of wrist unit.

CAUTION	The equipment to be mounted on the wrist should be selected so that the sum of those masses (including the end-effecter and the work-piece) is less than the payload mass of the wrist.
CAUTION	Because the material of the tap is aluminum cast, the length of the screw depth should be from 14 to 15 mm. (The tap is through)

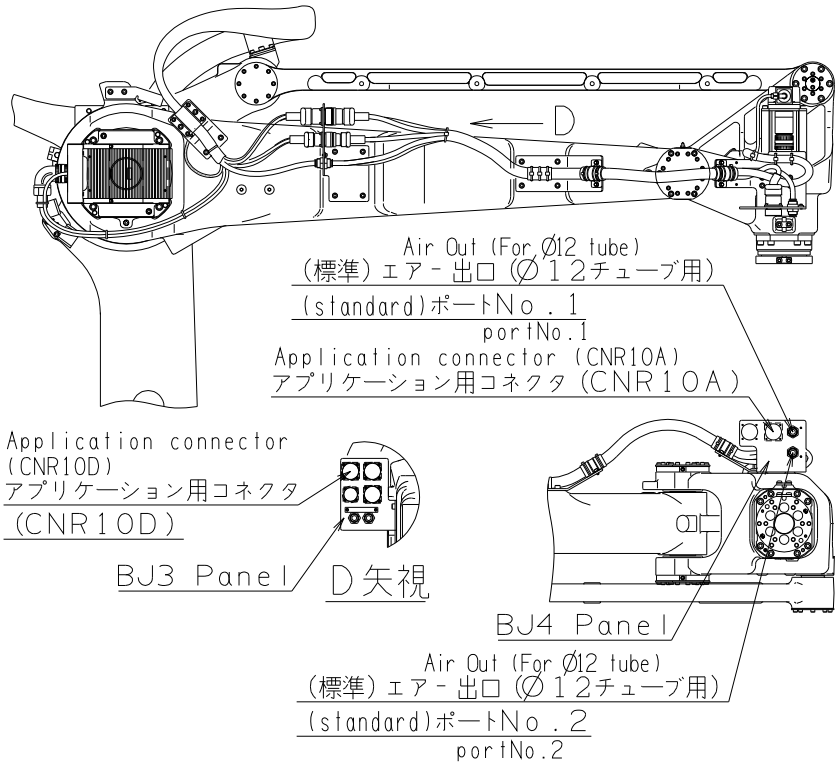
[LP130-01] [LP180-01] [LP210-01]



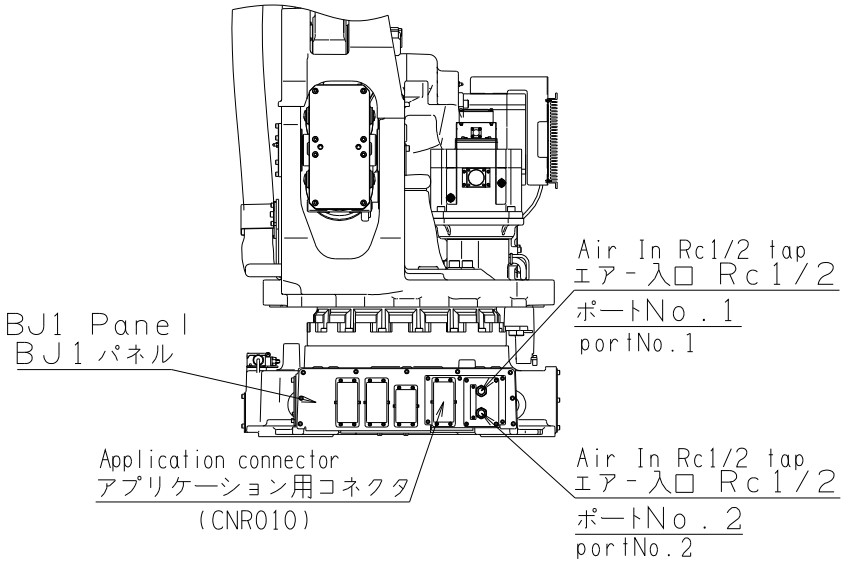
1.4 Wiring and piping diagram for application

IMPORTANT	Use air pressure from -101.3 [KPa] to 690 [KPa].

■ Upper part of forearm - wiring and piping diagram for application
[LP130-01] [LP180-01] [LP210-01]

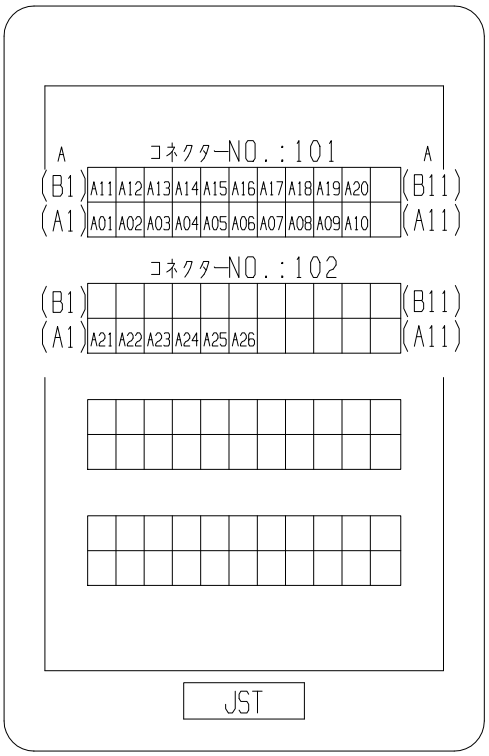


■ Base frame - Wiring and piping diagram for application
[LP130-01] [LP180-01] [LP210-01]



■ **Details of application connectors**

(1) BJ1 side (connector)



Connectors for application cables

Wire-side shell : JFM-WSA-4-A (JST)
or JFM-WSA-4-C (JST)

Guide plate A kit : JFM-GPAK-4 (JST)

Receptacle housing : JFM2FDN-22V-K (JST)

Receptacle contact :
a : SJ2F-01GF-P1.0 (JST) (0.20 - 0.50sq)
b : SJ2F-21GF-P1.0 (JST) (0.30 - 0.75sq)

Manual crimp tool :
a : YRS-8861
b : YRF-1120

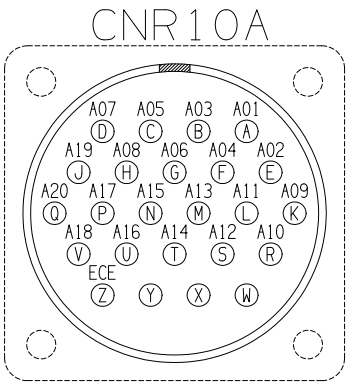
Cable diameter suitable for wire-side shell
JFM-WSA-4-A : φ26.2~φ28.0
JFM-WSA-4-C : φ15.5~φ16.5

(Pin allocation shows the view of the connector mounted on the robot seen from the connection side.)

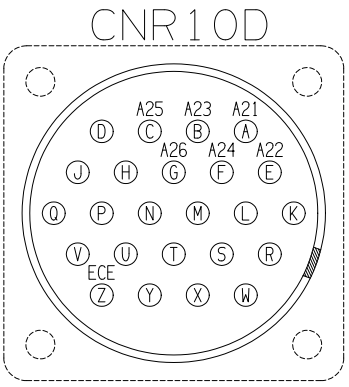
Specification of Application wires :
Rated voltage maximum AC/DC 115 V
Rated ampere maximum 1 A

(2) BJ3･BJ4 side (connector)

BJ4 side connector
Key position “standard”



BJ3 side connector
Key position “X”



(This pin allocation shows the view seen from the connection side.)

Connector type (CNR10A)	N/MS3102A24-28S (JAE)
Receptacle	N/MS3106B24-28P (JAE)
Connector type (CNR10D)	N/MS3102A24-28SX (JAE)
Receptacle	N/MS3106B24-28PX (JAE)

CAUTION	Do not apply external force or fix other cables to the robot cables.

1.5 Operating range adjustment

WARNING	With stoppers dismounted, do not operate the robot. Doing so may result in damage to the peripheral equipment and the like, or death or serious injury.
WARNING	When changing the mechanical stopper's position, change the position of the over-travel limit switch and the setting of the software limit also. If not changed, the mechanical stopper may be damaged. And, the mechanical stopper should be installed outside of the motion range defined by the software limit function and the over-travel limit switch.

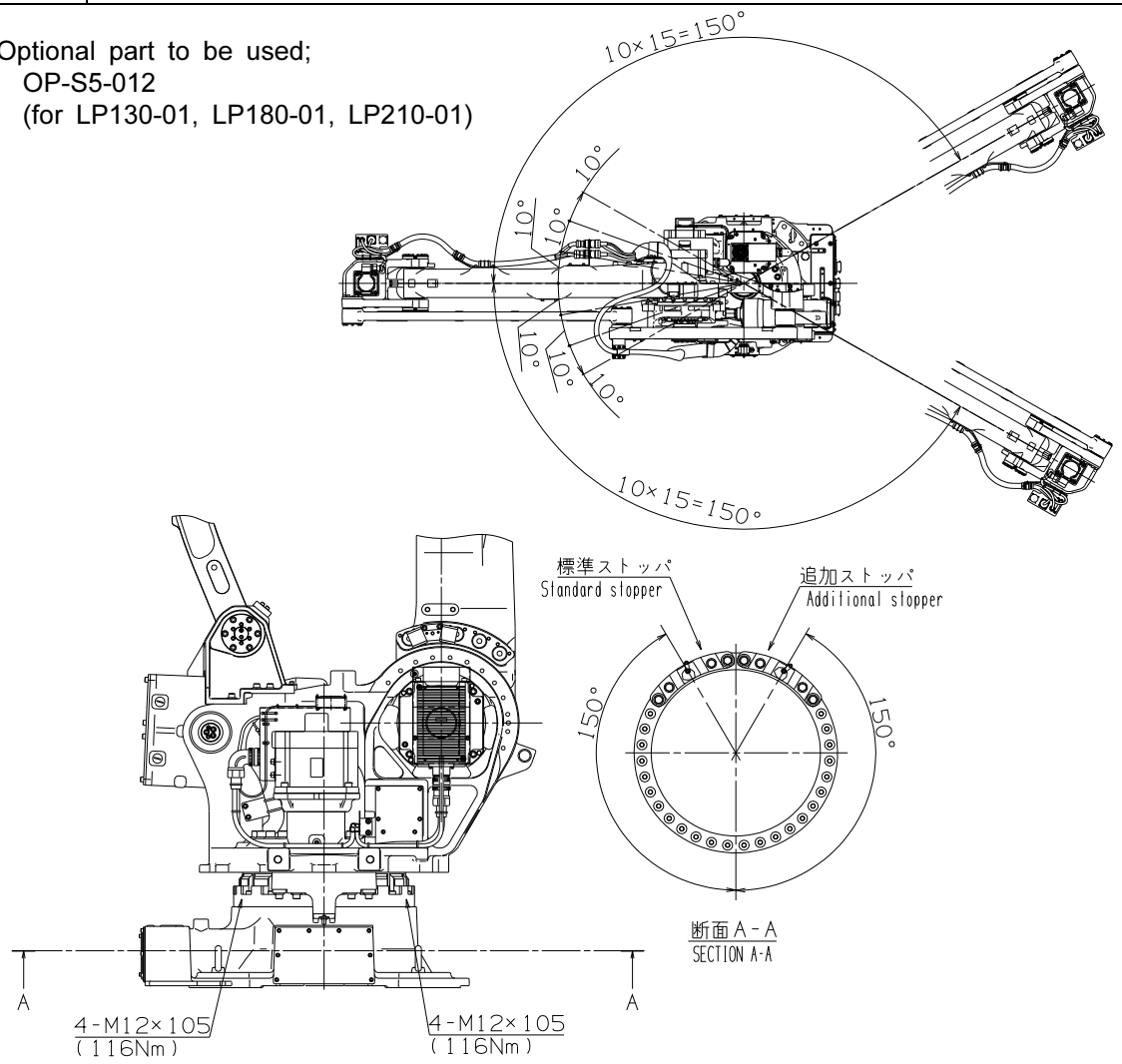
■ **J1-axis adjustable stopper (option)**

Mounting the standard stopper and the additional stopper (option) of the same shape as that of the standard stopper makes it possible to adjust the operating angle of the J1 axis in steps of 10°. In this case, a maximum operating range of the J1 axis comes to ±150°.

(1) Dismount the stopper from the standard mounting position, and then mount the stoppers according to an angle to be adjusted. (Fixing bolt: M12 × 105 × 4 bolts)
(2) Adjust the software limit according to the angle adjusted. (Refer to Instruction manual "INSTALLATION" (for AX) or "SETUP" (for FD).

IMPORTANT	The end of a mechanical stopper is provided in a position exceeding the software limit of J1 axis by 3°.

Optional part to be used;
OP-S5-012
(for LP130-01, LP180-01, LP210-01)

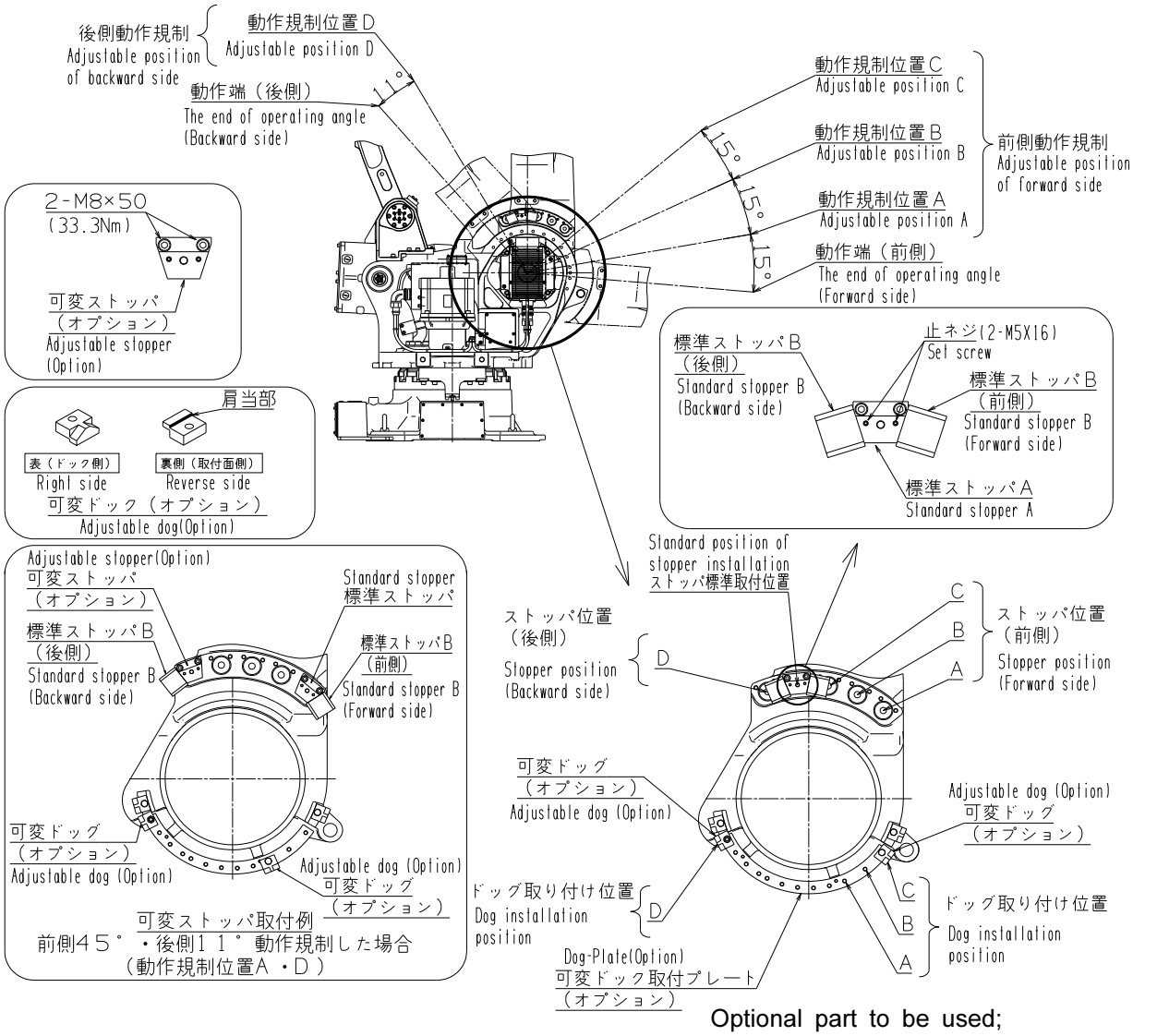


■ **J2-axis adjustable stopper (option)**

WARNING	NEVER mount a stopper only on the front (lower) side or the rear (upper) side.

It is possible to adjust the operating angle of J2 axis.

(1) Unscrew the setscrews from the standard stopper B on the adjustable side, and then dismount the stopper B from the standard stopper A.
(2) Mount the adjustable stopper (option) at an angle to be adjusted. (Fixing bolt: M8 × 50 × 2 bolts)
(3) Mount the standard stopper B to the adjustable stopper, and then fix them with the set-screws.
(4) Mount the adjustable dog (option) of the limit switch according to the adjusted angle.
(5) Adjust the software limit according to the angle adjusted. (Refer to Instruction manual "INSTALLATION" (for AX) or "SETUP" (for FD).



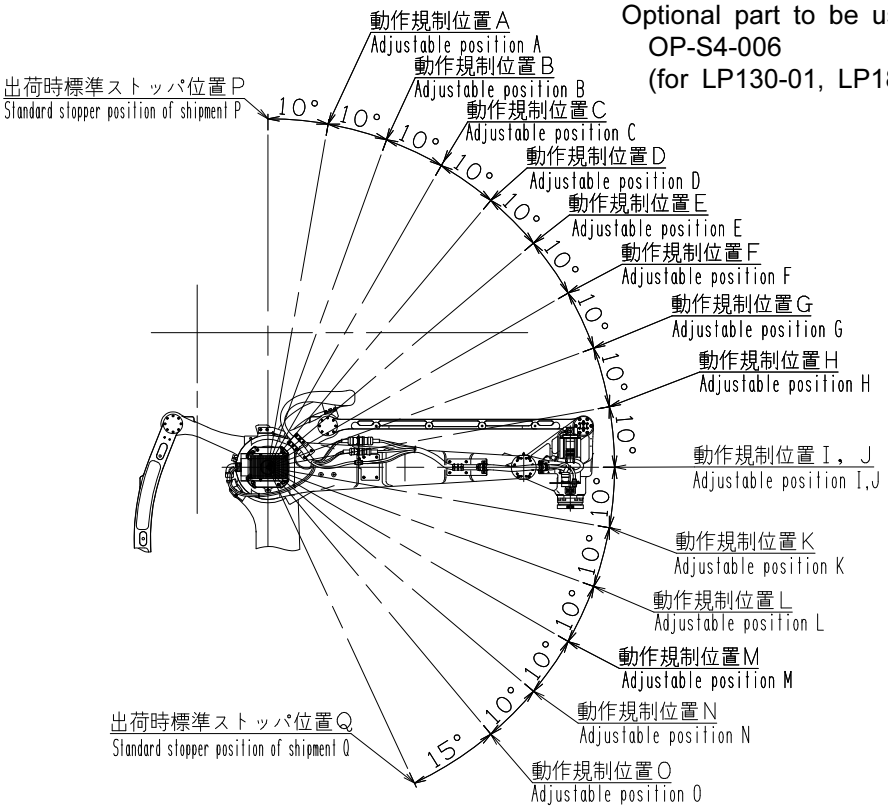
Optional part to be used;
OP-A5-024
(for LP130-01, LP180-01, LP210-01)

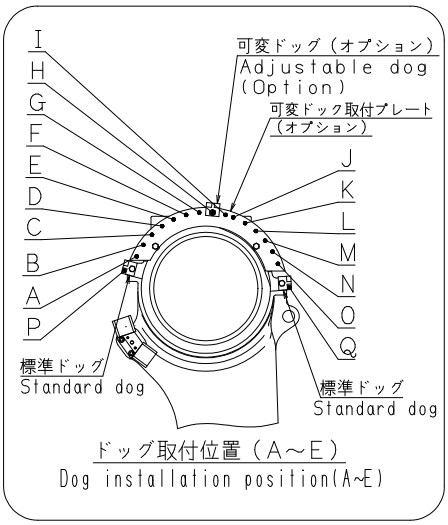
■ **J3-axis adjustable stopper (option)**

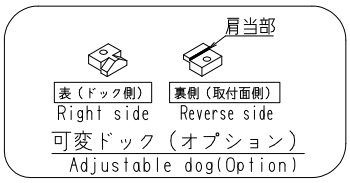
It is possible to adjust the movement of J3 axis.

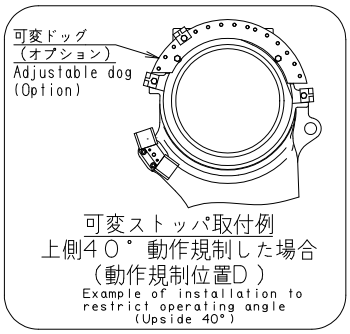
(1) Mount the adjustable dog (option) of the limit switch according to the adjusted angle.
(2) Adjust the software limit according to the angle adjusted. (Refer to Instruction manual "INSTALLATION" (for AX) or "SETUP" (for FD).

Optional part to be used;
OP-S4-006
(for LP130-01, LP180-01, LP210-01)



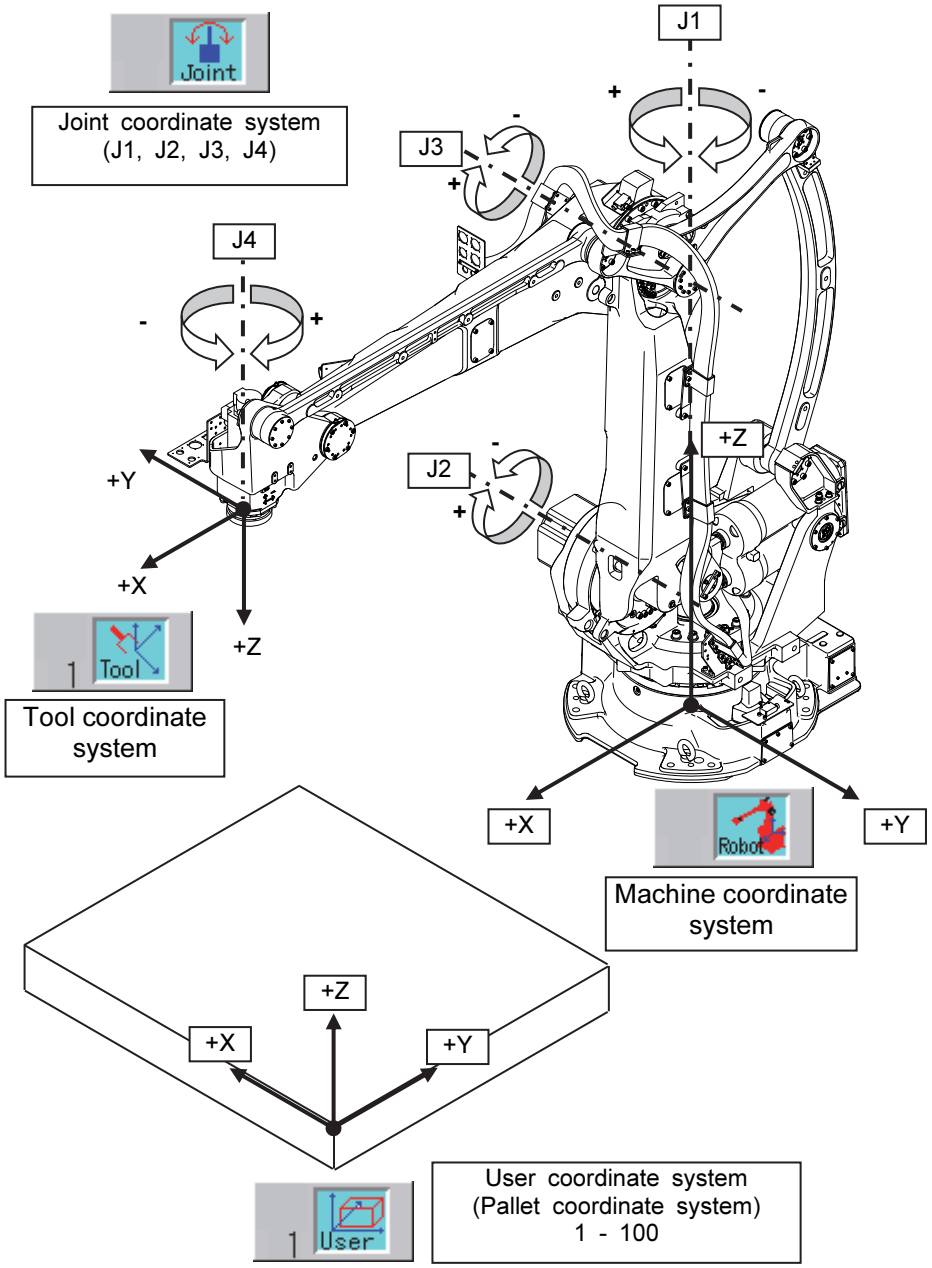






1.6 Coordinate systems for manual operation

When moving a robot in manual mode, it is possible to select a coordinate system which is used as a reference coordinate system.



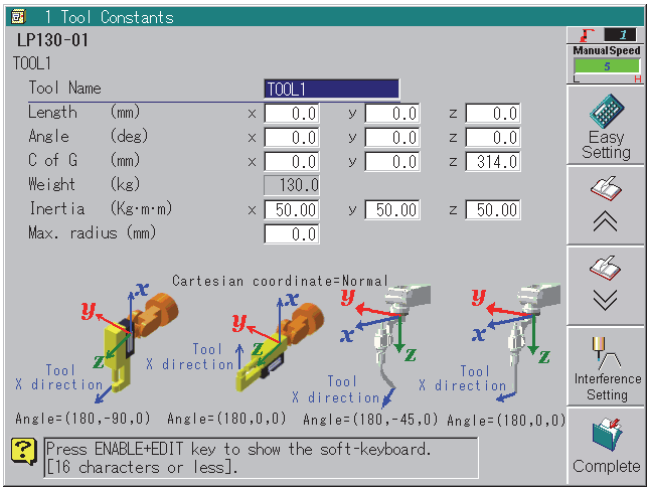
(NOTES)

To select a user coordinate system number for manual operation, please use the following operations.

(1) Select a pallet number using software key <Select Pallet>. By this operation, the appropriate user coordinate system attached to the pallet is automatically selected.
(*) For details, refer to "6.2.1 Select Pallet" in the operating manual "Palletize Function Part1 Advanced Palletize Function" (for AX) or “Palletize Function” (for FD).
(2) Set a user coordinate system number in [Constant Setting] [5 Operation Constants] [5 Coordinate regis tration] in advance. (If the number is set here, it becomes possible to select the user coordinate system u sing [INTERP/COORD.] key.

1.7 Precautions for tool setting

■ **[Constant Setting][3 Machine Constants][1 Tool Constants] screen**



Parameter	Description	Setting method
Tool Name	The name of the tool.	A name can be set for each of the tools. A tool name may consist of not more than 16 alpha numeric and symbols. For the operation, refer to [2.5 To input characters] of the "Basic operations manual".
Length	The coordinates of the Tool Center Point (= the origin of the tool coordinate system)	It is not necessary to modify this setting. The initial setting can be used as it is. (NOTE1)
Angle	Angles to determine the direction of the tool coordinate system.	
C of G	The coordinates of the center of the gravity of the tool	Calculate the coordinates of the COG referring to the drawing of the tool and the work-piece and input the values manually. (NOTE 2)
Weight	Weight of the tool.	Please use [Service Utilities] [19 Automatic COG Setting] (NOTE 2)
Inertia	Moment of inertia of the tool.	Please use [Inertia Set] key of [Easy Setting] (NOTE 3)
Max. radius	The maximum rotation radius of the tool. This is used for a interference area detection etc.	Manually input the value. For details, refer to the instruction manual "Installation Manual" (for AX) or “SETUP” (for FD).

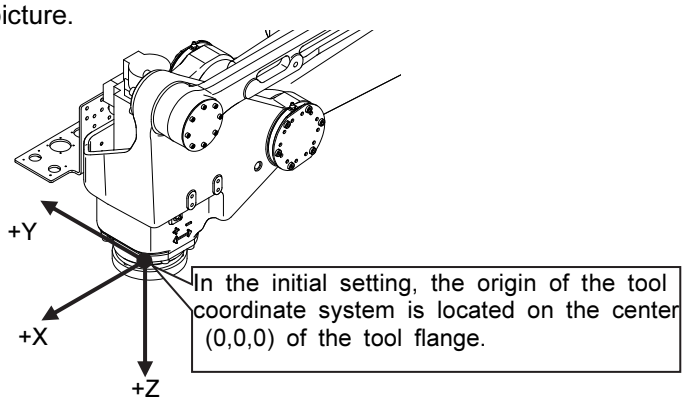
(NOTE 1)
- If this settings (Length and Angle) are modified after making a palletize pattern, it may become necessary to modify the palletize pattern again.

(NOTE 2)
- In case of this robot (LP-01 series), only "Weight" is calculated and set when executing "Automatic COG Setting" function ("COG" values will not change). Those COG coordinates should be calculated referring to the drawing of the tool and the work-piece and inputted manually. (See [0 ■ (Reference) Setting example of a COG of a **tool**])
- To get a better motion control, make 2 settings of "Without a work-piece (not holding a work-piece)" and "With a work-piece (Holding a work-piece)" and make settings of "Weight" and "COG" respectively for those 2 tool settings.
- Refer to the instruction manual "Installation Manual" (for AX) or “SETUP” (for FD) also.

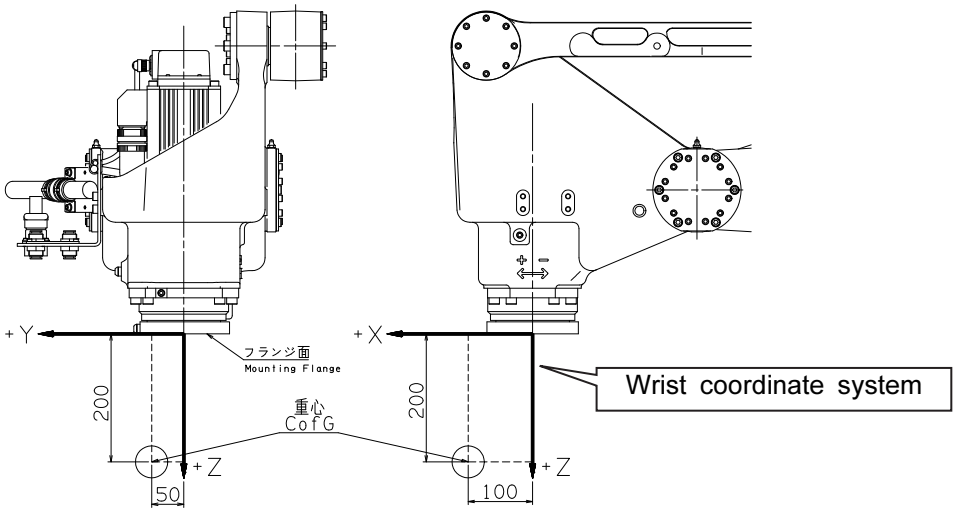
(NOTE 3)
- "Automatic tool moment of inertia setting function" is not available.
- This setting should be done after finishing the setting of "COG" and the "Weight" of the tool.

■ **(Reference) The initial setting of the tool coordinate system**

The position and the direction of the tool coordinate system when "Length" and "Angle" are the initial settings are shown in the following picture.



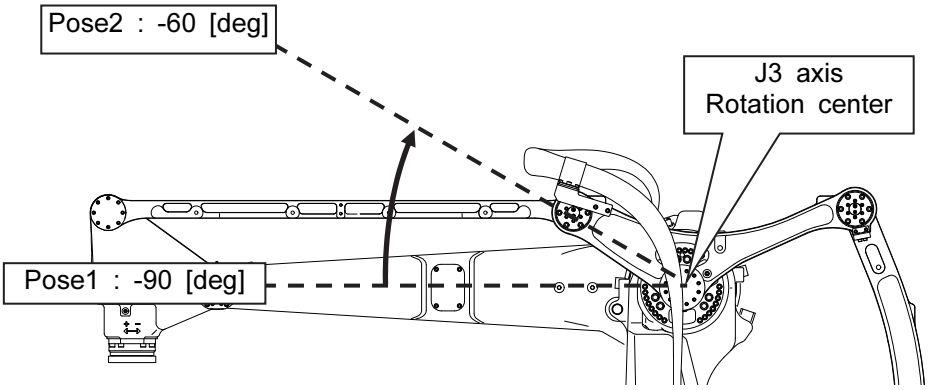
■ **(Reference) Setting example of a COG of a tool**



The coordinates of the "C of G" (center of the gravity of the tool) should be set based on the "Wrist coordinate system" which is fixed on the wrist flange (mounting flange) center. For example, if the "C of G" is located on a position like the figure shown as above, the coordinates of the "C of G" are;
(x,y,z) for "C of G" = (100, 50, 200)

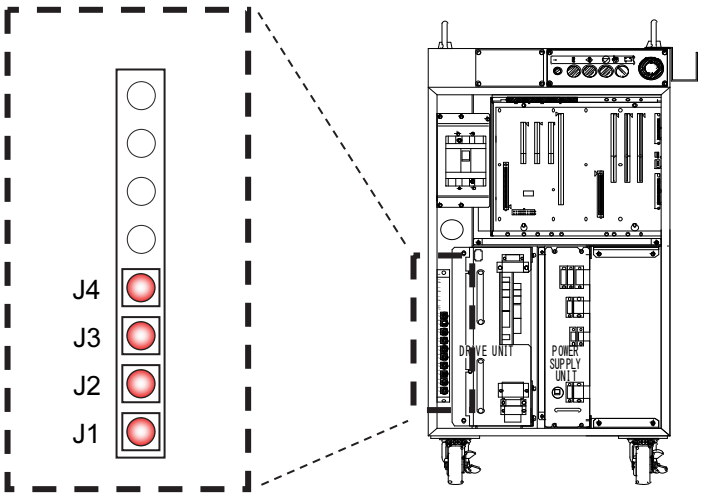
■ **(Reference) J3 angle for "Automatic COG Setting" function**

For both pose1 and pose2, use poses in which a large unbalance torque is added to the J3 a xis. (in a range within ±30 [deg]) But, the pose1 and the pose2 must be different.
(Example) Pose1 : -90 [deg] / Pose2 : -60 [deg]



1.8 Brake release switch (option)

Only needed switches (same quantity as axis number) are mounted on the brake release switch (option). Pay utmost attention to operate these switches.
Please refer to “AX20 controller maintenance manual” or “FD controller instruction manual / Controller Maintenance”.

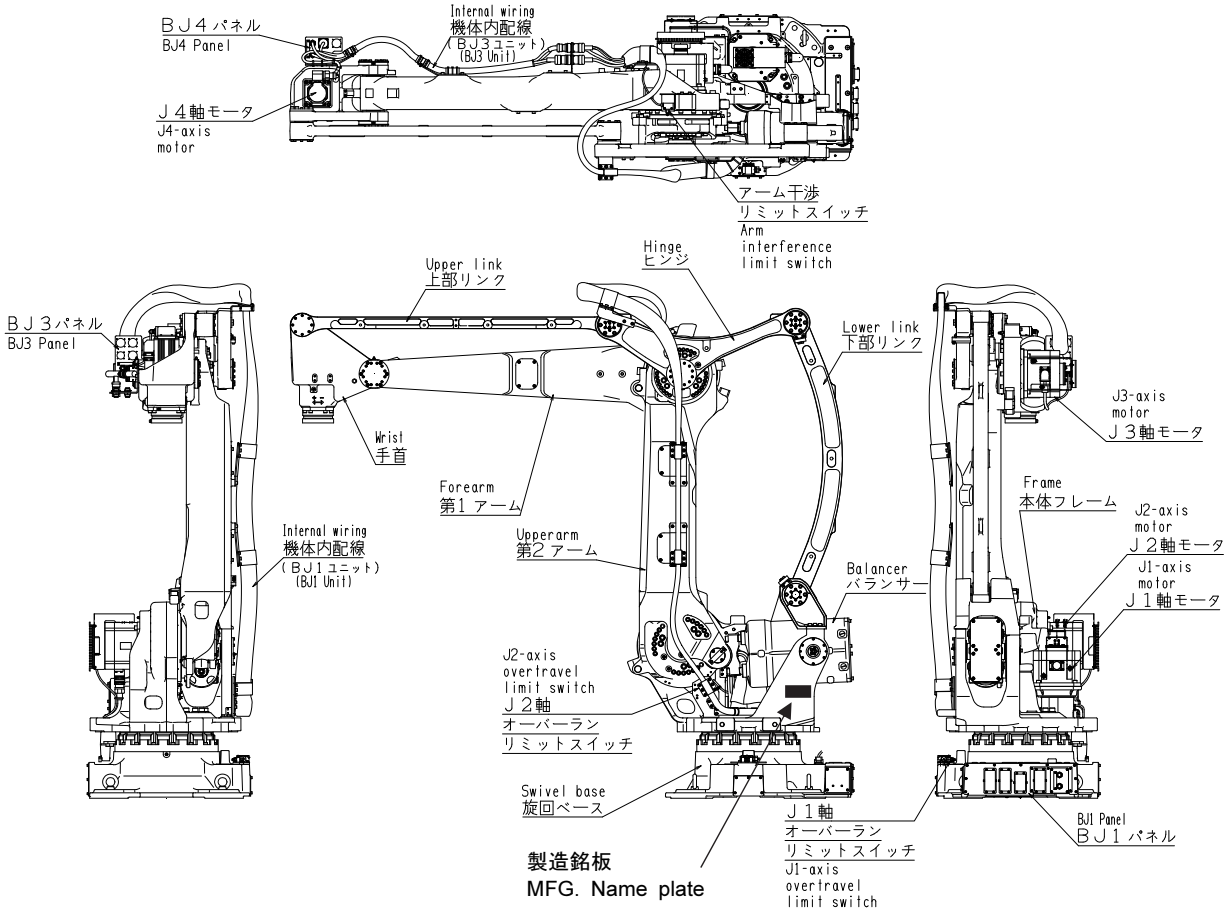


Sample of brake release switch (option) : Type 1 of AX20 controller

NOTE

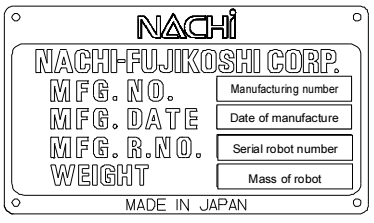
Chapter 2 Precautions for handling

2.1 Names of robot components



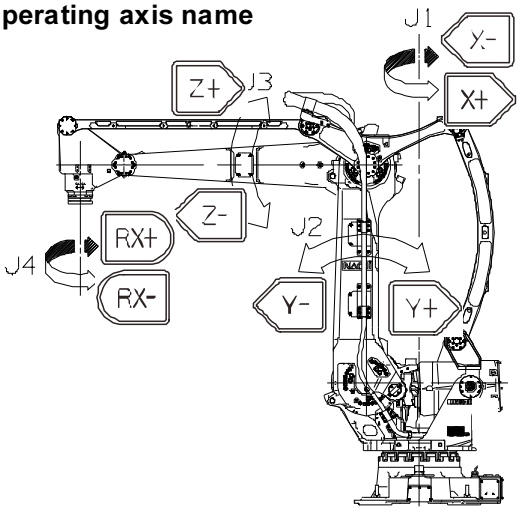
IMPORTANT	The over travel limit switches are redundant circuit type as standard. (Robot shipped before February 2012 has single circuit type.)
WARNING	The balancer device is internally compressed even in the normal state. Never attempt to dismount or disassemble this device. Otherwise it will result in a highly hazardous situation.

Manufacturing plate



(Mass is typed only for CE specification.)

Operating axis name



2.2 Transport procedure

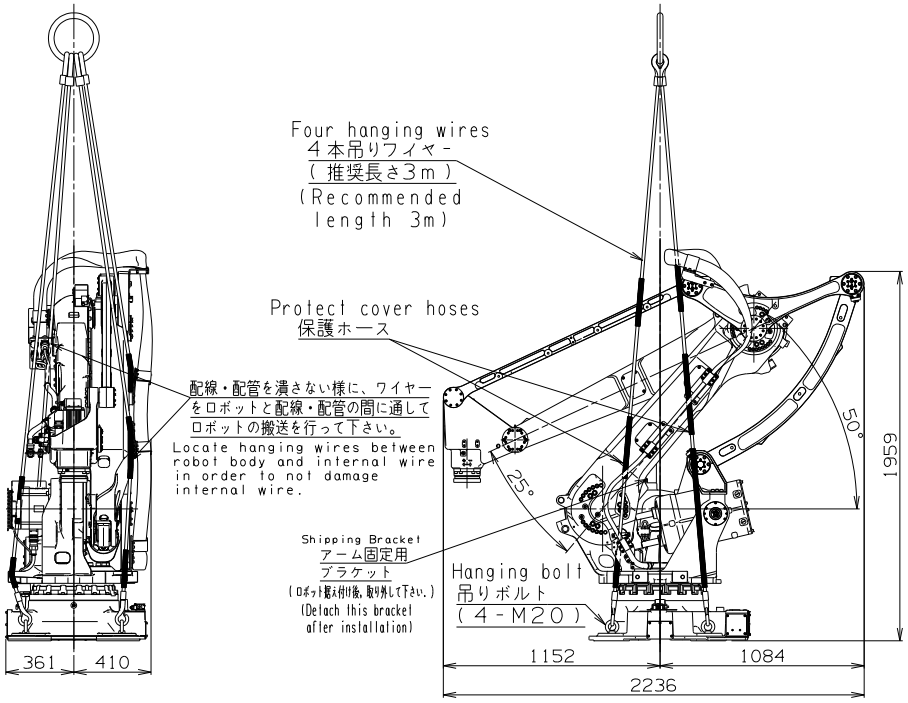
WARNING	The robot must be transported by personnel who have licenses required for slinging work, crane operation, forklift truck operation, and others. When the transportation work is covered by the personnel who does not have necessary skill, it will cause the robot to topple over or drop during transport, thus resulting in hazards.
WARNING	To lift the robot or the controller, follow the procedures specified in the Maintenance Manual. Following any procedures other than those specified will cause the robot to topple over or drop during transport, thus resulting in accidents.
WARNING	During transport or installation work of the robot, pay utmost care not to cause damage to wirings. Furthermore, after installing the robot, take protective measures such as using protective guards so that the wirings will not be damaged by workers or other persons, or forklift trucks or else.

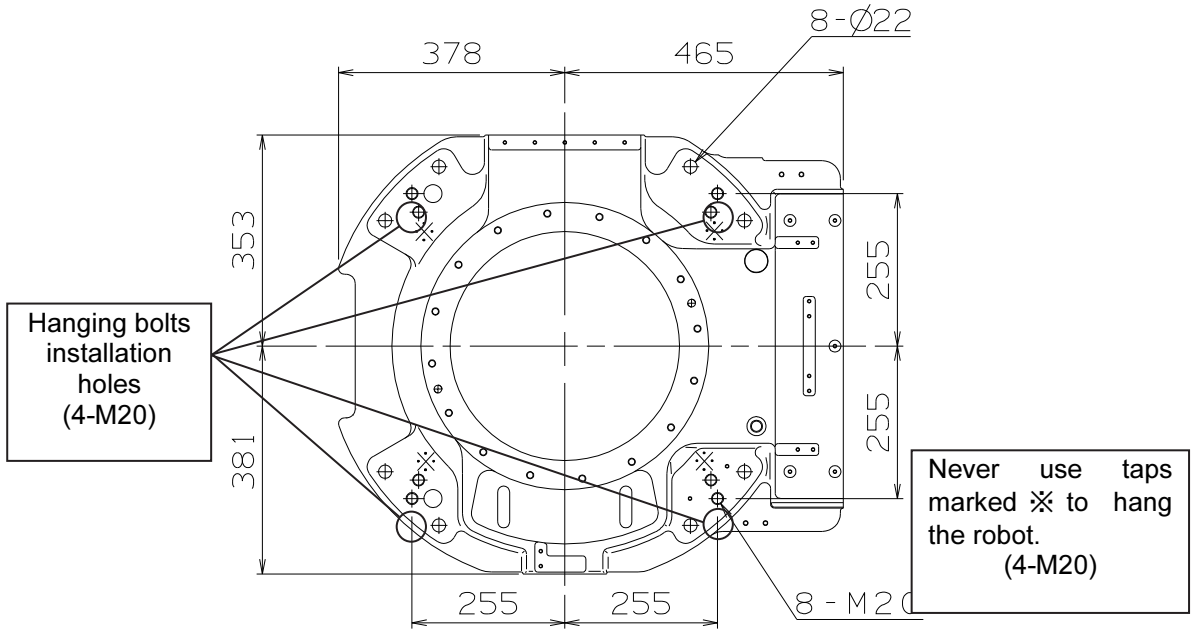
[LP130-01] [LP180-01] [LP210-01]

To transport the robot, make it a rule to use a crane.

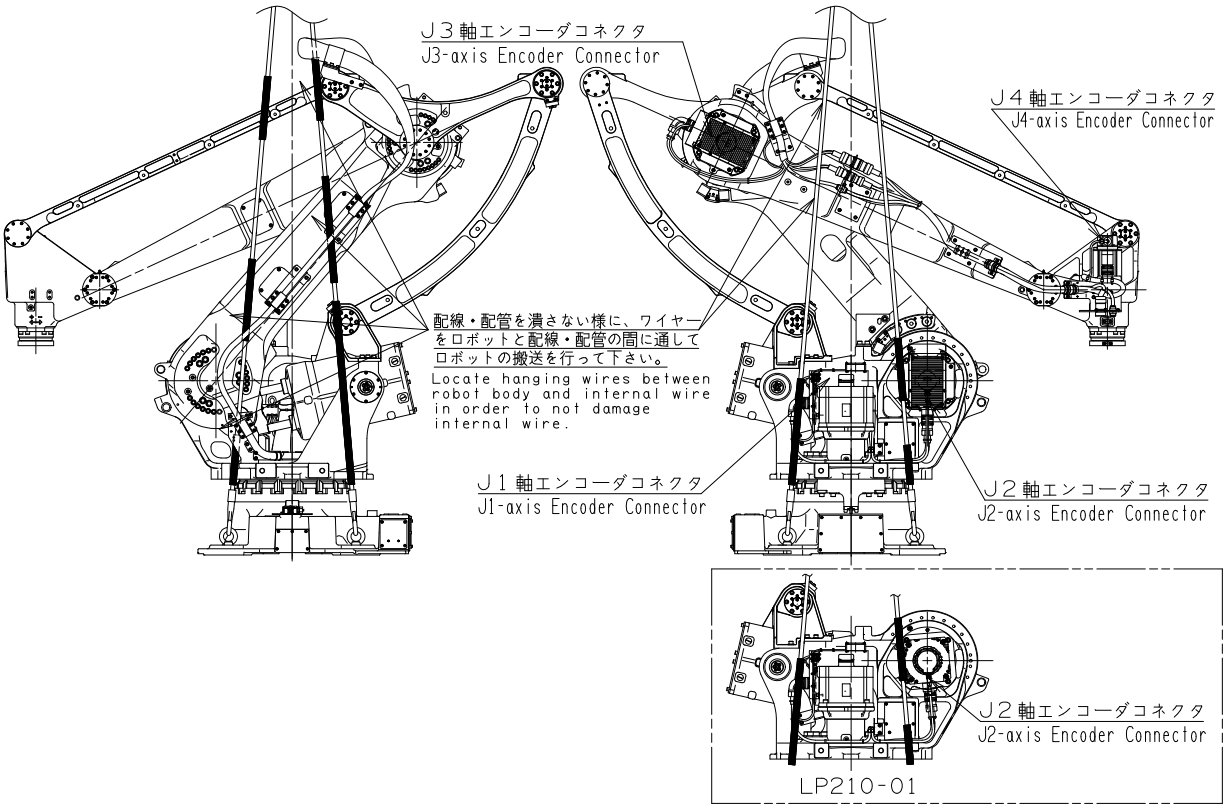
First, put the robot into the configuration shown in the figure and mount the four M20 hanging bolts to the robot frame. Then, be sure to lift the robot using four hanging wires.

Protect areas that contact the robot, using rubber hoses to cover the wire ropes. For the areas to be covered with the rubber hoses, refer to the figure shown as below.

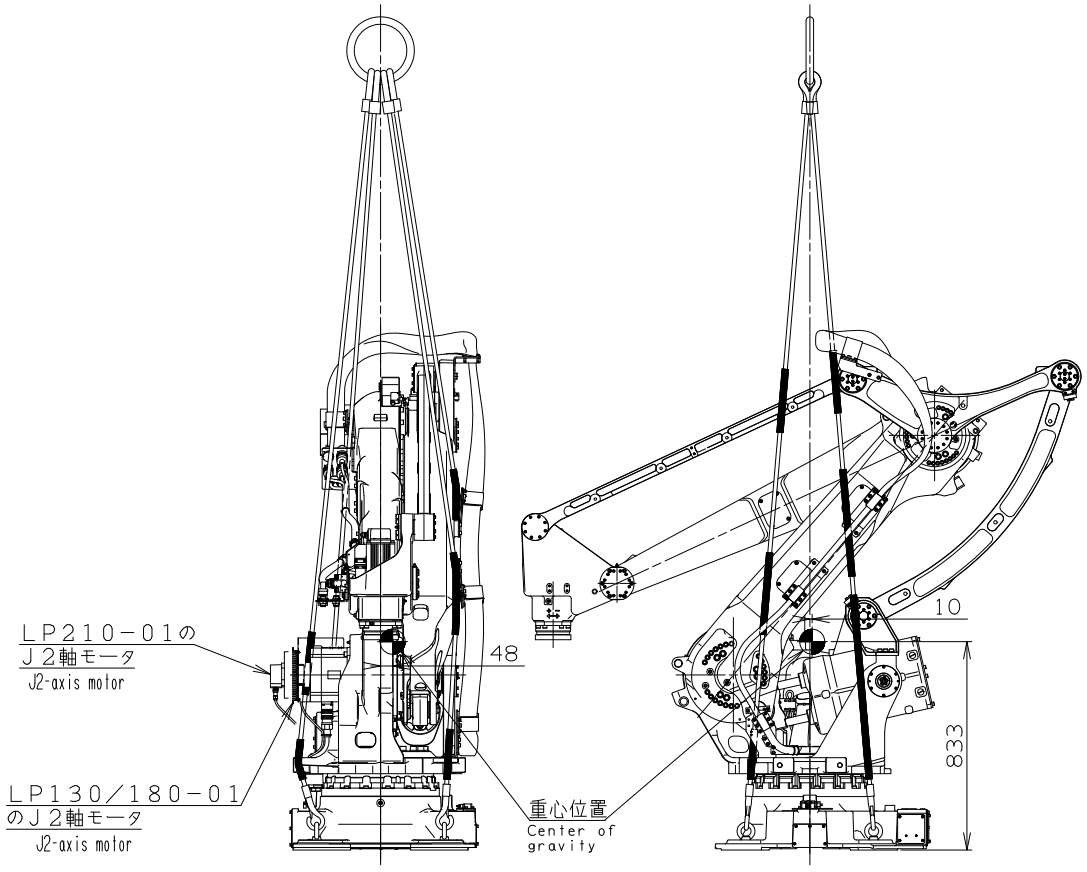




If hanging wires push the encoder connectors and the wires/tubes, the connectors or the wires/tubes may be broken when hanging the robot. When hanging a robot, please pay attention not to make the wires touch the encoder connectors and the wires/tubes.



COG position for transporting posture (without a wrist load) is shown below.



2.3 Installation procedure

The installation location and the installation procedure of the robot are critical factors to maintain robot functions. The ambient conditions of installation location not only have influence on the life of mechanical sections of the robot, but also get involved in safety issues. Consequently, strictly observe the environmental conditions shown below. Furthermore, utmost care should be exerted for the installation procedure and the foundation for the robot in order to maintain the robot performance. Strictly observe the installation procedure for the robot provided below.

Installation

To install the robot, give it first priority to thoroughly consider safety of workers and take safety measures. The following section describes precautions for this purpose.

Safety measures against entry in the robot operating area

WARNING

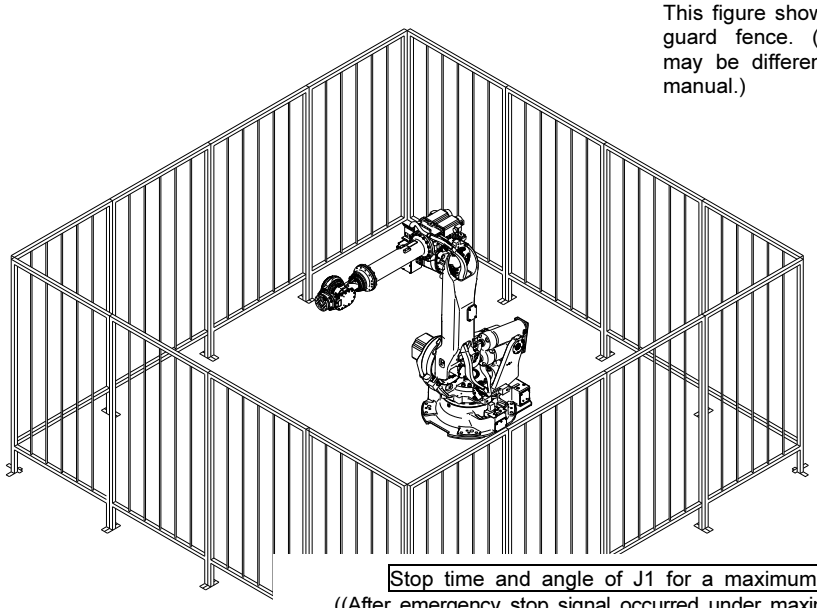
While the robot is in operation, workers are in danger of coming in contact with the robot. To avoid that, install a **guard fence** so as to keep the worker away from the robot. Not doing so will cause the workers or other persons to accidentally enter the operating area, thus resulting in accidents.

DANGER

Guard fence

Refer to information in ISO13857: Safety of machinery – Safety distances to prevent hazard zones being reached by upper and lower limbs

This figure shows the image of the guard fence. (Robot appearance may be different from that of this manual.)



Stop time and angle of J1 for a maximum travel

((After emergency stop signal occurred under maximum speed)

	LP130-01、LP180-01	LP210-01
Stop time	0.83 [sec]	0.68 [sec]
Stop angle	0.74 [rad]	0.58 [rad]

WARNING

The guard fence must have construction by which no one can easily get over or move the guard fence. Provide an access door for the guard fence that must be equipped with a **safety plug** and designed not to open unless the safety plug is unplugged.

If above construction is not secured, someone can get in the guard fence, thus inducing a hazardous situation.

WARNING

Design the system so that **motor power is turned OFF** when safety plug is unplugged or access door is opened. This can make it possible to detect the entry of a person and atop the robot automatically. (The controller has an input signal of safety plug and to turn off the motor power.)

WARNING

Design the system so that **low-speed playback mode** will become functional in order to operate the robot with the safety plug unplugged. If the robot is operated at a high speed under the said condition, no one can escape from the robot, thus resulting in accidents. (The controller has an input signal to select low-speed playback mode.)

WARNING	Mount **Emergency Stop buttons** for the robot **in locations where workers are able to immediately press them**. If the workers are unable to immediately press the switch, accidents may result. (The controller has an input signal of emergency stop.)
WARNING	If no guard fence is installed, mount **photoelectronic switches and/or mat switches, etc.** at all entrances to the robot operating area to use them in place of the safety plug. These switches make it possible to automatically stop the robot when anyone enters the guard fence.
WARNING	**Coat the floor** of the hazardous area (the robot operating area) **with color paint** to facilitate discrimination of the hazardous area.

Safety measures against the robot and peripheral equipment

WARNING	In order to connect the primary power supply to the controller and the peripheral equipment, check to be sure that the power on the supply side is turned OFF. Otherwise it will create a hazardous situation resulting in electric shocks since high voltages such as 100VAC, 200VAC, or 400VAC are applied.
WARNING	Do not install the operation part and the adjustment part in the robot operating area, such as locations in which a person can get caught in the robot. Install the robot control panel, interlock panel, and all other operation panels so that they can be operated **outside the guard fence**.
WARNING	To install an operation stand, mount an **Emergency Stop button on the operation stand**. If any abnormality occurs while the robot is being operated by the use of the operation stand, the robot will be able to make an emergency stop through pressing this switch.
WARNING	Do not route wirings, piping, and the like among the robot, control panel, interlock panel, and others in such a manner that workers will stub their toes over them or forklift trucks will directly **tread** them. Otherwise it may cause workers to topple over or the wirings to be broken, thus resulting in accidents.
WARNING	Do not install the control panel, interlock panel, operation stand, or else in places from which the movements of the robot are **out of sight**. When the robot movements go out of sight, even if an abnormality occurs in any movement, you will delay in taking notice of the abnormality, thus resulting in a disaster. Furthermore, you will not find someone near the robot to cause an accident.
WARNING	If the robot operating area required is smaller than the operable area possessed by the robot, **limit the robot operating area**. The area can be limited by using the software limit, limit switch, and mechanical stopper. Even if the robot exceeds the normal operating area due to an abnormality, this function will enable the robot to stop before initiating operation.
WARNING	Install **light shielding boards, enclosures**, and others to the extent that the movements of the robot can be monitored in directions in which workers may be exposed to spatters during welding. Otherwise it may cause injury to workers with welding arcs, spatters, or else.
WARNING	Provide **a large and highly visible display** of automatic and manual mode indicating the operating status of the robot so that it can be recognized even from locations at some distance. Furthermore, it is effective to provide audible alarm using a buzzer or announcement to alert workers to the initiation of automatic operation, thus facilitating awareness of automatic operation in progress from distant locations.
WARNING	Eliminate **protrusions** from the peripheral equipment and the like of the robot to a minimum. If necessary, be sure to cover them up. Otherwise it may induce a hazardous situation when a worker touches them or is surprised with a sudden movement of the robot to topple over.
WARNING	Do not attempt to install the robot so that a worker will need to **put his/her hands in the guard fence** to carry in or out workpieces. There may be cases where the robot moves when the worker put his/her hands in the guard fence.

Safety measures against installation work

WARNING	To install the robot, it is important to position the robot so that no workers will get pinched by the robot inside or around a device to use the robot. The robot must not come into contact with any peripheral equipment when operating in the maximum operating range with a tool mounted on it.
WARNING	Be sure to install the robot according to the specified procedure. Otherwise it will cause the robot to move or topple over while in operation, thus inducing an imminent hazardous situation.
WARNING	To make wire connections between the robot and the controller or the peripheral equipment, fully understand the connection procedure for proper wire connections. Making wire connections according to improper procedure will cause the robot to malfunction.
WARNING	Be sure to establish a proper ground for the robot. If equipment such as a welder that causes substantial noises is needed to use, establish the specified ground for the equipment.
WARNING	During transport or installation of the robot, pay utmost care not to cause damage to wirings. Furthermore, after installing the robot, take protective measures such as using protective guards so that the wirings will not be damaged by workers or other persons, or forklift trucks or else.

■ Installation location and ambient conditions

Conditions (temperature, humidity, height and vibration) are written in “Chapter 1 Basic Specifications”. Further ambient conditions listed below must be observed.

(1) Location with the drainage structure so that swivel base is not flooded, when the liquid such as water or cutting fluid is splashed on the robot body
(2) Location with no flammable or corrosive fluid or gas.
(3) Type D grounding (the grounding resistance is 100Ω or less) is necessary.

IMPORTANT	**Special environment such as X-ray environment** Our company's robot, controller and related option equipment are designed for general industrial use. Unless otherwise specified in the specifications or manuals, operations in special conditions and environments such as outdoor, X-ray environment, radiation environment, nuclear power control, aerospace equipment, public transportation, medical equipment, etc. are not assumed. Our company and its subsidiaries are not liable for any accidents, failures, etc., that may occur if the robot is used in such an environment without asking our company to do so.
IMPORTANT	Using mounting condition that does not comply with specifications may cause the robot system to malfunction or fail prematurely. In that case, robot will be out of warranty. Please understand it in advance.

■ Installation procedure

While robot moves, large reaction force is applied to the swiveling base from all directions. Consequently, the robot should be installed in such a manner that the foundation endures reaction force caused by accelerating or decelerating the speed to lock the robot, not to mention that it endures static loads. Repair uneven spots, cracks, and others on the floor, and then install the robot by following to the table below. If thickness of floor concrete is less than needed level, an independent foundation should be constructed. Inspect the foundation prior to the robot installation, and then construct the foundation, if necessary.

Robot Model	LP130-01	LP180-01	LP210-01
Thickness of floor concrete	Not less than 160 mm		
Installation parts *1	8 bolts of M20 (JIS: Strength class 12.9) not less than 65mm 8 plain washers of not less than 4.5 mm in thickness and HRC35 in hardness		
Tightening torque *2	560 ± 30 N·m		
Allowable repeated tensile *3	Approximately 35,000 N	Approximately 42,000 N	Approximately 46,000 N

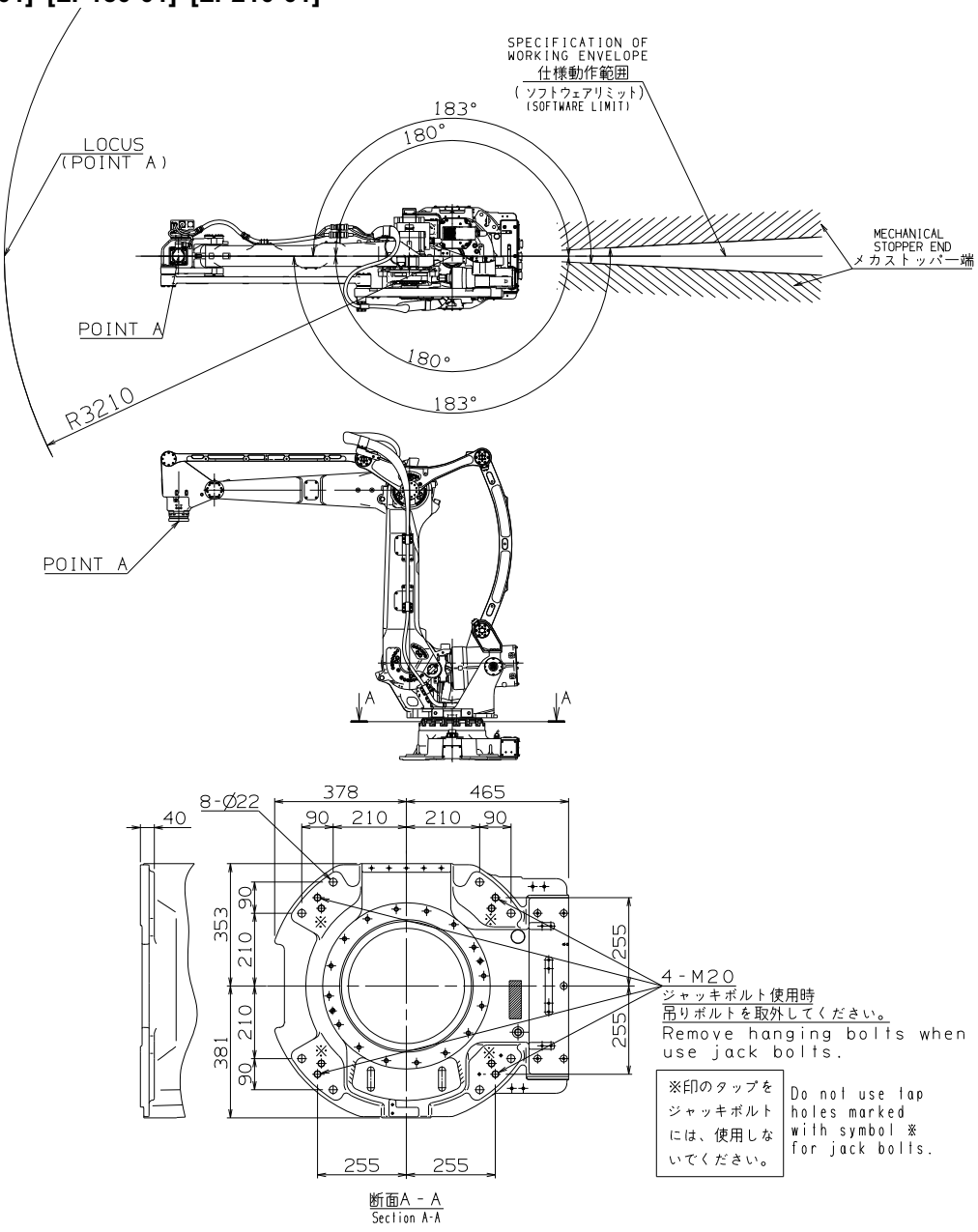
*1 : Installation parts are not accessory of robot.
*2 : Apply a coating of lubricating oil to the threaded parts of bolts, and then tighten bolts by using torque wrench to the specified tightening torque.
*3 : This tensile is per installation bolt when robot is installed with all bolts written in table above.

■ **Installation space**

To install the robot, lock the swiveling base of the robot.

WARNING	The mechanical stopper end is located in a position exceeding the specified operating range (software limit) of the J1 axis by 3 degrees. To install the guard fence, consider the motion range specification, the wrist configuration and the shape of end effecter etc.
WARNING	On the J1, J2, and J3 axes, the robot operating range can be regulated for safety (optional function). Since optional parts should be installed to enable this function, do not independently move the standard parts (e.g. stopper block).
WARNING	If mechanical stopper collides and robot stops, it's possible that some parts are already damaged, for example, mechanical stopper is transformed or fixing bolts are broken. In this case, sufficient intensity and function can not been kept. Mechanical stopper and reduction gear of collided joint are needed to be replaced to the new one.

[LP130-01] [LP180-01] [LP210-01]

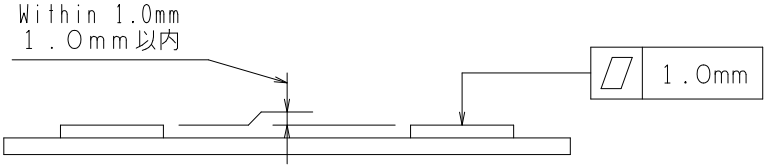


■ **Accuracy of installation surface**

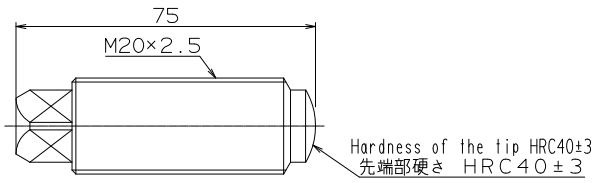
When installing the robot, strictly observe precautions listed below to cause no deformation in the swiveling base.

(1) Ensure that the flatness of the four plates on the installation surface of the robot is within 1.0 mm.

(2) Make the deviation in height between the four robot installation surface plates and the installation surface fall in the range of 1.0 (±0.5 mm).

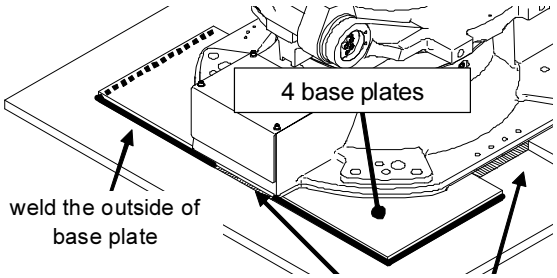


(3) If the two precautions above cannot be observed, use jack bolts to bring the four places into even contact with the installation surface.



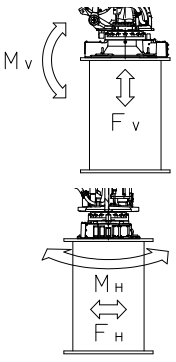
■ **Welding the base plates**

The internal wirings inside the robot base unit may be burned or damaged because of welding spatters or sparks. Therefore, when welding the base plates with attached to the robot base unit, please cover the 4 gaps shown in the following picture in advance.



■ **Maximum robot generative force**

Robot Model	Max. vertical generative force F_V	Max. horizontal generative force F_H	Max. vertical generative moment M_V	Max. horizontal generative moment M_H
LP130-01	40,800 N	28,700 N	80,400 N·m	69,900 N·m
LP180-01	45,700 N	33,100 N	96,600 N·m	84,400 N·m
LP210-01	48,600 N	35,700 N	106,300 N·m	93,200 N·m

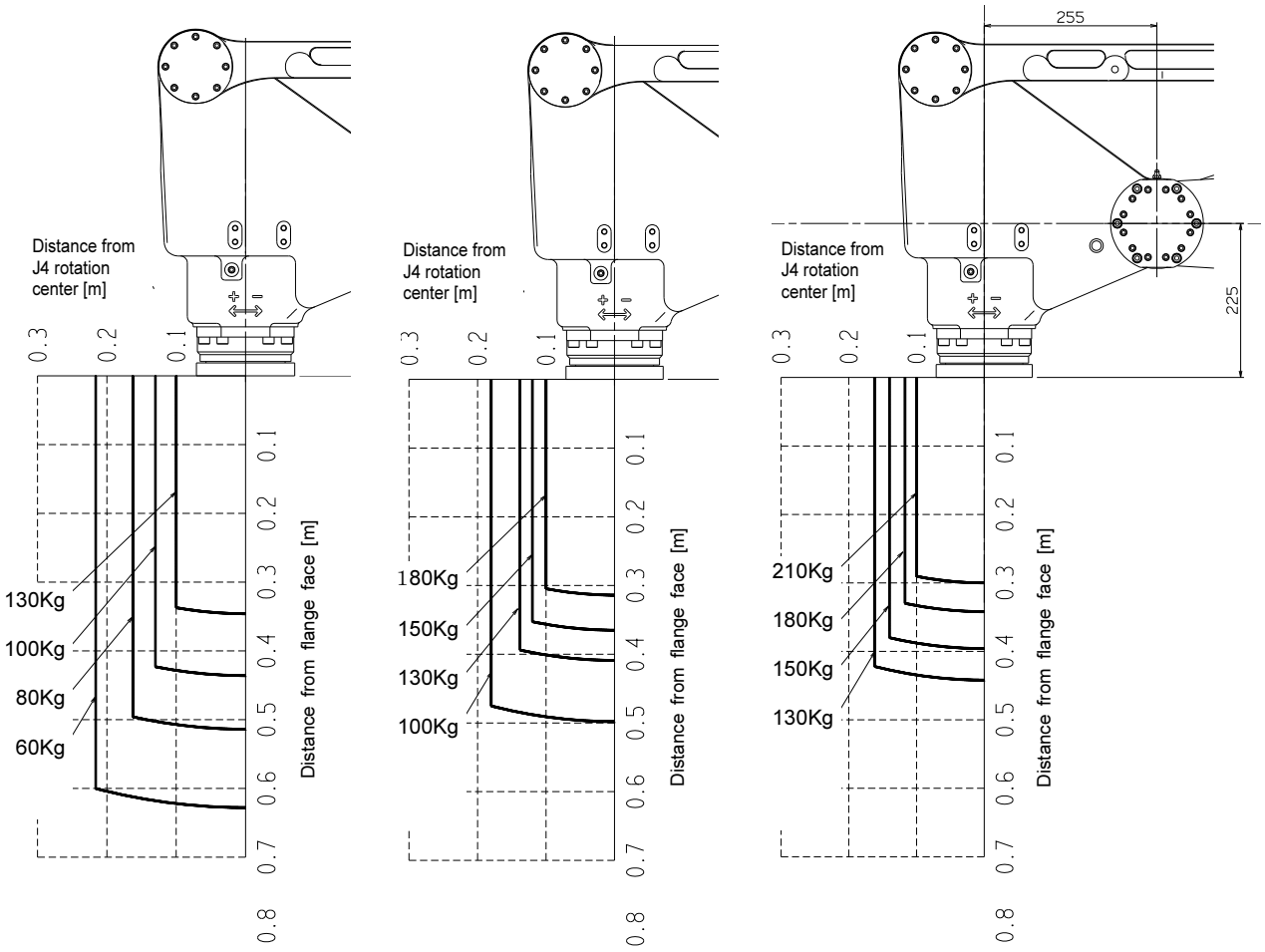


2.4 Allowable load

CAUTION	**The wrist load is regulated by the allowable pay load mass, allowable static load torque, and allowable moment of inertia. If wrist load exceeds these allowable values, this robot is out of guarantee.** Please refer to “1.1 List of basic specifications” and following figures for detail.
CAUTION	Before using the robot, please register the "weight", "COG (center of gravity) position" and "inertia Moment" of wrist payload as the load condition. Robot is controlled to minimize the operating time according to the registered value. Therefore, even if the load condition was within the specifications, if that is incorrect, excessive acceleration will be generated, and reliability and life may be damaged. Even if the correct value is registered, vibration or servo tracking error may occur due to the insufficient rigidity of the payload. If such problem occurs, please adjust the “speed”, “acceleration” and “smoothness”. Those factors can be adjusted in every step. See the instruction manual for details. AX controller instruction manual BASIC OPERATIONS (TAXEN-002) 4.3 Teaching FD controller instruction manual BASIC OPERATIONS (TCFEN-002) 4.3 Teaching

■ **Torque map for the wrist load**

Use the robot under condition that COG of wrist load falls in the range shown below.

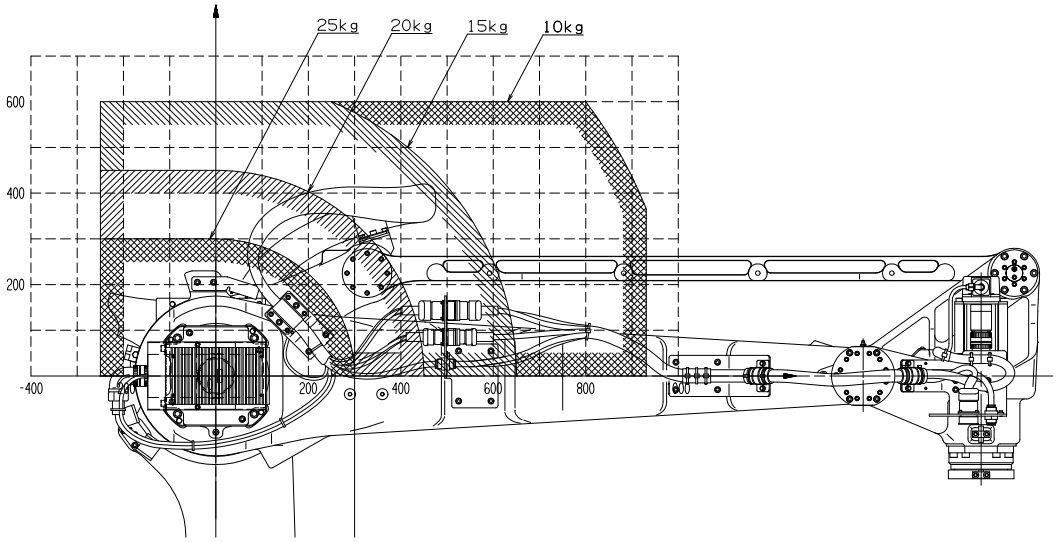


[LP130-01] [LP180-01] [LP210-01]

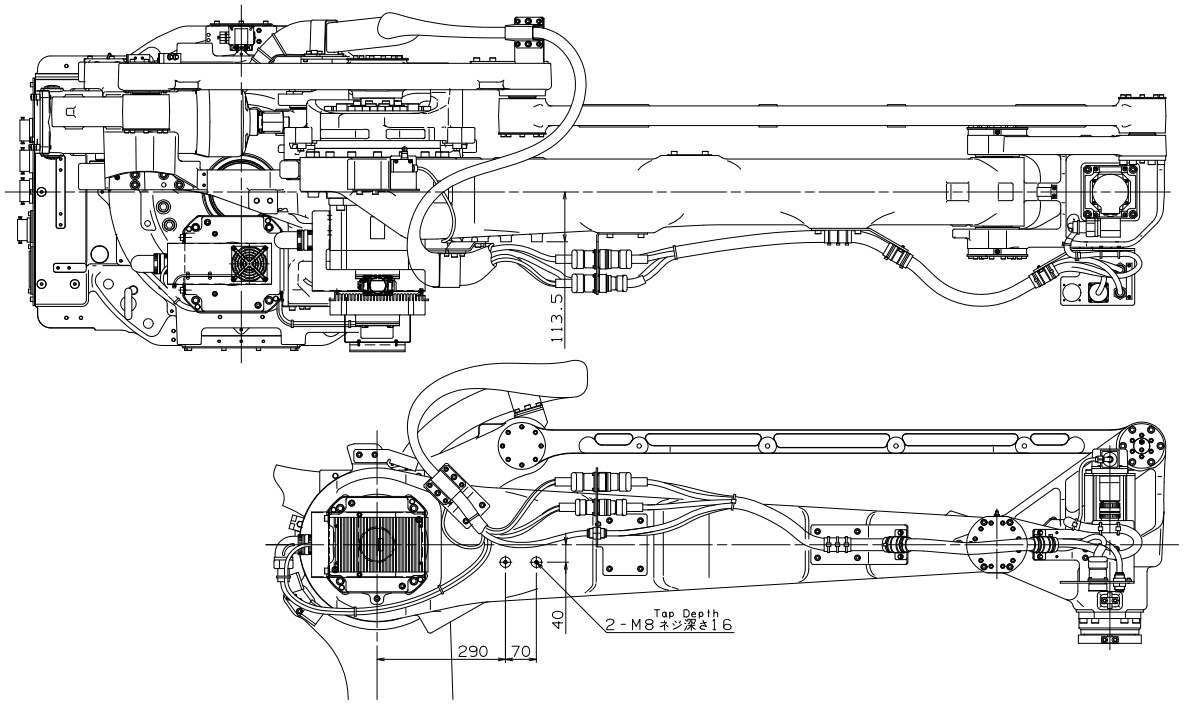
■ **Load on the forearm**

Ancillary equipment can be mounted to the upper part of robot forearm. If the wrist load mass is maximum, use the ancillary equipment on the load condition that the load gravity center falls in the shaded range, referring to the figure below. Furthermore, if the wrist load mass is small, the location where the ancillary equipment can be mounted will change according to the mass and COG (the maximum mass is 25kg).
For details, request the technical information to our Engineering department.

[LP130-01] [LP180-01] [LP210-01]



It is possible to mount an ancillary equipment on the fore arm using taps shown below Because the material of the tap is aluminum cast, the length of the screw depth of the bolts should be from 14 to 15 mm.



2.5 Performing encoder correction

CAUTION	At NACHI factory, encoder correction is performed under the load condition and robot posture specified by NACHI. This load condition and robot posture may have influence on the reference position. So please perform encoder correction for all axes **after all of the load are mounted on wrist and upper arm,** **before staring the teaching procedure,** by referring to information in “5.2.4 Encoder Correction”. (At this time, encoder resetting procedure is not required.) If encoder correction is carelessly performed after teaching is done, all of the taught points are needed to be modified because tool top position may change largely.
CAUTION	Also encoder correction is necessary when motor / encoder is replaced. At this time, encoder correction must be performed under the **same load condition and same robot posture as the first time encoder correction that is performed immediately after the loads are mounted**, because load condition and robot posture may have influence on the reference position. Therefore, the “reference posture” (where all axes are in “reference position” by using zeroing pin or like that) is recommended as the posture of encoder correction. (☞ “5.2.4 Encoder Correction”)

2.6 Emergency stop during transportation of work-piece

CAUTION	While the work-piece is in transport, if an operator makes an emergency stop of the robot or the robot detects an error to make an emergency stop, the work-piece in transport may be damaged.
CAUTION	While paying careful attention for the operator not to become victim to the damaged work-piece, remove it from or around the robot.

NOTE

Chapter 3 Inspection

WARNING	To perform daily inspection, repair, or part replacement of the robot, be sure to turn OFF the power supply. Furthermore, in order to prevent other workers from improperly turning ON the power supply, post the warning signs such as “DON’T POWER ON” at the primary power supply switch and others.

3.1 Inspection items and periods

The inspection should be performed in order to maintain the high performance of the robot for an extended period of time. Personnel who are engaged in the inspection must create and implement the inspection program.

Furthermore, perform overhauls **every 20,000 operating hours or every 4 years, whichever comes earlier.** For high frequency of works in which the estimated lifespan becomes 20,000 hours or less, it is recommended to perform inspections at **approximately 1/2 of the periods specified.** Should you have any questions, contact your NACHI representative.

Inspection items and periods (1)

No.	Period			Inspection Item	Inspection Method	Criterion	Remark
	Daily	Quarterly	Yearly				
Common to Whole Robot and Each Axis							
1	○			Cleaning of robot	• Wiping of dirt or the like • Removing dusts		
2		○		Related to manipulator wirings	• Visual check of cables for damage • Visual check of the cable clamp fixing bolts for the coating of paint • Visual check for cable covers for damage • Visual check for cable covers (if it is open or not.)		3.4
			○		• Retighten the fixing bolts, and then apply a coating of paint lock to them.		
3		○		Major bolts	• Visual check of the coating of paint		3.3
			○		• Refasten the fixing bolts, and then apply a coating of paint lock to them.		
4			○	Limit switch dogs	• Activate and deactivate the limit switch to check them for functions. • Retighten the fixing bolts, and then apply a coating of paint lock to them.	E0065 occurs	
5	○			Motors	• Check for abnormal heat generation. • Check for any abnormal sounds.		
6			○	Brakes	• Set the brake release switch to ON and OFF to check it for operation. **Note:** When setting the brake release switch to ON, the robot arm or the operating axis will drop. Consequently, to check the switch for the operation, set it back to “OFF” within one second.	With the brake release switch set to “OFF”, the arm or the end effecter does not drop.	Motors with a brake for all axes
7		○		Support point of the link	• Visual check of the gap between the links • Visual check of the gap between the shaft and the plate • Check by hearing for any abnormal sounds • Visual check for any vibration or shaking		3.5
8		○		Support point of the balancer	• Visual check of the installation angle of the bearings and the shafts • Check for deformation of the plate • Check for grease leakage from the seal part		3.5

(NOTE) Brake release switch is controller option.

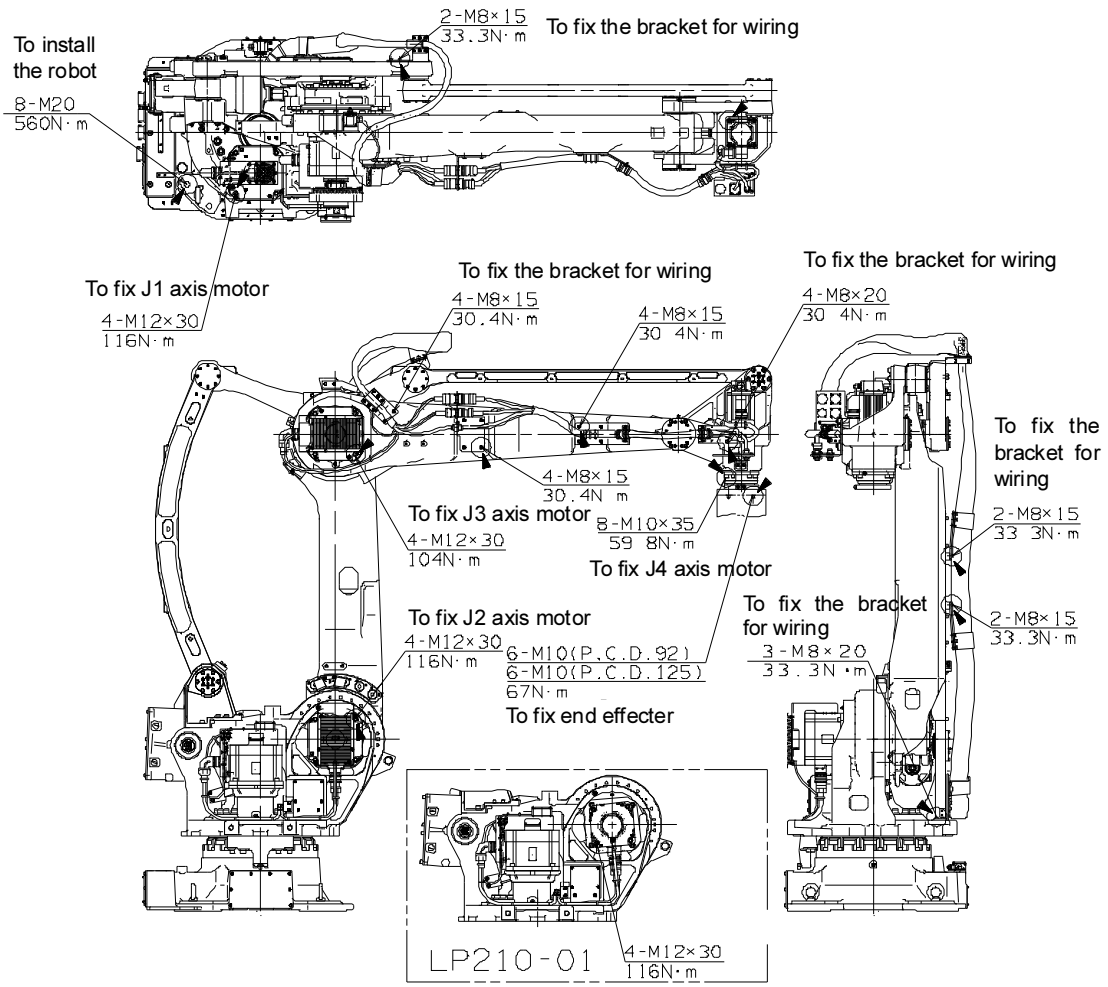
Inspection items and periods (2)

No.	Period			Inspection Item	Inspection Method	Criterion	Remark
	Daily	Quarterl	Yearly				
Related to J1, J2, and J3 axes							
9			○	Grease in bearings	• Check for grease steel dust density		3.5 3.5
10	○			Reduction gears	• Check by hearing for any abnormal sounds • Visual check for any vibration or shaking		
			○	Grease in reduction gears	• Checking the density of steel dust in the grease		3.5
Related to J4							
11		○		Reduction gears	• Check by hearing for any abnormal sounds • Visual check for any vibration or shaking		
12		○		End effecter fixing bolts	• Visual check of the fixing bolts for paint coating conditions		
			○		• Retighten the fixing bolts, and then apply a coating of paint lock to them.		
13		○		Backlash and play	• Apply loads to each axis in the forward and reverse rotating directions to check it for any backlash and play.	No backlash or play to be felt by hand.	
Option parts							
14		○		Cooling fans	• Check for rotation • Check for oil and dusts		3.6
					• Visual check of the fixing bolts for paint coating conditions		

3.2 Inspection of major bolts

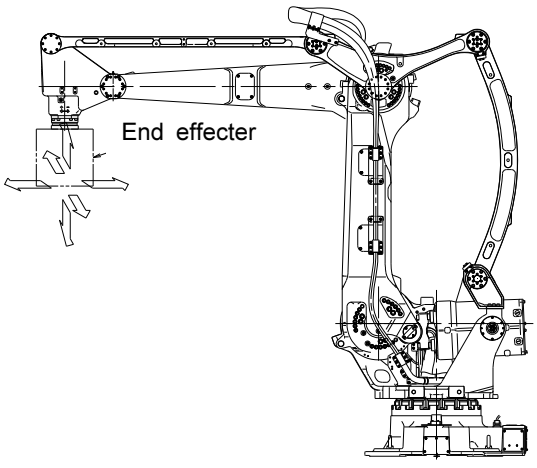
CAUTION	Recommended torque is shown in the figure below. Be sure to use a torque wrench to fasten the bolts to proper torque, and then apply a coating of paint lock to them. Furthermore, be careful not to needlessly refasten bolts that are not unfastened.

[LP130-01] [LP180-01] [LP210-01]



3.3 Inspection of wrist

Apply loads to the end effecter (e.g. gripper unit etc.) mounted to the wrist tip in the forward/backward, right/left, and upward/downward, and then check it for any backlash and play felt by hand.



3.4 Inspection of wirings

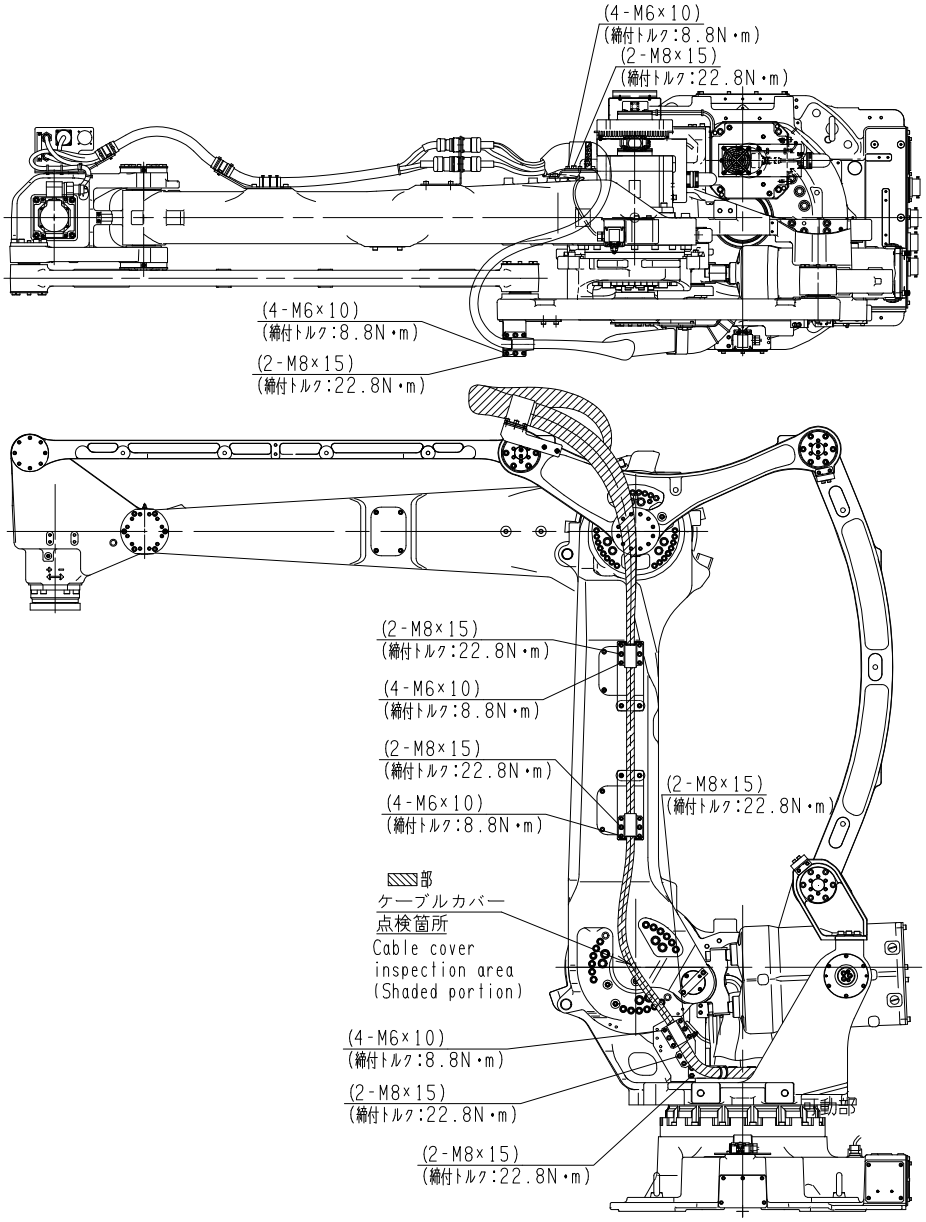
If any damage is found on cables and tubes, **immediately repair or replace the part**.
To purchase any manipulator wiring, contact to your local service center. NEVER attempt to use any cables other than specified by NACHI. For the replacement, order to your local service center

■ **Inspection points: Cables cover (hook tube) and clamp portion**

Check for the following items.
- Check if the connectors of the motors or encoders loosen or not.
- Holes and fractures on the cable cover / Damage of the hook tube (*)
- Check if the cable cover fastening part loosens or not (*)
- Check if the clamp bolt gets unfastened or comes off.

(*) When checking or replacing the cover, please pay special attention not to let any dusts get into the inside part of the cover.

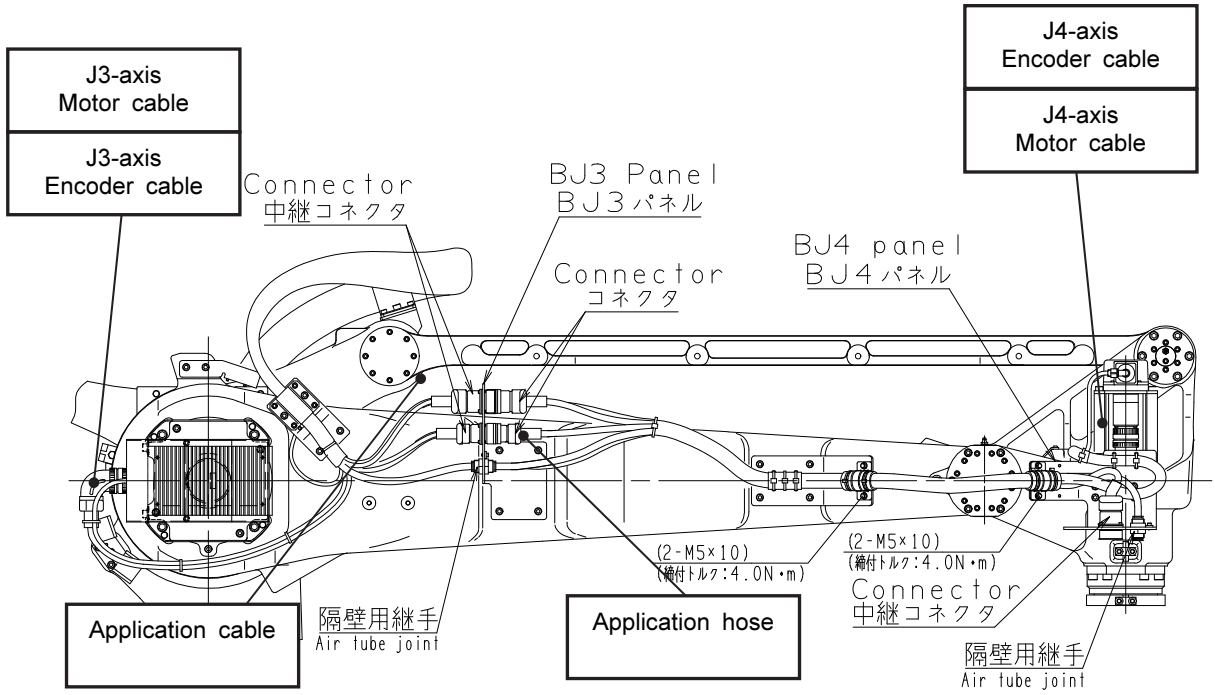
If damage to the cover is observed, replace it.
If the cover is not closed, close (fasten) the cover.
If any unfastened bolt is observed, refasten the bolt to the specified torque, and then put marking on it. The M6 bolts and the M8 bolts are used



■ **Inspection points : Cables and hoses around the fore arm**

Check for the following items.

- Check if the connectors of the motors or encoders loosen or not.
- Check if the relay connector loosens or not.
- Check if the relay connector is securely installed on the installation panel.
- Check if the nut of the bulk head female union (joint) is securely installed on the installation panel.
- Check if any cable sharply bends over or gets crushed or not.
- Check if any cable shield has scratches or fractures or not.
- Check if any hose surface has scratches or fractures or not.
- Check if any cable tie is broken or not.
- Check if the fixing bolts of the cable clamping saddle loosen or not.



■ **Inspection points : J1 axis wiring**

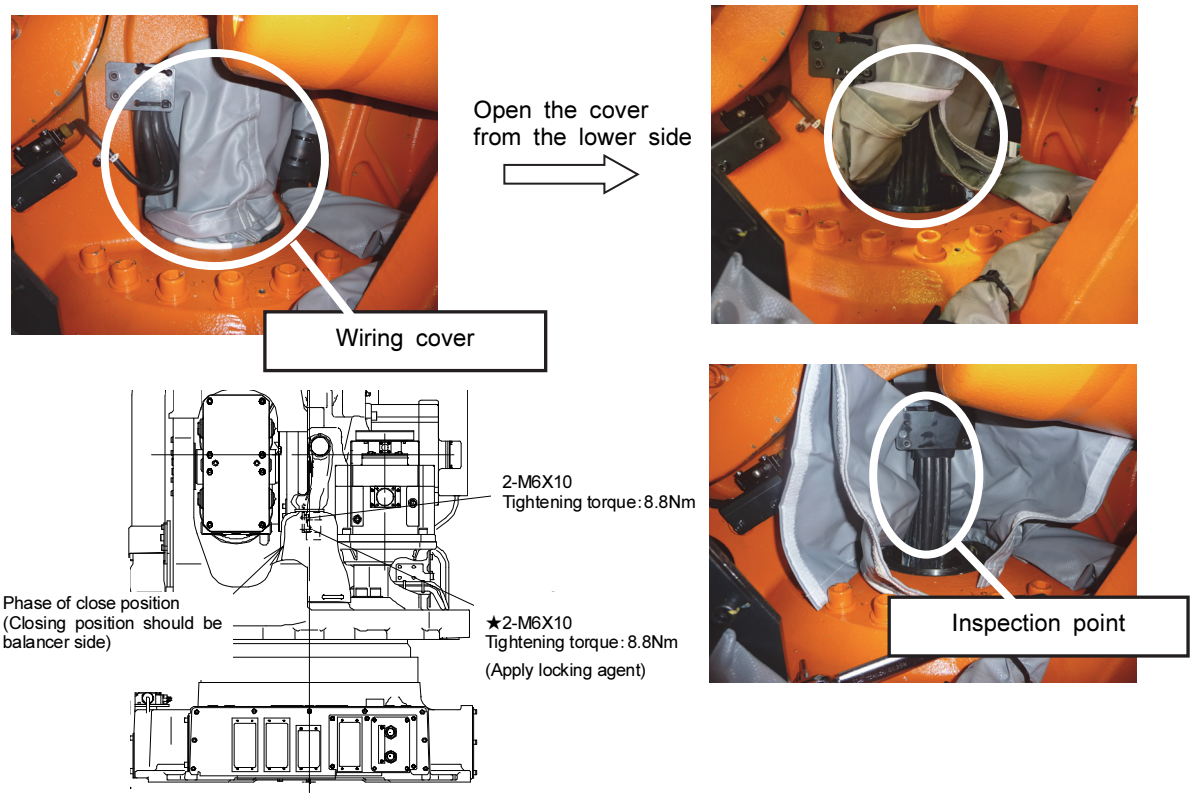
Open the wiring cover at the center of the frame from the lower side and visually inspect the wiring inside the cover.

Check for the items below;

- Check if any cable cover has scratches or fractures.
- Check if the clamp bolt gets unfastened or comes off.

After inspection, refasten (close) the cable cover.

(*) When checking cables and hoses inside the wiring cover, please pay special attention not to let any dusts get into the inside part of the cover or stick to the cables and hoses.

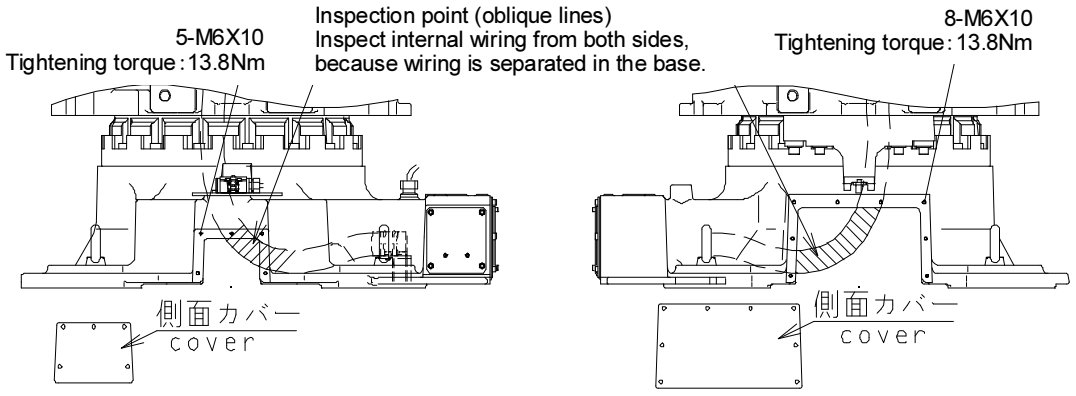


Open the side cover on the swivel base and visually inspect the internal cables/hoses.

Check for the items below;

- Check if any cable cover has scratches or fractures.
- Check if any cable scratches on the floor or the installation plate's surface.

After the inspection, re-attach the cover and tighten the fixing bolts at specified torque and apply marking on them.



3.5 Inspection of grease

Please check the density of steel dust in the grease in designated interval written in “3.1 Inspection items and periods”.
If the measurement result exceeds its criterion, please contact our service center for grease replacement or reduction gear replacement.

Required tools

- Grease steel dust meter
  Recommended grease steel dust meter OM-810 (Idemitsu Kosan Ltd.)
- Grease gun (Lubrication amount counter function, A nozzle of less than 17 mm in diameter.)
- Seal tape

CAUTION	If the grease leaks out too much when inspecting the steel dust density, lubricate grease using a grease gun. For lubrication, use a grease gun with a nozzle of less than 17 mm in diameter. Note that lubricating grease more than the leaked amount may result in leakage of grease or faulty robot locus. After the completion of inspection/lubrication, in order to prevent the leakage of grease, be sure to wind sealing tape around the grease nipples and socket head plug.
CAUTION	A grease gun that has a capacity to measure the lubrication amount is recommended. If a grease gun like this can not be prepared, please measure the weight of the grease can before/after the lubrication work to confirm the amount.
CAUTION	Immediately after removing the drain plug, grease may splash, because internal pressure is still high, for example soon after robot stops,

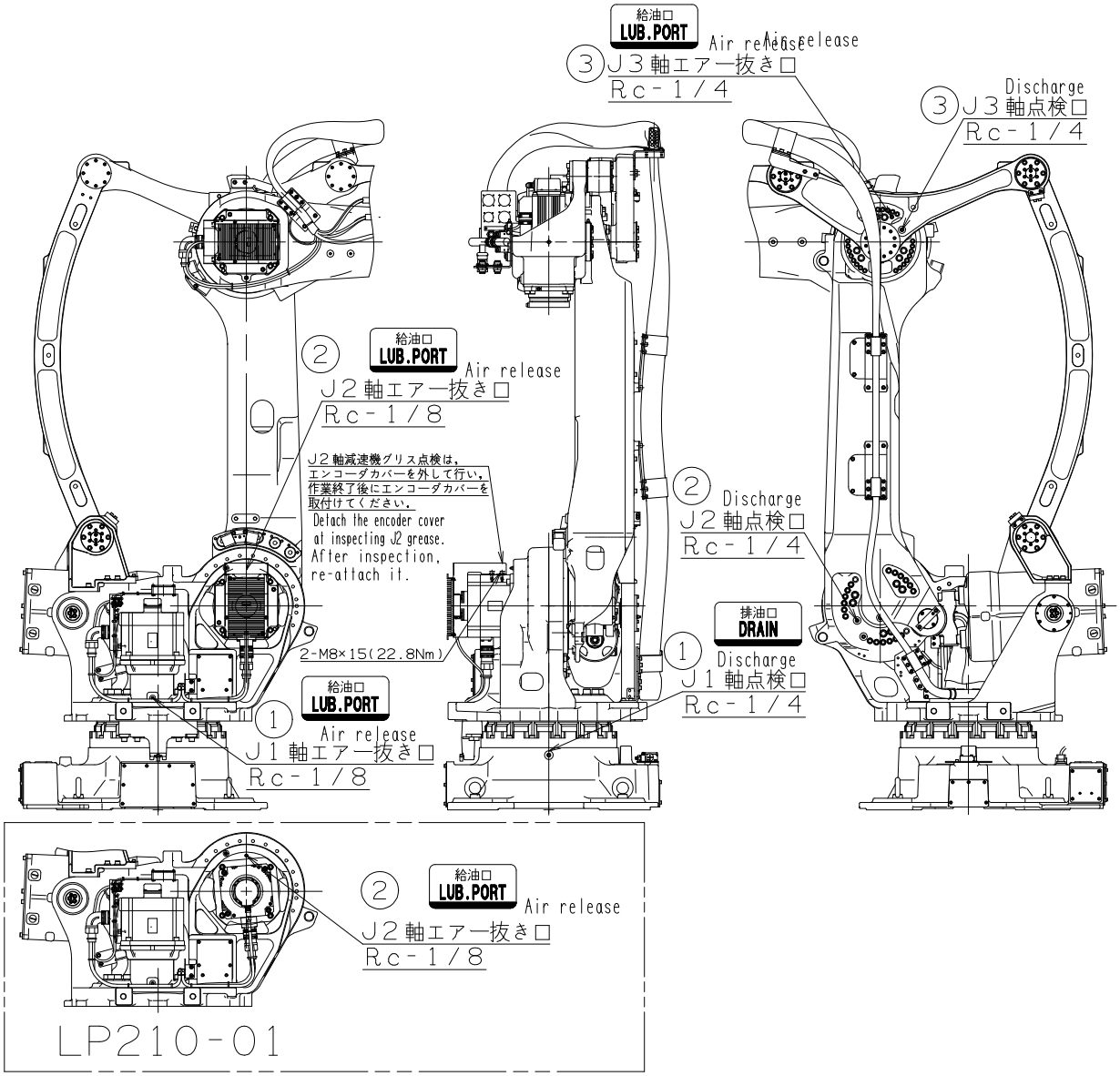
■ **Grease inspection of reduction gear**

No.	Inspection points	Applied Grease type	Inspection amount	Purpose	Type	Size	Tightening torque	Criterion
1	J1 axis Reduction gear	MOLYWHITE RE No.00	10 cc	Air release	Plug	Rc-1/8	12.7 N·m	grease steel dust density 0.1 % or less
				Discharge	Plug	Rc-1/4	29.4 N·m	
2	J2 axis Reduction gear	〃	〃	Air release	Plug	Rc-1/8	12.7 N·m	
				Discharge	Plug	Rc-1/4	29.4 N·m	
3	J3 axis Reduction gear	〃	〃	Air release	Plug	Rc-1/4	29.4 N·m	
				Discharge	Plug	Rc-1/4	29.4 N·m	

Density of grease : MOLYWHITE RE No.00 0.87g/cc

<Notes>

- In order to prevent the grease from splashing out (this is caused by e.g. rising of internal pressure or internal temperature), unplug the air release plug shown in figure in advance. When releasing the plug, loosen the plug slowly to release the remaining pressure slowly.
- After the completion of inspection, wipe grease running out from the lubrication port. Then, wind sealing tape around the threaded part of the socket head plug to prevent the leakage of grease, and plug it again.
- When inspecting J2 and J3 axis, please make the reference pose of the robot in advance.



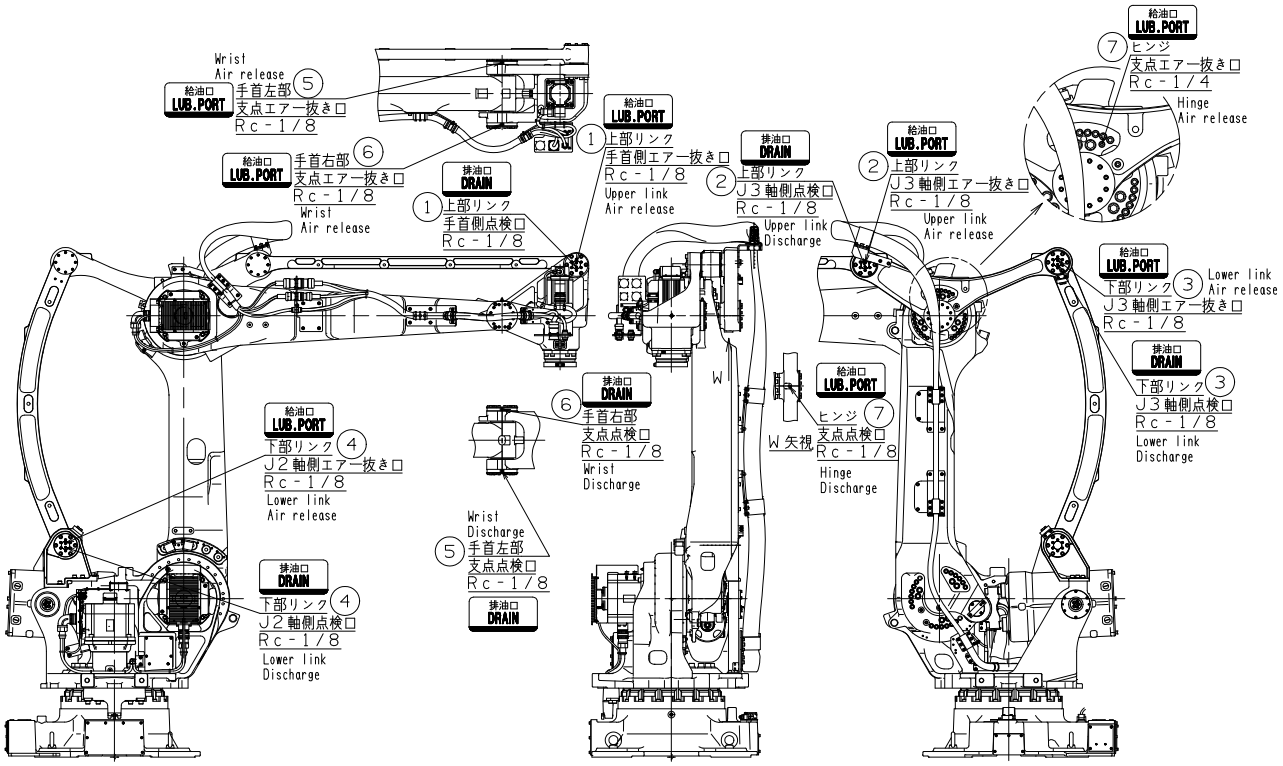
■ **Grease inspection of link support points**

No.	Inspection points	Applied Grease type	Inspection amount	Purpose	Type	Size	Tightening torque	Criterion
1	Upper link wrist side	MOLYWHITE RE No.00	10 cc	Air release	Grease nipple	Rc-1/8	12.7 N·m	grease steel dust density 0.5 % or less
				Discharge	Plug	Rc-1/8	12.7 N·m	
2	Upper link J3 axis side	〃	〃	Air release	Grease nipple	Rc-1/8	12.7 N·m	
				Discharge	Plug	Rc-1/8	12.7 N·m	
3	Lower link J3 axis side	〃	〃	Air release	Grease nipple	Rc-1/8	12.7 N·m	
				Discharge	Plug	Rc-1/8	12.7 N·m	
4	Lower link J2 axis side	〃	〃	Air release	Grease nipple	Rc-1/8	12.7 N·m	
				Discharge	Plug	Rc-1/8	12.7 N·m	
5	Left side support point of the wrist	〃	〃	Air release	Grease nipple	Rc-1/8	12.7 N·m	
				Discharge	Plug	Rc-1/8	29.4 N·m	
6	Right side support point of the wrist	〃	〃	Air release	Grease nipple	Rc-1/8	12.7 N·m	
				Discharge	Plug	Rc-1/8	12.7 N·m	
7	Hinge support portion	〃	〃	Air release	Grease nipple	Rc-1/8	12.7 N·m	
				Discharge	Plug	Rc-1/8	12.7 N·m	

Density of grease : MOLYWHITE RE No.00 0.87g/cc

<Notes>

- In order to prevent the grease from splashing out (this is caused by e.g. rising of internal pressure or internal temperature), unplug the air release plug shown in figure in advance. When releasing the plug, loosen the plug slowly to release the remaining pressure slowly.
- After the completion of inspection, wipe grease running out from the lubrication port. Then, wind sealing tape around the threaded part of the socket head plug to prevent the leakage of grease, and plug it again.



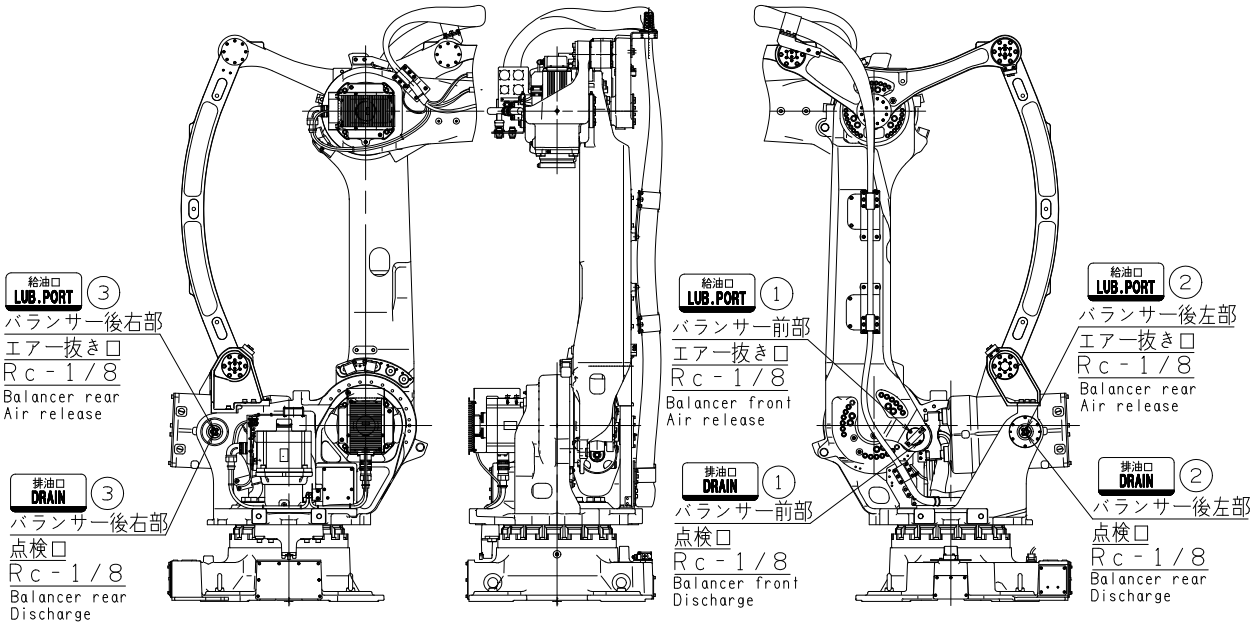
■ **Grease inspection of balancer support points**

No.	Inspection points	Applied Grease type	Inspection amount	Purpose	Type	Size	Tightening torque	Criterion
1	Balancer support point (forward)	MOLYWHITE RE No.00	10 cc	Air release	Grease nipple	Rc-1/8	12.7 N·m	grease steel dust density 0.5 % or less
				Discharge	Plug	Rc-1/8	12.7 N·m	
2	Balancer support point (Back / left)	〃	〃	Air release	Grease nipple	Rc-1/8	12.7 N·m	
				Discharge	Plug	Rc-1/8	12.7 N·m	
3	Balancer support point (Back / right)	〃	〃	Air release	Grease nipple	Rc-1/8	12.7 N·m	
				Discharge	Plug	Rc-1/8	12.7 N·m	

Density of grease : MOLYWHITE RE No.00 0.87g/cc

<Notes>

- In order to prevent the grease from splashing out (this is caused by e.g. rising of internal pressure or internal temperature), unplug the air release plug shown in figure in advance. When releasing the plug, loosen the plug slowly to release the remaining pressure slowly.
- After the completion of inspection, wipe grease running out from the lubrication port. Then, wind sealing tape around the threaded part of the socket head plug to prevent the leakage of grease, and plug it again.



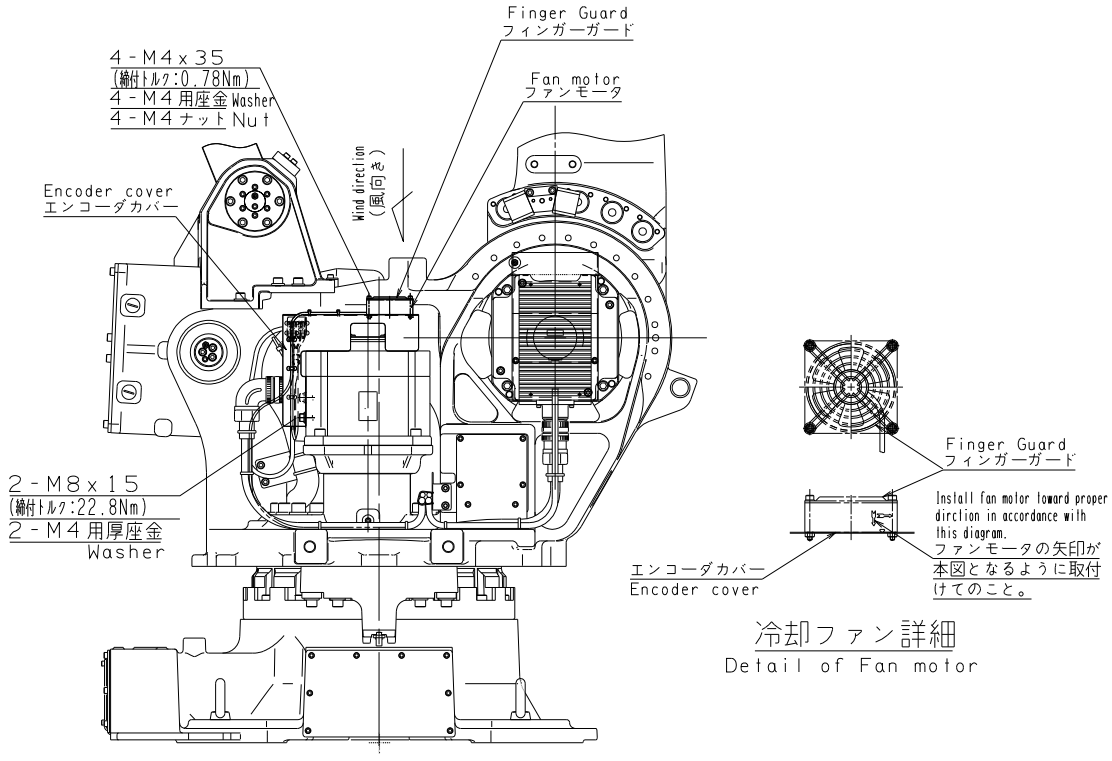
3.6 Inspection of cooling fan

Perform inspections for J1 axis cooling fan referring to the following descriptions. (Cooling fan is optional for the robots shipped on July 2012 or before, standard for the robots shipped on August 2012 or after.)

- Check if the cooling fan normally rotates when the enable switch is grasped in Teach mode (=servo ON),
- Check if the fan is dirty or not. (e.g. Oil and dusts, etc.)

If the cooling fan is defective, replace it. And, if the fan is dirty because of oil or dusts etc., clean/wipe the fan.
And, if the encoder cover fixing bolts (2-M8×15) and the finger guard fixing bolts (4-M4×35) have been removed, apply locking agent (ThreeBond 1374) 1 or 2 drops to the screw thread of the bolts and tighten those bolts again with their rated torque by referring to the figure shown below.

CAUTION	When cleaning/wiping the cooling fan, be sure to turn OFF the primary power and confirm that the rotation of the cooling fan has surely stopped in advance. If the cleaning work is done while the fan is rotating, the finger of the worker or the cleaning cloth etc. is caught and result in injury etc.
CAUTION	If the robot is operated with the cooling fan is stopped, the motor temperature will go up and the performance of the robot will not be drawn out. Therefore, please be sure to perform the inspection.
CAUTION	The power supply lines for the cooling fan are connected to the motor brake's control lines. Therefore, the cooling fan does not rotate in the condition where the motor brake is locked (=the servo OFF condition)



NOTE

Chapter 4 Maintenance

WARNING	To perform daily inspection, repair, or part replacement of the robot, be sure to turn OFF the power supply. Furthermore, in order to prevent other workers from improperly turning ON the power supply, post the warning signs such as “DON’T POWER ON” at the primary power supply switch and others.

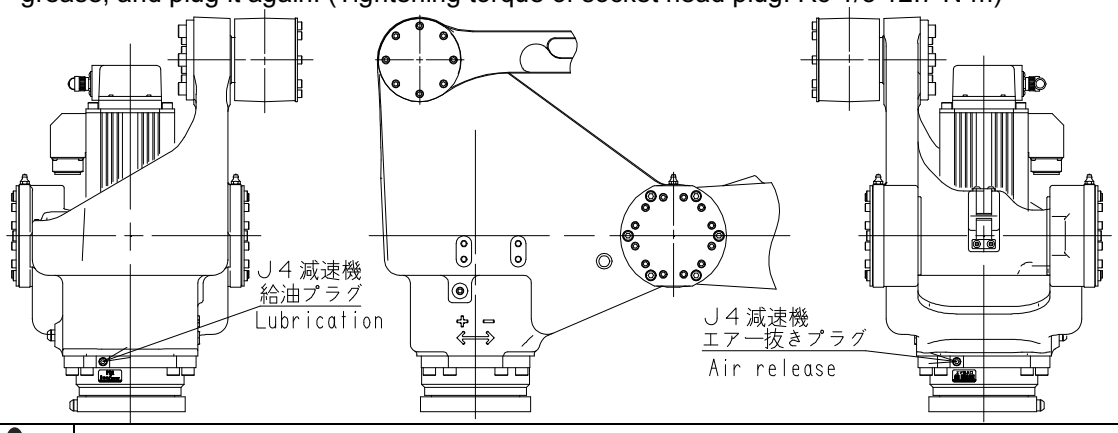
4.1 Lubrication

CAUTION	For lubrication and grease replacement, **never use grease other than specified type**. Specified type of grease is written in this manual.
IMPORTANT	If grease other than specified type is used, chemical reaction with original grease occurs and grease will change in quality. Insufficient lubricating efficiency may cause the unexpected shortening of robot life time.
CAUTION	Periodical lubrication is needed for some portion and grease replacement is needed for other portion. Please do the correct maintenance (lubrication and grease replacement) by referring to this manual.
CAUTION	In order to prevent the internal pressure from rising due to pressure caused by the lubrication, unplug the air vent plug. Its location is written in this manual.

Lubricate the mechanical sections of the robot with grease not only when insufficient grease is observed by checking but also at regular intervals of time. Lubrication frequency is normally every 12 months, but, it should be every 6 months If the frequency of the robot movement is high. Regarding the criteria, refer to the section of “3.1 Inspection items and periods”.

№	Lubrication point	Lubrication port	Cycle	Grease type	Amount	Remarks
1	J4 axis reduction gear	Front side of the wrist unit	12 months	Long Time PD2	3^{+1}_{0} cc	

- In order to prevent the internal pressure from rising due to pressure caused by the lubrication, unplug the air vent plug shown below If the pressure caused by the lubrication is applied to the oil seal part, leakage of grease will result.
- Unplug the socket head plug and plug a grease nipple Rc-1/8 instead and then lubricate.
- After the completion of lubrication, wipe grease running out from the lubrication port. Then, wind sealing tape around the threaded part of the socket head plug to prevent the leakage of grease, and plug it again. (Tightening torque of socket head plug: Rc-1/8 12.7 N･m)



CAUTION	For lubrication, use a grease gun with a nozzle of not more than 17 mm in diameter. Furthermore, for lubrication points with an air release hole specified, unplug the plug according to the figures, and then lubricate them.
CAUTION	Note that lubricating grease more than the recommended amount may result in leakage of grease or faulty robot locus. Furthermore, no lubrication is required for any points other than those specified.

4.2 Grease replacement

CAUTION	For lubrication and grease replacement, **never use grease other than specified type**. Specified type of grease is written in this manual.
IMPORTANT	If grease other than specified type is used, chemical reaction with original grease occurs and grease will change in quality. Insufficient lubricating efficiency may cause the unexpected shortening of robot life time.
CAUTION	Periodical lubrication is needed for some portion and grease replacement is needed for other portion. Please do the correct maintenance (lubrication and grease replacement) by referring to this manual.
CAUTION	Lubricatiing work must be done keeping the feeding speed to 40cc per 10 seconds or less. If lubricating is done rapidly, the oil seal may be broken and grease leakage may occur because of rise of pressure inside robot.

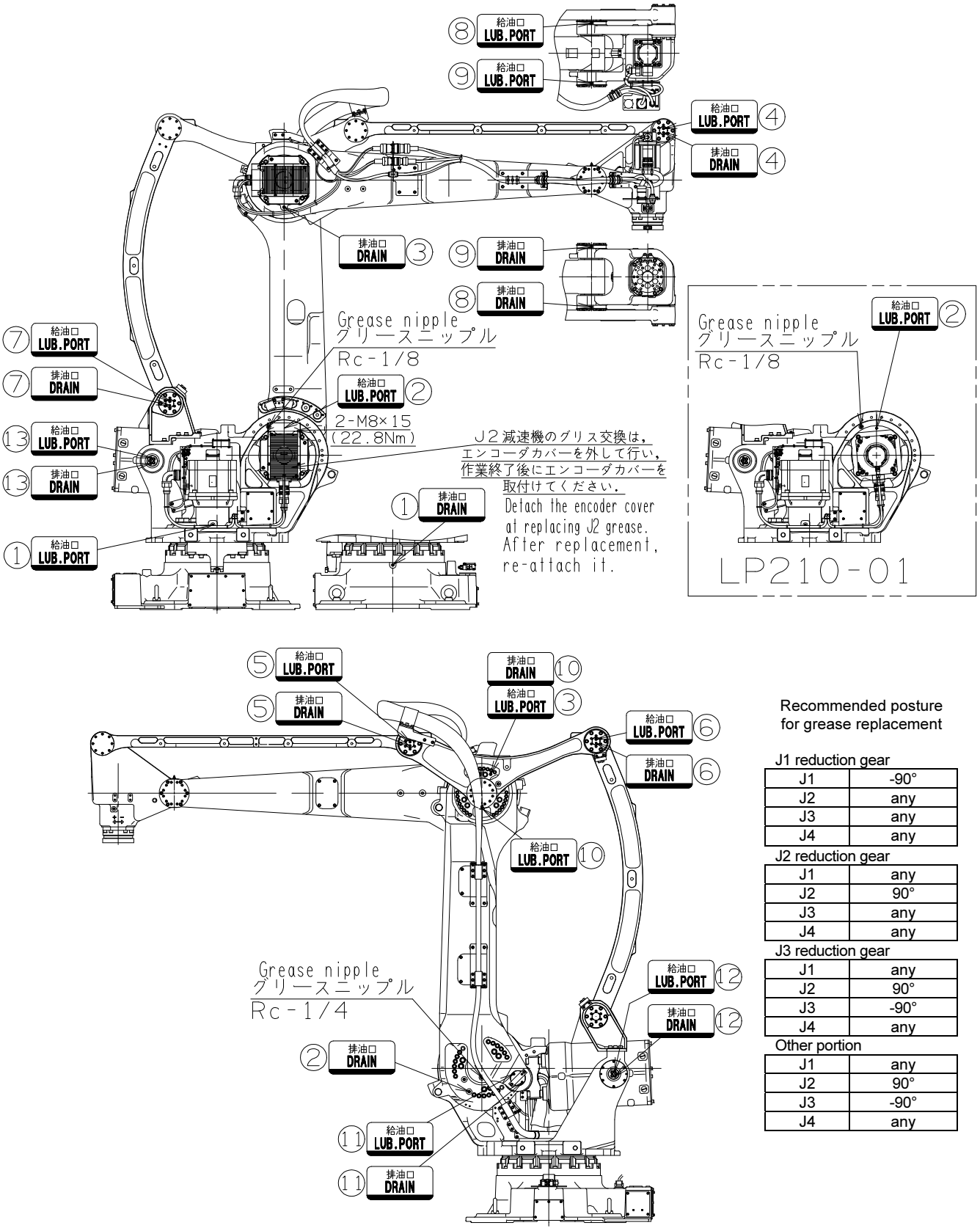
Replace grease every 10,000 operating hours or every 2 years whichever comes earlier. If the frequency of the robot movement is high, the replacement frequency should be every 5,000 operating hours or every 1 year whichever comes earlier regarding the criteria, refer to the section of “3.1 Inspection items and periods”.

№	Replacement point	Grease	Lubrication amount	Application	Lubrication port *1	Size	Torque
1	J1 reduction Gear	MOLYWHITE RE No.00	3400 cc or more	Lub.	Plug	Rc-1/8	12.7 N·m
				Drain	Plug	Rc-1/4	29.4 N·m
2	J2 reduction Gear		1500 cc or more	Lub.	Plug	Rc-1/8	12.7 N·m
				Drain	Plug	Rc-1/4	29.4 N·m
3	J3 reduction gear (*2)		1000 cc or more	Lub.	Plug	Rc-1/4	29.4 N·m
				Drain	Plug	Rc-1/4	29.4 N·m
4	Upper link (front)	MOLYWHITE RE No.00	40 cc or more	Lub.	Grease nipple	Rc-1/8	---
				Drain	Plug	Rc-1/8	12.7 N·m
5	Upper link (back)		40 cc or more	Lub.	Grease nipple	Rc-1/8	---
				Drain	Plug	Rc-1/8	12.7 N·m
6	Lower link (upper)		40 cc or more	Lub.	Grease nipple	Rc-1/8	---
				Drain	Plug	Rc-1/8	12.7 N·m
7	Lower link (lower)		40 cc or more	Lub.	Grease nipple	Rc-1/8	---
				Drain	Plug	Rc-1/8	12.7 N·m
8	Wrist (left)		90 cc or more	Lub.	Grease nipple	Rc-1/8	---
				Drain	Plug	Rc-1/8	12.7 N·m
9	Wrist (right)		70 cc or more	Lub.	Grease nipple	Rc-1/8	12.7 N·m
				Drain	Plug	Rc-1/8	12.7 N·m
10	Hinge support point (*2)		55 cc or more	Lub.	Plug	Rc-1/8	---
				Drain	Plug	Rc-1/8	12.7 N·m
11	Balancer (front)		40 cc or more	Lub.	Grease nipple	Rc-1/8	---
				Drain	Plug	Rc-1/8	12.7 N·m
12	Balancer (left)		40 cc or more	Lub.	Grease nipple	Rc-1/8	---
				Drain	Plug	Rc-1/8	12.7 N·m
13	Balancer (right)		40 cc or more	Lub.	Grease nipple	Rc-1/8	---
				Drain	Plug	Rc-1/8	12.7 N·m

Density of grease ; MOLYWHITE RE No. 00 0.87g/cc

(*1) If a "Plug" is attached to the lubrication port, please remove it and install a grease nipple (See next figure) instead and lubricate.
(*2) The grease bus of the "Hinge support point"(No.10) and the "J3 reduction gear"(No.3) are connected inside the robot. Therefore, the drain port of No.10 and the lubrication port of No.3 is the same. To avoid the mixture of grease, grease replacement of "J3 reduction gear"(No.3) should be done after the completion of the grease replacement of "Hinge support point"(No.10).

[LP130-01] [LP180-01] [LP210-01]



Recommended posture for grease replacement

J1 reduction gear

J1	-90°
J2	any
J3	any
J4	any

J2 reduction gear

J1	any
J2	90°
J3	any
J4	any

J3 reduction gear

J1	any
J2	90°
J3	-90°
J4	any

Other portion

J1	any
J2	90°
J3	-90°
J4	any

Grease replacement portions

Tools required (prepared by customer)

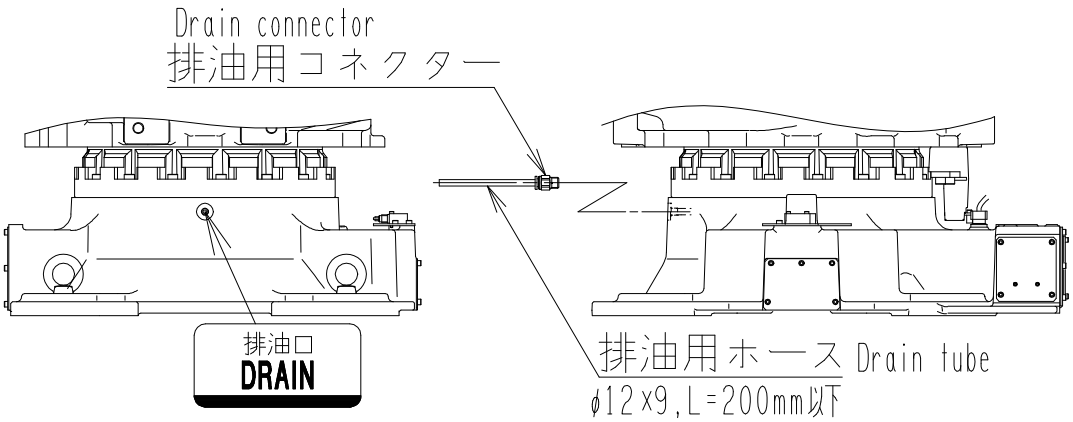
Name	Specification	Q'ty
Grease gun	with a nozzle of not more than 17 mm in diameter, with lubrication amount counter	1
Drain connector	Rc-1/4,φ12	1
Drain hose	φ12X9 0.2m	1
Air precision regulator	Maximum 0.2Mpa and adjustable every approx. 0.01Mpa SMC "PRECISION REGULATOR IR2000-02BG-X1" is recommended	1
Air supply source	(in market)	1
Weight meter	which can measure the weight of ejected grease + container	1
Seal tape	(in market)	1

CAUTION	For lubrication, use a grease gun with a nozzle of not more than 17 mm in diameter. Note that lubricating grease more than the recommended amount may result in leakage of grease or faulty robot locus. After the completion of lubrication, in order to prevent the leakage of grease, be sure to wind sealing tape around the grease nipples and socket head plug.
CAUTION	A grease gun that has a capacity to measure the lubrication amount is recommended. If a grease gun like this can not be prepared, please measure the weight of the grease can before/after the lubrication work to confirm the amount.
CAUTION	Immediately after removing the drain plug, grease may splash, because internal pressure is still high, for example soon after robot stops,

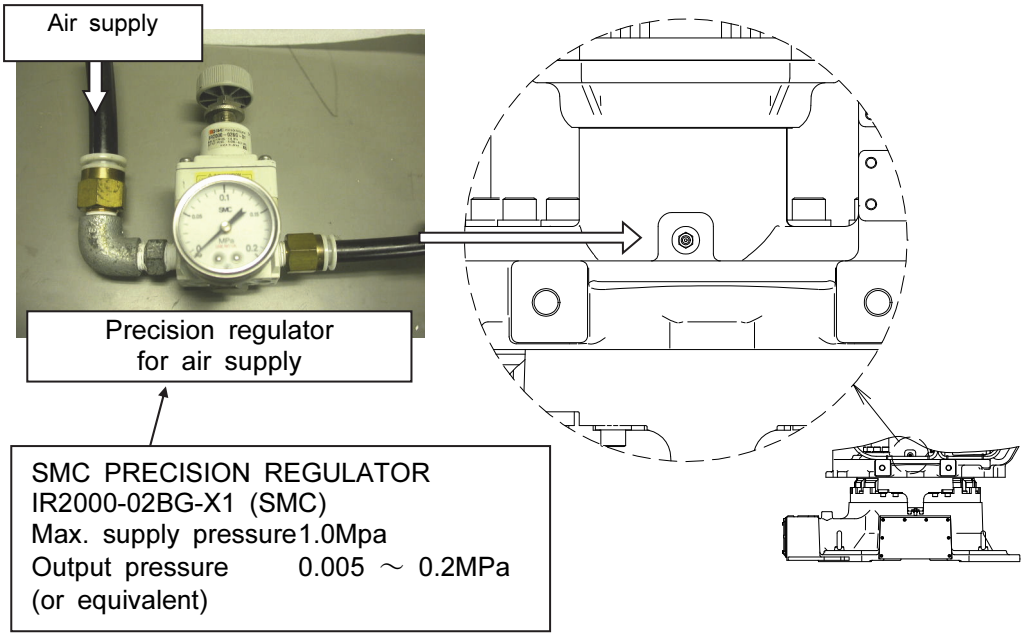
Grease replacement procedure of J1 axis reduction gear

(1) Place a container to receive grease ejected under the ejection outlet. In advance, confirm the weight of the container.
(2) Unplug the socket head plug [Rc-1/4] from the ejection outlet. To prevent the robot from getting dirty, attach a drain connector [Rc-1/4, φ12] and a drain tube [φ12×9, maximum length is 0.2m]
(3) Unplug the socket head plug [Rc-1/8] from the inlet, and attach the grease nipple [Rc-1/8]
(4) Use a grease gun to feed grease. At this time, grease feeding operation must be done ***keeping the feeding speed to 40cc per 10 seconds.*** The amount of the grease to be lubricated is shown in pre-described table. Keep the feeding operation until the color of the grease that is pushed out from the ejection outlet change to a color of new grease.
(5) When the lubricated (fed) amount reaches the designated values, confirm the ***(a):lubricated amount*** and the ***(b):ejected amount***. (a) can be calculated by comparing the grease can's weight before and after the lubrication work or checking the counter display on the grease gun. (b) can be calculated by measuring the weight of the container(for this calculation, please check the weight of the empty container measured in step (1) in advance).
(6) If (a) is larger than (b), too much (surplus) grease remains inside the gear box. To make (a) and (b) the same, use air to push the grease out. Supply air from the lubrication inlet and eject the surplus grease from the ejection outlet. Be sure that the air pressure should be kept ***under 0.025Mpa by using precise regulator.***
If only air comes out from the ejection outlet and grease does not come out, move the J1 axis while supplying air referring to the figure to push the grease out.
(7) If (a) is less than (b), grease is lacked inside the gear box. To make (a) and (b) the same, swap the inlet and outlet, and supply the lacked amount of grease from the ejection outlet.
(8) Wrap seal tapes on socket head plug [Rc-1/8] and attach to the inlet (LUB.PORT).
Wrap seal tapes on socket head plug [Rc-1/4] and attach to the outlet (DRAIN).

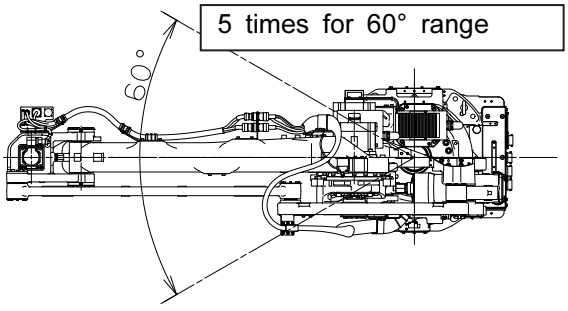
WARNING	In case that robot operation with slow speed playback or teaching operation is necessary, never get into the robot moving envelope while playback. And perform above procedure with two persons one pair. One person keeps being ready to push the emergency button anytime, other person operates the robot paying much attention. Please ensure the escape route in advance.



Connection of the drain tube and the connector



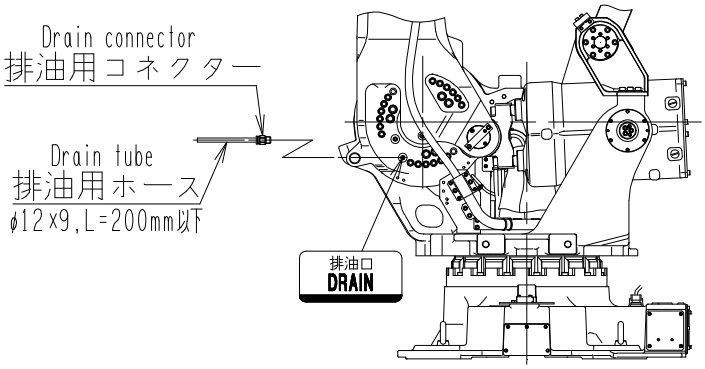
Connection of a precise regulator for air supply



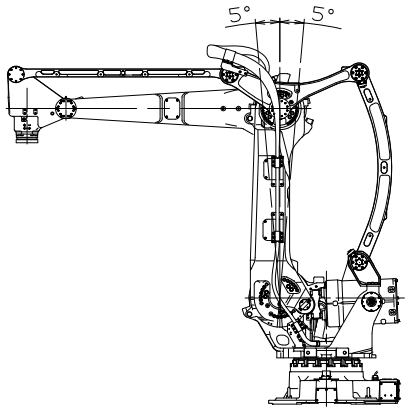
J1 axis low speed motion range

Grease replacement procedure of J2 axis reduction gear

(1) Place a container to receive grease ejected under the ejection outlet. In advance, confirm the weight of the container.
(2) Unplug the socket head plug [Rc-1/4] from the ejection outlet. To prevent the robot from getting dirty, attach a drain connector [Rc-1/4, φ12] and a drain tube [φ12×9, maximum length is 0.2m]
(3) Unplug the socket head plug [Rc-1/8] from the inlet, and attach the grease nipple [Rc-1/8]
(4) Use a grease gun to feed grease. At this time, grease feeding operation must be done ***keeping the feeding speed to 40cc per 10 seconds.*** The amount of the grease to be lubricated is shown in pre-described table. Keep the feeding operation until the color of the grease that is pushed out from the ejection outlet change to a color of new grease.
(5) When the lubricated (fed) amount reaches the designated values, confirm the ***(a):lubricated amount*** and the ***(b):ejected amount***. (a) can be calculated by comparing the grease can's weight before and after the lubrication work or checking the counter display on the grease gun. (b) can be calculated by measuring the weight of the container(for this calculation, please check the weight of the empty container measured in step (1) in advance).
(6) If (a) is larger than (b), too much (surplus) grease remains inside the gear box. To make (a) and (b) the same, use air to push the grease out. Supply air from the lubrication inlet and eject the surplus grease from the ejection outlet. Be sure that the air pressure should be kept ***under 0.025Mpa by using precise regulator.***
If only air comes out from the ejection outlet and grease does not come out, move the J2 axis while supplying air referring to the figure to push the grease out.
(7) If (a) is less than (b), grease is lacked inside the gear box. To make (a) and (b) the same, swap the inlet and outlet, and supply the lacked amount of grease from the ejection outlet.
(8) Wrap seal tapes on socket head plug [Rc-1/8] and attach to the inlet (LUB.PORT).
Wrap seal tapes on socket head plug [Rc-1/4] and attach to the outlet (DRAIN).



Connection of the drain tube and the connector



J2 axis low speed motion range

Grease replacement procedure of J3 axis reduction gear

(1) Place a container to receive grease ejected under the ejection outlet. In advance, confirm the weight of the container.
(2) Unplug the socket head plug [Rc-1/4] from the ejection outlet. To prevent the robot from getting dirty, attach a drain connector [Rc-1/4, φ12] and a drain tube [φ12×9, maximum length is 0.2m]
(3) Unplug the socket head plug [Rc-1/4] from the inlet, and attach the grease nipple [Rc-1/4]
(4) Use a grease gun to feed grease. At this time, grease feeding operation must be done ***keeping the feeding speed to 40cc per 10 seconds.*** The amount of the grease to be lubricated is shown in pre-described table. Keep the feeding operation until the color of

the grease that is pushed out from the ejection outlet change to a color of new grease.

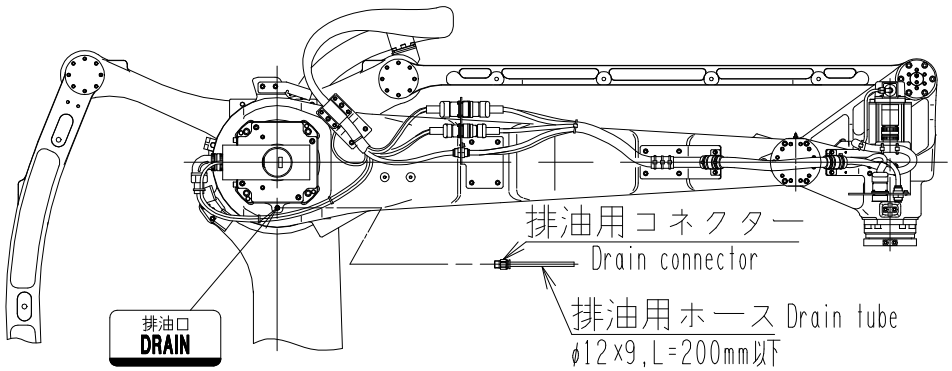
(5) When the lubricated (fed) amount reaches the designated values, confirm the ***(a):lubricated amount*** and the ***(b):ejected amount***. (a) can be calculated by comparing the grease can's weight before and after the lubrication work or checking the counter display on the grease gun. (b) can be calculated by measuring the weight of the container(for this calculation, please check the weight of the empty container measured in step (1) in advance).

(6) If (a) is larger than (b), too much (surplus) grease remains inside the gear box. To make (a) and (b) the same, use air to push the grease out. Supply air from the lubrication inlet and eject the surplus grease from the ejection outlet. Be sure that the air pressure should be kept ***under 0.025Mpa by using precise regulator.***

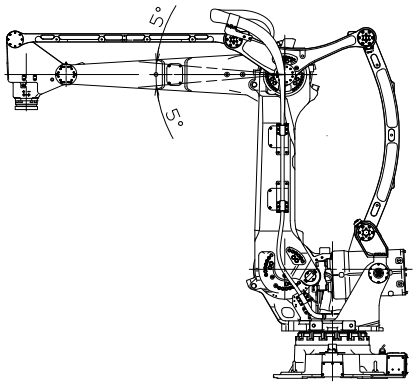
If only air comes out from the ejection outlet and grease does not come out, move the J3 axis while supplying air referring to the figure to push the grease out.

(7) If (a) is less than (b), grease is lacked inside the gear box. To make (a) and (b) the same, swap the inlet and outlet, and supply the lacked amount of grease from the ejection outlet.

(8) Wrap seal tapes on socket head plug [Rc-1/4] and attach to the inlet (LUB.PORT).
Wrap seal tapes on socket head plug [Rc-1/4] and attach to the outlet (DRAIN).



Connection for J3 axis lubrication



J3 axis low speed motion range

Grease replacement procedure of Link, Wrist, Hinge and Balancer

(1) Place a container to receive grease ejected under the ejection outlet. In advance, confirm the weight of the container.

(2) Unplug the socket head plug [Rc-1/8] from the ejection outlet.

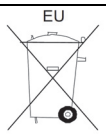
(3) Use a grease gun to feed grease. At this time, grease feeding operation must be done ***keeping the feeding speed to 40cc per 10 seconds.*** The amount of the grease to be lubricated is shown in pre-described table. Keep the feeding operation until the color of the grease that is pushed out from the ejection outlet change to a color of new grease.

(4) Wrap seal tapes on socket head plug [Rc-1/8] and attach to the inlet (LUB.PORT).

(NOTE) The Hinge support point lubrication port (inlet) has a socket head plug. When lubricating, attach a grease nipple instead of the socket in advance.

4.3 Battery replacement

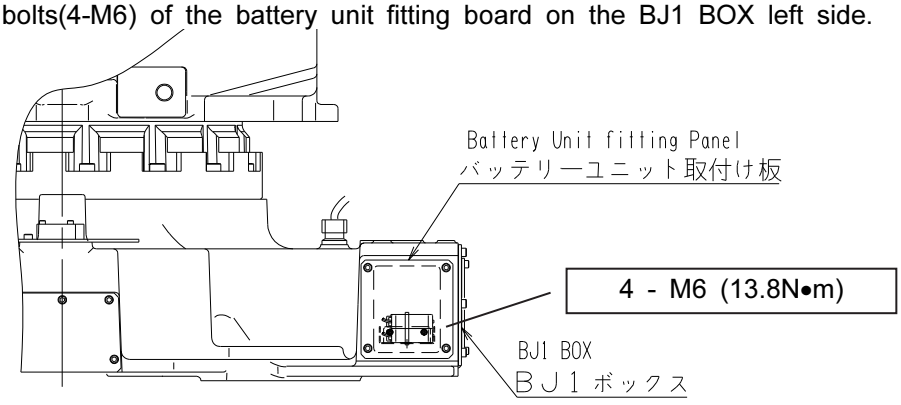
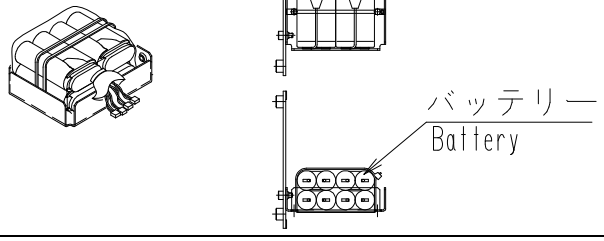
The robot uses lithium batteries for the backup of encoder data.
If the battery voltage drops below the given limit, the data will not be kept normal.

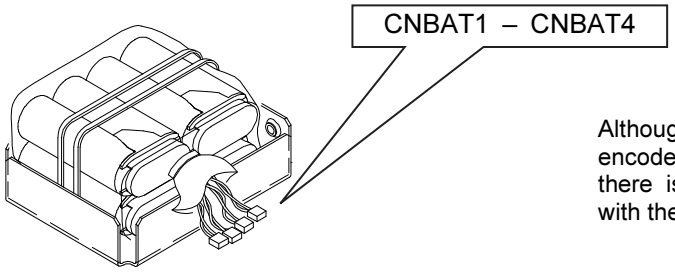
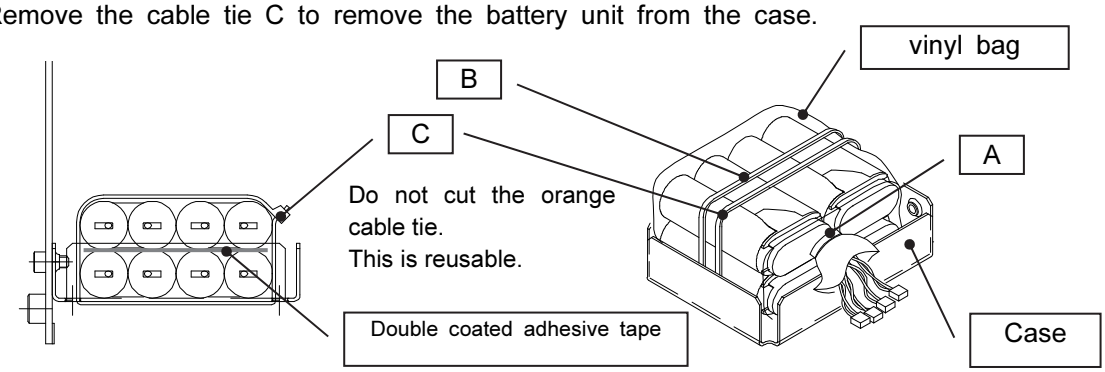
IMPORTANT	Replace batteries **every 8 years**, under the condition that operation time length is 8h/day and shut down the power 16h/day.
IMPORTANT	The replacement period varies with use environments (mainly temperatures). If the battery voltage drops below the given limit, an error indicating the voltage drop will be displayed on the controller. In this case, replace the battery.
IMPORTANT	Replace the battery with the power supply of the controller turned ON. Replacing the battery with the power supply turned OFF can result in the encoder data error, thus requiring the resetting of the encoder..
IMPORTANT	Do not store the batteries in places with high temperature and high humidity. Store them in well-ventilated places to avoid dew condensation. It is recommended to store the batteries in places with less temperature changes at ambient temperatures (20±15°C) and relative humidity of not more than 70%.
IMPORTANT	Discarding lithium batteries according to your local trash separation rule When discarding used lithium batteries, insulate the electrical terminals. And then follow the respective trash separation rules in your local district and discard them separately as ***"Used lithium batteries"***. 

Tools required

- Torque wrench for M4 (Tightening torque : 3.33 Nm)
- Torque wrench for M6 (Tightening torque : 13.38 Nm)
- Double coated adhesive tape
- Nipper and Cable tie

Battery replacement procedure

STEP	Work performed
1	Turn ON the primary power of the robot controller.
2	Lock the robot by pressing the emergency stop button.
3	Remove the bolts(4-M6) of the battery unit fitting board on the BJ1 BOX left side. 
4	Pull out the battery unit from the BJ1 BOX. 

5	Disconnect the connecters CNBAT1 - CNBAT4.  Although a warning message of encoder battery voltage is displayed, there is no problem. Please proceed with the next procedures.
6	Remove the cable tie C to remove the battery unit from the case. 
7	Install a new battery unit to the case with the cable tie C. When replacing the batteries one by one, please follow the procedures shown below. (1) Fix each battery with double coated adhesive tape. (2) Put the battery in the plastic bag and fasten the cable tie A. (3) Fasten the plastic bag with the cable tie B. (4) Install the battery to the case with the cable tie C.
8	Connect CNBAT1 - CNBAT4.
9	Place the battery unit fitting plate to the original position and fix it with the fixing bolts (4-M6). (Tightening torque : 13.8N•m) If the battery unit fitting plate is damaged, please replace it.
10	Turn OFF the primary power of the robot controller and turn it ON again.

NOTE

Chapter 5 Troubleshooting

5.1 Probing into causes of troubles

WARNING	To perform daily inspection, repair, or part replacement of the robot, turn OFF the power supply. Furthermore, in order to prevent other workers from improperly turning ON the power supply, post the warning signs such as “DON’T POWER ON”.
WARNING	If any abnormality occurs in the robot, do not attempt to directly operate the robot. Inform the abnormality to the maintenance personnel who received the given education and training immediately, and then probe the cause of the abnormality to deal with it. Furthermore, incorporate the said course in the Operation Rules and establish a framework to surely implement the Rules.

When any abnormality occurs in the robot movement or operation, if no external causative factors can be discerned, the abnormality will result from damage to mechanical parts. To promptly solve troubles, it is necessary to have a good grasp of symptoms and then probe what part is defective to cause the trouble.

Step 1 What axis has caused the abnormality?

Judge what axis has caused the abnormal symptom, first. For abnormalities hard to be judged since they do not appear in the robot movement, check for the following points.

- Any places producing abnormal sounds?
- Any places generating abnormal heat?
- Any places having backlash/play?

Step 2 What part has damage?

If the axis causing the abnormality is probed, check what part is the cause of the abnormality. A number of parts can be the cause of a single symptom. (Refer to following table)

Step 3 Measures against defective parts

If the defective parts are probed, take measures. Some measures can be taken by customers. For measures hard to be taken, contact our Service Department.

Defective part / Symptom	Reduction gear	Brakes	Motors	Encoder	Fulcrum bearing	Belt	Tool
Overload *1	○	○	○		○	○	
Displacement	○		○	○		○	
Abnormal sound	○	○	○		○	○	
Shaking while in operation *2			○		○	○	
Sway when stopped *3			○	○	○	○	○
Irregular twitching *4			○	○	○		
Abnormal deviation			○	○			
Gravity drop of axis	○	○				○	
Abnormal heat generation	○	○	○				
Malfunction and runaway			○	○			

*1: A symptom, which will occur when a load exceeding the rated specification conditions of the motor is applied. To be more precise, a thermal relay or a circuit protector will be tripped.

*2: A symptom, which the robot causes vibration while in operation.

*3: A symptom, which the robot will repeat oscillations several times near the stop position when it makes a stop.

*4: A symptom, which the robot twitches at irregular intervals of time in the holding configuration.

Check and remedy by each part is explained after here.

WARNING	The brake release switch must be operated in order to move the robot without supplying power to its motors (in the Motors OFF status). An axis whose brake has been released is free to move, and since the arm may drop or move either backward / forward or up/down as a result, it must be supported by a crane, chain hoist or other means without fail before the brake release switch is operated.

■ **Balancer bearing**

If balancer bearing is damaged, vibration or abnormal sounds will be produced, thus resulting in overload.

(1) Checking method

- (Front portion of balancer) Check whether or not the plate shown in Fig.5.3.1-2 is transformed. Furthermore check whether or not (1) bearing attachment portion has some incline (2) grease leaks from seal.
- (Rear left and rear right portion of balancer) Check whether or not (1) shaft has some incline (2) grease leaks from seal. (Refer to Fig.5.3.1-3 and Fig.5.3.1-4)
- Check whether or not the robot hits against the peripheral equipment or else before an abnormality occurs.

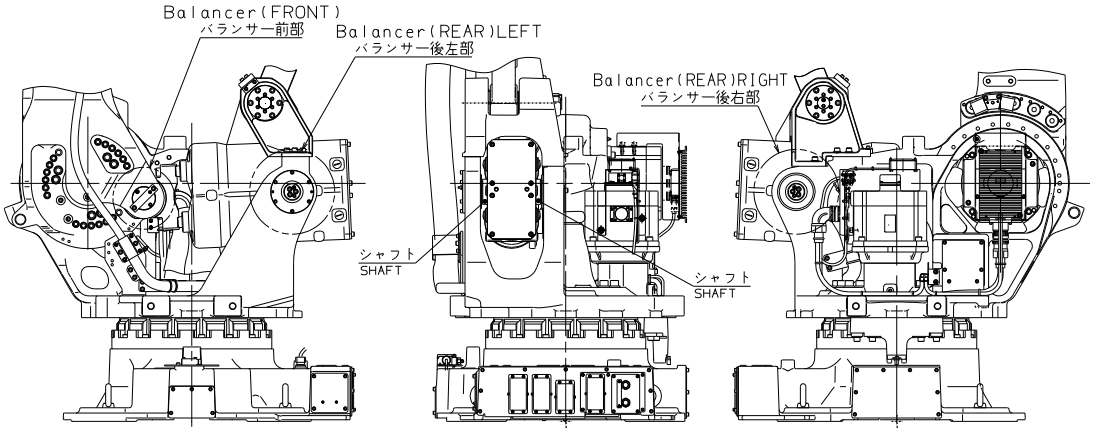


Fig. 5.3.1-1 Checking location

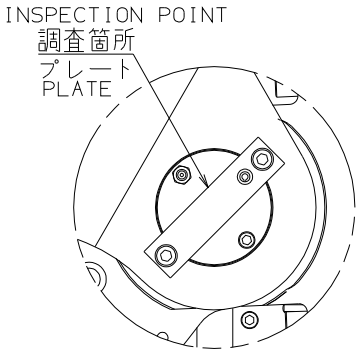


Fig. 5.3.1-2 Checking location
Front portion of balancer

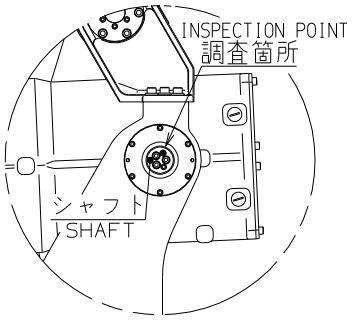


Fig. 5.3.1-3 Checking location
Rear left portion of balancer

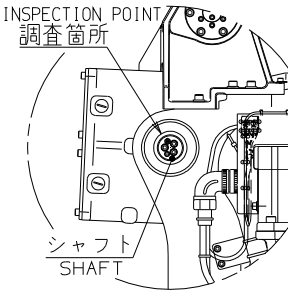


Fig. 5.3.1-4 Checking location
Rear right portion of balancer

(2) Remedy

- Replace the defective bearing. For this purpose, it is necessary to dismount the balancer unit. Because there is a spring compressed with very strong power inside the balancer unit, it is very dangerous part. Therefore, please contact our service department if it is necessary to dismount.

■ **Support bearing**

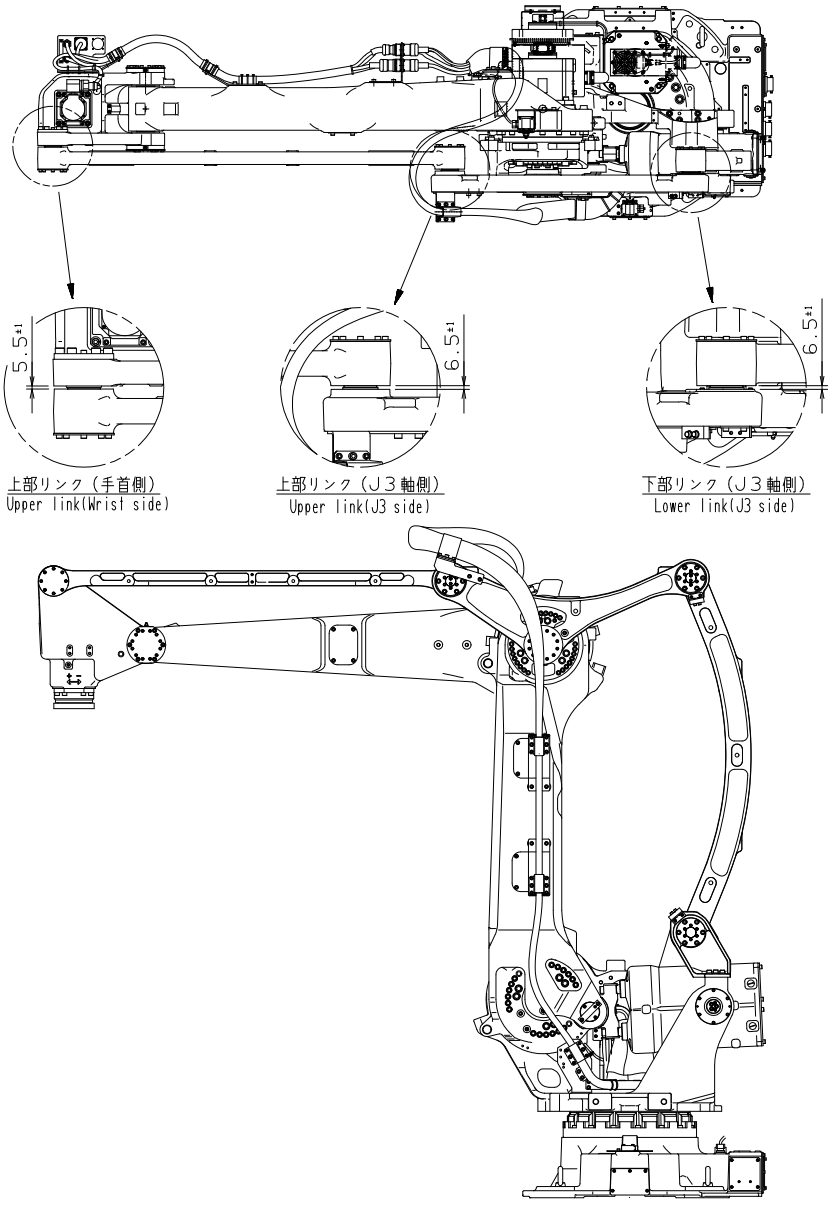
If support bearing is damaged, vibration or abnormal sounds will be produced, thus resulting in overload. And, if looseness occurs in the bearing nut that fixes the bearings, gap may occur in the bearing. This gap may cause damage to the bearing.

(1) Checking method

- Check whether or not there is a gap in the bearing by pushing wrist unit, fore-arm (No.1 arm) or upper-arm (No.2 arm).

(If chain block etc. is available, use it to hold the No.1 arm and the No.2 arm to make a condition in which any load / torque is not added to the reduction gears and check if there is a gap or not.)

- Check if the gap is within ±1.0 [mm] at the respective link support points (see figure below)
- Check whether or not the robot hits against the peripheral equipment or else before an abnormality occurs.



(2) Remedy

- Replace the bearing. For this purpose, in order to lift the robot arm, equipment such as a chain block should be provided. If it is hard to replace the bearing, contact our service department.

■ **Reduction gear**

If a reduction gear is damaged, vibration or abnormal sounds will be produced. In this case, normal operation will be impaired to cause overload or abnormal deviation, thus resulting in abnormal heat generation. Furthermore, the robot will completely stop or cause displacement.

J1, J2, and J3 axes

(1) Checking method

- While in operation, check for any vibration or abnormal sounds, or abnormal heat generation from the reduction gear part.
- Turn OFF the motors, check the reduction gear for backlash/play or scratch, and whether or not any abnormality is felt by hand through holding the forearm to swivel the robot with the brake release switch (option) of the J1 axis set to “ON”. To check J2 and J3 axis, upper arm must be held using crane or chain block before releasing. Move the arm by operating crane or chain block and check whether or not any abnormality is felt by hand.
- Check whether or not the robot hits against the peripheral equipment or else before an abnormality occurs.
  (The reduction gear may be damaged by shocks given when the robot hits against it.)

 WARNING	Never forget that upper arm must be held using crane or chain block before releasing. Especially as for J2 axis, upper arm may fall down or may jump up due to the payload and robot posture. After supporting upper arm, release brake by inching operation to see the moving direction of upper arm and to secure that supporting method is adequate.

(2) Remedy

- Replace the reduction gear. For this purpose, in order to lift the robot arm, equipment such as a chain block should be provided. If it is hard to replace the bearing, contact our Service Department.

Wrist axis (J4)

(1) Checking method

- While in operation, check for any vibration or abnormal sounds, or abnormal heat generation from the reduction gear part.
- Check the reduction gear for backlash/play through applying loads to the end effecter (e.g. a spot gun or hand unit).
- Turn OFF the motors, and then check whether or not the axis moves by hand with the brake release switch (option) set to “ON”. If the axis does not move, the reduction gear may have an abnormality.
- Check whether or not the robot hits against the peripheral equipment or else before an abnormality occurs.
  (The reduction gear may be damaged by shocks given when the robot hits against it.)

(2) Remedy

- If J4 axis reduction gear is abnormal. just replace J4 axis reduction gear.

■ **Brakes**

If any brake causes an abnormality, an axis may drop with the motors “OFF”. Furthermore, with the motors “ON”, the brake may remain applied, thus resulting in overload or noises.

(1) Checking method

- With the Motors OFF state, check whether or not the brake produces operating sounds through setting the brake release switch to “ON” and “OFF”. If the brake produces no operating sounds, it is assumed that the brake has a broken wiring.
  (In order to set the brake release switch to “ON” or “OFF”, pay utmost care for the drop of the robot arm.

 WARNING	Never forget that upper arm must be held using crane or chain block before releasing. Especially as for J2 axis, upper arm may fall down or may jump up due to the payload and robot posture. After supporting upper arm, release brake by inching operation to see the moving direction of upper arm and to secure that supporting method is adequate.

(2) Remedy
- Check for brake wirings. Since the motor with an integrated brake for all axes is used, if no wirings are broken, replace the motor referring to information in “5.4 Motor Replacement”.

■ **Motors**

If the motor causes an abnormality, malfunctions (e.g. shaking while in operation, sway when stopped, or irregular twitching) will result. Furthermore, abnormal heat generation or abnormal sounds may result. Since the same symptoms as those caused when the reduction gear is damaged appear, it is hard to judge whether the abnormality results from the motor or the reduction gear. In this connection, investigate the reduction gear and the bearing at the same time.

(1) Checking method
- Check for any abnormal sounds or abnormal heat generation.

(2) Remedy
- Replace the motor referring to information in “5.4 Motor Replacement”.

■ **Encoders**

If the encoder causes an abnormality, the robot will cause displacement, malfunction, or runaway, thus leading to sway when stopped or irregular twitching. Furthermore, this abnormality will almost never result in symptoms such as mechanical noises, heat generation, or vibration.

(1) Checking method
- Check the encoder data for any errors.
- Align the zeroing pin with the reference position, and then check the position data for any errors.
- Move each axis of the robot to check whether or not there are any points in which data (bits) show irregular changes.
- Check the drive unit model number of the controller. (The model of the drive unit varies with the number of robot axes in use and the motor capacity of each axis.)
- If any drive unit of the corresponding model for the same model of controller is available, replace the drive unit to check whether or not the symptom is transferred to this drive unit, referring to information in the “Part Replacement Procedure” section in the Maintenance Manual for the Controller.

(2) Remedy
- Check for brake wirings. If no wirings are broken, replace the encoder unit.
- When the drive unit is replaced with the one of another controller, if the symptom is transferred to the controller to which the drive unit is installed, replace this drive unit with new one.

CAUTION	**Caution on the encoders** If the battery has discharged completely or if the battery is not connected properly so that the encoder has been left standing without any power supplied to it from the controller, the data stored inside the encoder may be lost and the encoder itself may not operate properly. This state is detected as an abnormality in the encoder system when the encoder operation is checked at power-on. When abnormal encoder circuit condition has been detected, encoders must be reset.

■ **Tool**

(1) Checking method
・If the tool which is not so rigid has been mounted on the robot, the tool itself may repeat oscillations several times near the stop position.

(2) Remedy
・Robot teaching program is needed to be modified. For example, reducing the step speed or recording “smooth” parameter. (☞ “Basic Operations manual” ”Chapter 4 Teaching”)

5.2 Motor replacement

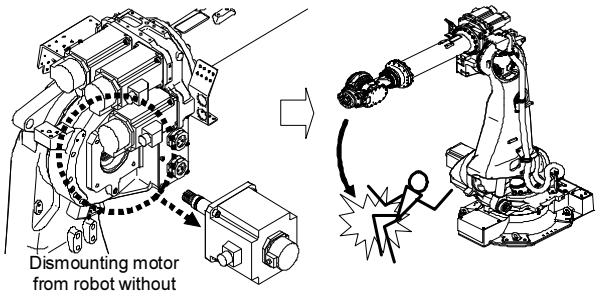
WARNING

Never forget to **hold robot arm or wrist/tool** in advance. If motor is disengaged without supporting them, forearm will fall down to the front or to the backwards (due to the payload and robot posture) in case of axis 2, forearm will fall down in case of axis 3, wrist and tool will fall down or will rotate quickly in case of wrist axes, possibly resulting in serious injury.

To hold robot arm, use a crane or chain block etc (*).To hold axis 2 and 3, wooden blocks or fixing jig set (option) can be used.

Note that zeroing pin and block are not for supporting arm.

Furthermore, Never attempt to hold robot arm with hands.



Dismounting motor from robot without holding arm...

CAUTION

When touching the motor immediately after robot stop operating, be sure that motor is NOT HOT and then touch it with attention.

CAUTION

The motor mass is listed below. Because of its weight, handle the motor with full attention.

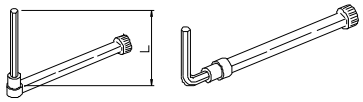
Robot type	J1	J2	J3	J4
LP130-01, LP180-01	28.0 kg			11.0 kg
LP210-01	28.0 kg	28.4 kg	28.0 kg	11.0 kg

CAUTION

This work includes some jobs that should be conducted with motors ON. Consequently, be sure to conduct the work at least by a pair of two persons. One person must be ready to press an Emergency Stop button at any time, while the other person must promptly finish the work paying enough attention to the robot operating area. Furthermore, before starting to work, confirm evacuation route.

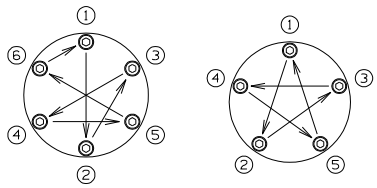
(*) Please use a crane or chain block, which can endure the weight including robot body, end effecter, work piece and all other loads.

Tools required (*Customer preparation required)

Part name	Axis name	Part No. (Model)
Torque wrench  Torque wrench L-shape Torque wrench	J1,J2,J3,J4	M5 torque wrench (Long type: L>= 200 mm) Or M5 L type torque wrench
	J1,J2,J3	M12 torque wrench (Long type: L>= 280 mm)
	J4	M8 torque wrench (Long type: L>= 280 mm)
Locking agent	J1,J2,J3,J4	ThreeBond 1374
Grease	J4	LONGTIME PD2
	J1,J2,J3	MOLYWHITE RE No.00
Lubrication	J1,J2,J3	ThreeBond 1801B

Be absolutely sure to use the torque wrench to tighten the bolts.

In case of tightening the bolts on circumference, tighten them equally and gradually.



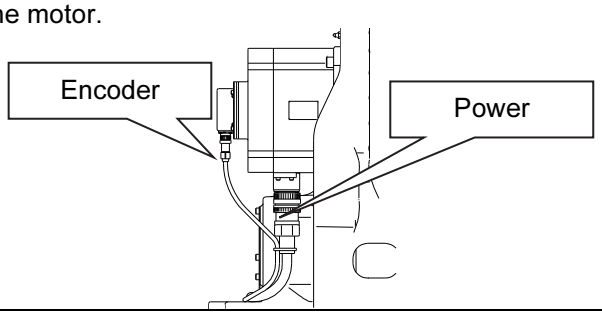
Order to tighten bolts

The “coupling gear set” includes motor fixing bolts, or seals also. When replacing a motor unit, it is recommended to replace the old bolts, seals etc. to the new ones that are included in the set in spite of their damage level

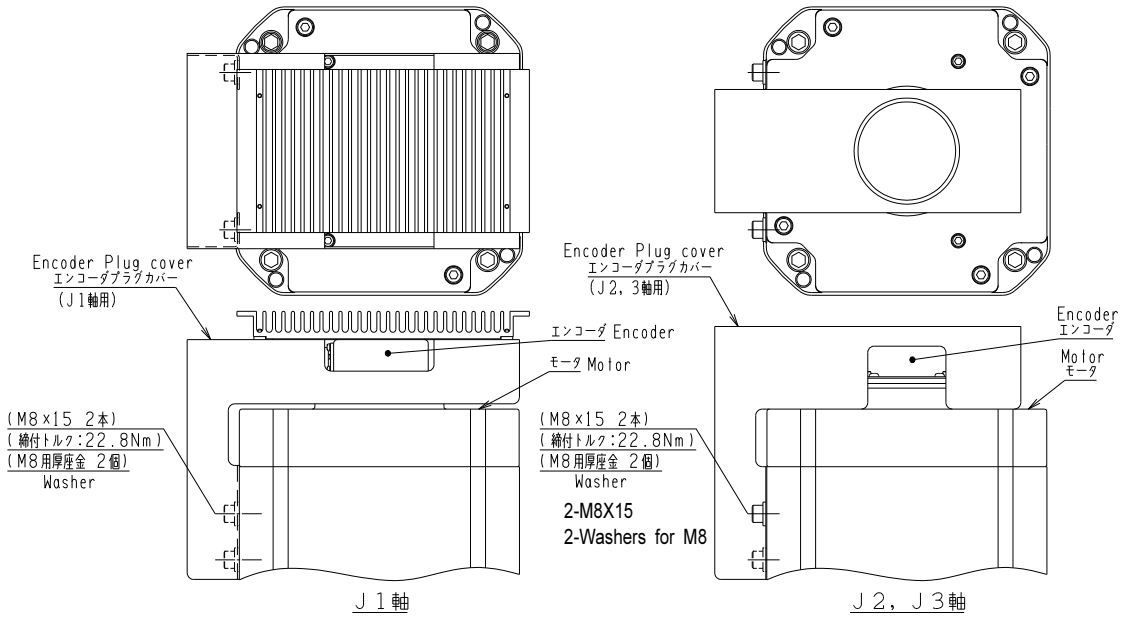
5.2.1 Motor replacement (J1,J2,J3 of LP130/180 and J1,J2 of LP210)

STEP	Required work	Checkpoints
1	Turn on the power of the controller, select the TEACH mode, and turn the Motors ON.	If Motors cannot be turned ON due to an abnormality or axis operations cannot be performed, start from step 3.
2	Refer to "5.2.5 Encoder correction" to proceed with the axis operation to the position where the zeroing pin can be inserted and to insert the zeroing pin.	Never use zeroing pin to support arm.
3	Secure the arm using J2 axis fixing jig set (option) or crane, chain block or other means.	As for J2 axis, if Motors ON cannot be selected due to an abnormality or axis operations cannot be performed, it is possible to secure the arm using J2 axis fixing jig set (option).

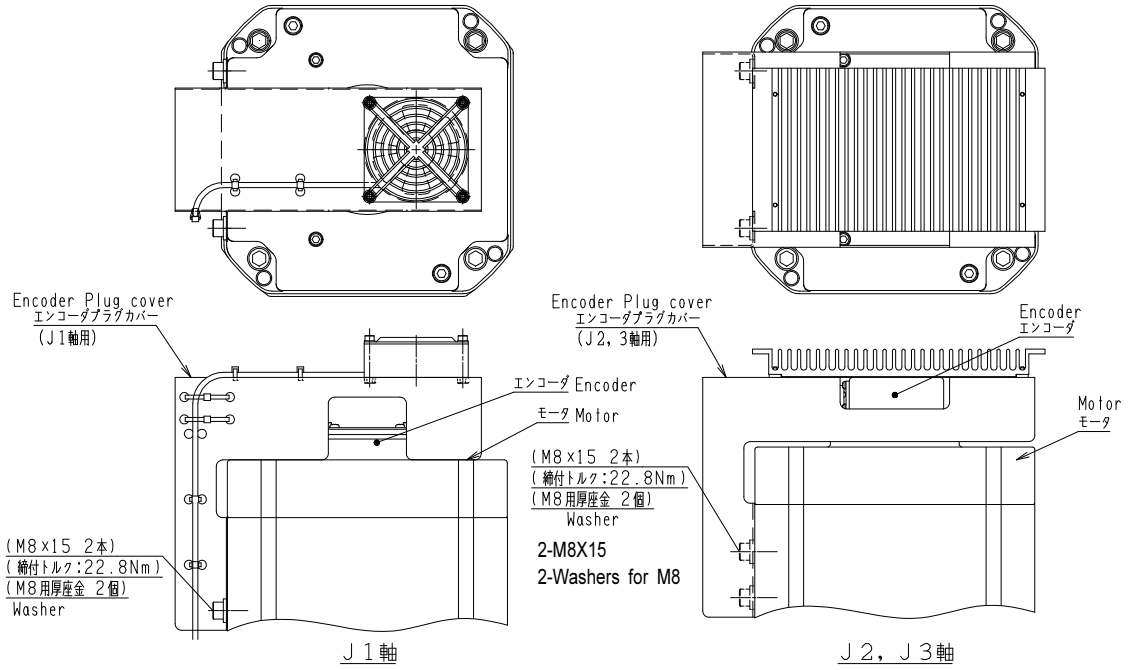
WARNING	Be absolutely sure to follow the above instructions to secure the arm ahead of time. Removing the motor without first securing the arm may cause the J2 axis to move forward or backward, and cause the J3 axis to drop, resulting in a serious accident. If motor fixing bolts are loosened without supporting robot arm, motor body may rotate with high speed because robot arm moves, resulting in a serious accident.

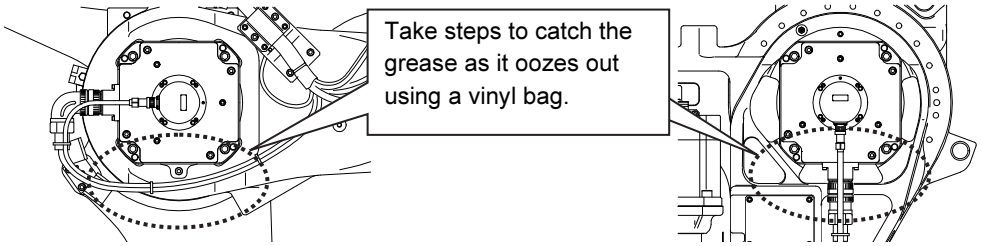
4	Turn the Motors OFF first, and then turn OFF the power of the controller.	
5	Disconnect the connectors (encoder and power) from the motor. 	Bear in mind that the encoder data will be lost when the encoder connector is disconnected.
6	Remove the encoder plug cover. Concerning the bolt locations, refer to the following figure.	

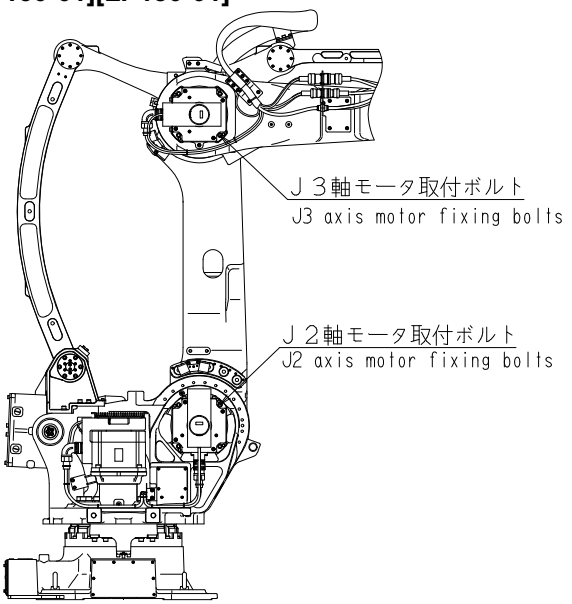
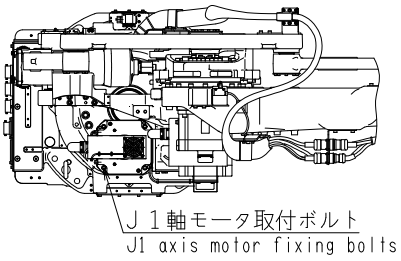
[Robots shipped on July 2012 or before]

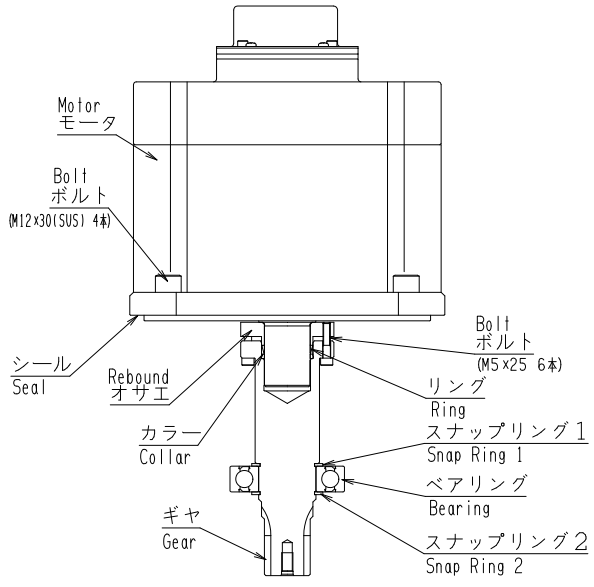


[Robots shipped on August 2012 or after]

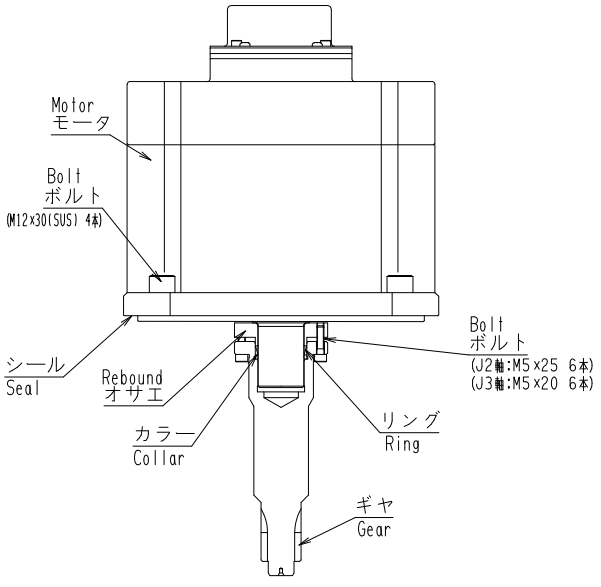


STEP	Required work	Checkpoints
7	Place a vinyl bag for catching the grease under the motor. (In the case of J1 axis, it is not necessary to attach the vinyl bag.)  	•In the case of the J2 or J3 axis, grease will ooze out when the motor is removed. •Fix the vinyl bag securely in place using adhesive tape or some other means.

STEP	Required work	Checkpoints
8	Remove the motor attachment bolt shown below, and remove the motor from the robot. **J1,J2,J3 axis** **4-M12X30** **[LP130-01][LP180-01]**  	•Before removing bolts, while bolts are loosened, check that no stress exists toward the motor rotating direction. If motor is stable even when rotated by hand, some stress still remains so motor may rotate with high speed when removed from robot body. Please check the supporting of robot arm. • Exercise caution since the J1, J2 and J3 axis motors are heavy. • Do not to apply excessive impact to the motor shaft. • Take care not to damage the oil seal lip by the gear attached to the motor shaft. • Bear in mind that when J2 axis motor is removed, J2 axis may move forward or backward depending on the state of the frame balancer. 
9	Remove the gear-assembly from the motor. **J1,J2,J3** (a) Remove the following bolts, and remove the gear. **J1/J2 :6-M5X25** **J3 :6-M5X20** (b) Attach the collar, ring X2 and holding plate.	• Do not apply excessive impact to the motor shaft.



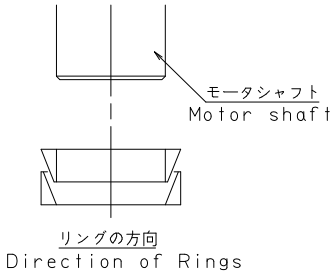
Motor gear ASSY (J1 axis)



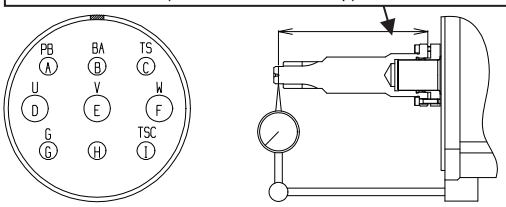
Motor gear ASSY (J2 and J3)

<table>
<tr><th>STEP</th><th>Required work</th><th>Checkpoints</th></tr>
<tr><td>10</td><td>Apply a thin coating of ThreeBond 1801B to the shaft of the new motor and two rings before attaching the gear-assy to the new motor.
Attach the gear-assy, which was removed, to the new motor.

(a) Attach the holding plate, ring X2 and collar.
(b) Using the following bolts, attach the gear.
J1: 6-M5X25 (Tightening torque : 9.8 N·m)
J2: 6-M5X25 (Tightening torque : 9.8 N·m)
J3: 6-M5X20 (Tightening torque : 9.8 N·m)

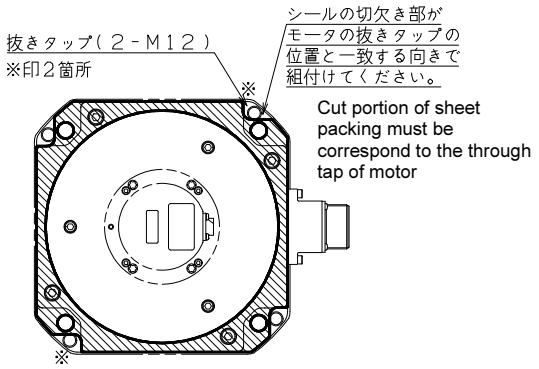
J2,J3
(c) Check the run-out tolerance of the gear.
(The run-out tolerance should be under 0.1mm)
If the run-out tolerance exceeds 0.1 mm, loosen the gear fixing bolts and repeat the steps from (b).</td><td>•When attaching the rings, make sure they are pointing in the proper direction.
 

• Do not to apply excessive impact to the motor shaft.
• Be absolutely sure to use the torque wrench to attach the bolts. Then tighten bolts gradually & uniformly using a torque wrench.</td></tr>
<tr><td></td><td><How to measure the run-out tolerance>
- To check the run-out tolerance, it is necessary to release the brake inside the motor and rotate the gear by hand. To release the brake, add DC24V voltage between pin A and pin B in the CNMB* connector.(A:+24V, B:0V)
- The run-out tolerance should be measured on the oil-seal touching surface using a dial gauge like shown as below.
- Please refer to “Chapter 6 Recommended Spare Parts and Special Tools for Maintenance” to know the way for identifying similar gears.

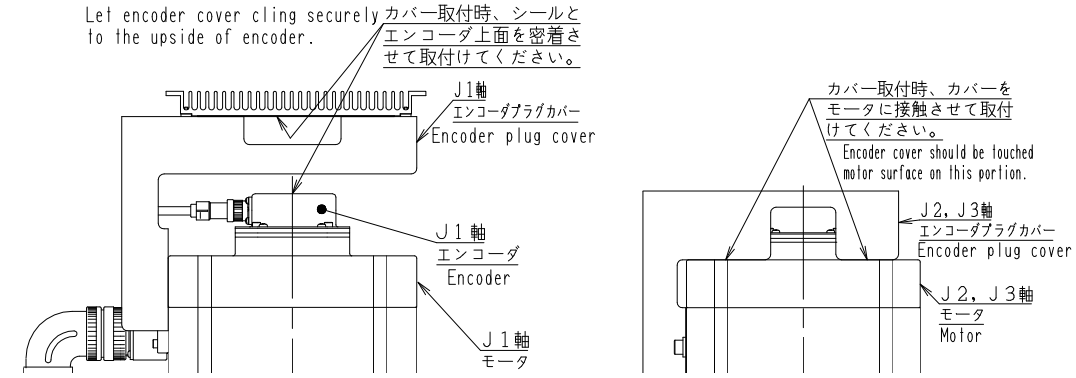
J2 axis : Gear with the stamp of RV-450E3-231 → 173mm
Gear without stamp → 180mm
J3 axis : 158mm (irrelevant to the stamp)
 

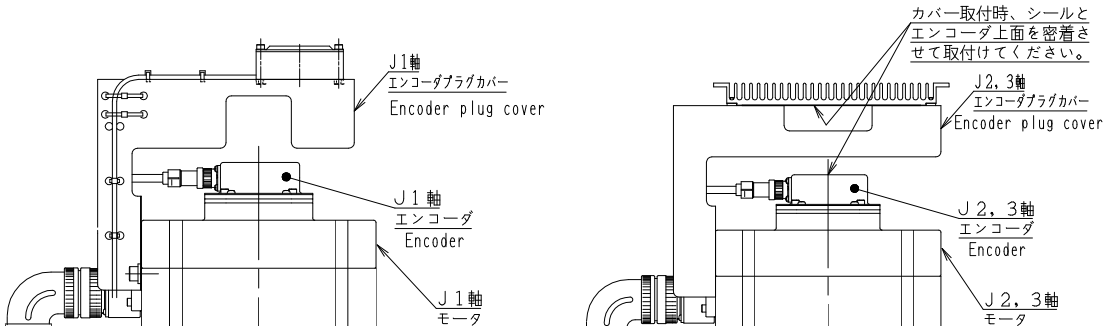
CNBM* Connector</td><td></td></tr>
<tr><td>11</td><td>Attach motor with following bolts.

J1,J2
4-M12X30 (Tightening torque : 116 N·m)
J3
4-M12X30 (Tightening torque : 104 N·m)

If sheet packing of motor is damaged, please replace it to new one. Its direction is as showed in right figure.
 
</td><td>• Bear in mind to use torque wrench to fasten the bolts. Fastening should be done equally and gradually.
• Bear in mind not to damage the gear surface when attaching the motor.</td></tr>
</table>

<table>
<tr><th>STEP</th><th>Required work</th><th>Checkpoints</th></tr>
<tr><td>12</td><td>Attach the removed encoder plug cover to the new motor.
J1,J2,J3
Attach the encoder plug cover with following bolts. At this time, apply one or two drops of locking agent (ThreeBond 1374) to the threads at the ends of the bolts, and then tighten the bolts.
2-M8X15 (Tightening torque : 22.8 N·m)
2-washers for M8

[Robots shipped on July 2012 or before]
 

[Robots shipped on August 2012 or after]
 
</td><td></td></tr>
<tr><td>13</td><td>Connect the connectors (encoder and power) to the motor.</td><td></td></tr>
<tr><td>14</td><td>During the replacement of J2 and J3-axis motors grease can be lost. Estimate amount of grease lost during replacement procedure and replenishment.
(grease : MOLYWHITE RE No.00)</td><td></td></tr>
<tr><td>15</td><td>Perform encoder reset on the axis concerned.
(☞ "5.2.4 Encoder reset ")</td><td></td></tr>
<tr><td>16</td><td>Perform encoder correction the axis concerned.
(☞ "5.2.5 Encoder correction ")</td><td></td></tr>
<tr><td>17</td><td>Remove the zeroing pin.</td><td>• Bear in mind that performing an axis operation by mistake without first having removed the zeroing pin may deform the pin and/or pin hole and make it impossible to remove the pin and implement encoder correction properly in the future.</td></tr>
<tr><td>18</td><td>Ensure that robot operation presents no problem.</td><td></td></tr>
</table>

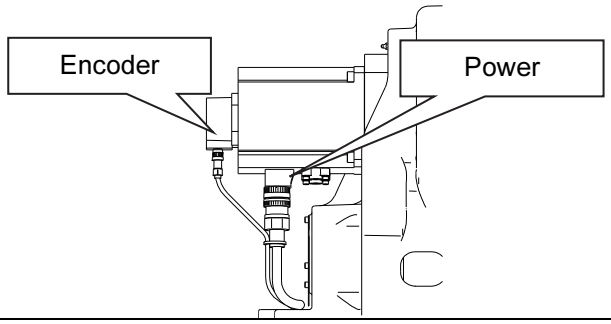
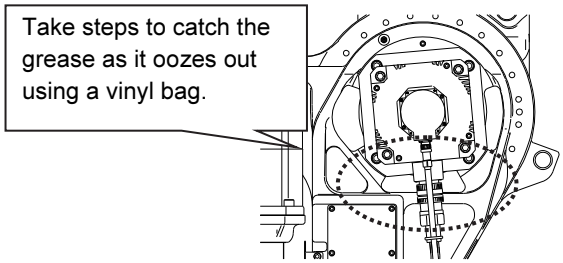
CAUTION	If encoder correction of J2 and J3 axes were performed in wrong position (that is not the reference position) J3 angle limitation between the ground can not be correctly checked. Unexpected collision may occur between the wrist (wrist attitude is kept) and J3 axis and this may cause the serious damage to the robot arm. If angle limitation error occurs before inserting the zeroing pin, once perform encoder correction and proceed with encoder correction again.

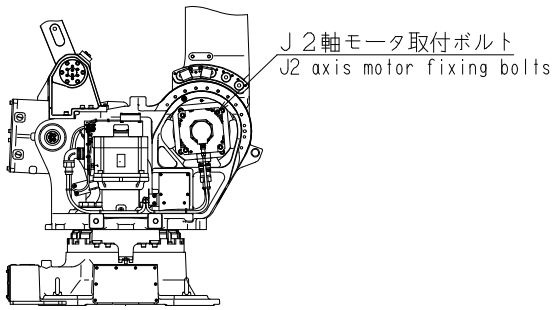
This now completes the J1, J2 or J3 axis motor replacement.

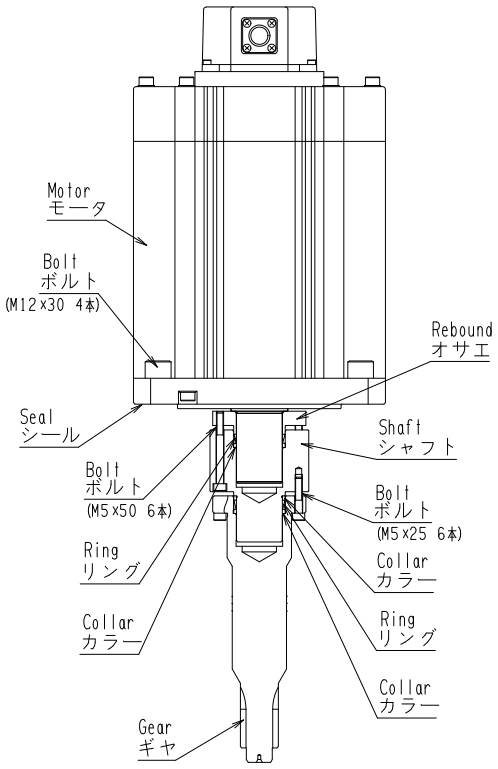
5.2.2 Motor replacement (J2 of LP210)

STEP	Required work	Checkpoints
1	Turn on the power of the controller, select the TEACH mode, and turn the Motors ON.	If Motors cannot be turned ON due to an abnormality or axis operations cannot be performed, start from step 3.
2	Refer to "5.2.5 Encoder correction" to proceed with the axis operation to the position where the zeroing pin can be inserted and to insert the zeroing pin.	Never use zeroing pin to support arm.
3	Secure the arm using J2 axis fixing jig set (option) or crane, chain block or other means.	As for J2 axis, if Motors ON cannot be selected due to an abnormality or axis operations cannot be performed, it is possible to secure the arm using J2 axis fixing jig set (option).

WARNING	Be absolutely sure to follow the above instructions to secure the arm ahead of time. Removing the motor without first securing the arm may cause the J2 axis to move forward or backward, and cause the J3 axis to drop, resulting in a serious accident. If motor fixing bolts are loosened without supporting robot arm, motor body may rotate with high speed because robot arm moves, resulting in a serious accident.

4	Turn the Motors OFF first, and then turn OFF the power of the controller.	
5	Disconnect the connectors (encoder and power) from the motor. 	Bear in mind that the encoder data will be lost when the encoder connector is disconnected.
6	Place a vinyl bag for catching the grease under the motor. 	•Grease will ooze out when the motor is removed. •Fix the vinyl bag securely in place using adhesive tape or some other means.

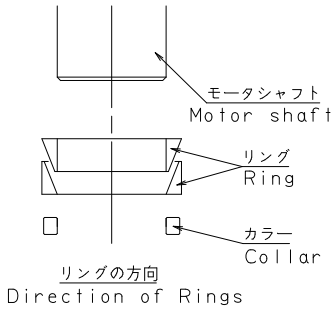
STEP	Required work	Checkpoints
7	Remove the motor attachment bolt shown below, and remove the motor from the robot. **4-M12X30**  	•Before removing bolts, while bolts are loosened, check that no stress exists toward the motor rotating direction. If motor is stable even when rotated by hand, some stress still remains so motor may rotate with high speed when removed from robot body. Please check the supporting of robot arm. • Exercise caution since motors are heavy. • Do not apply excessive impact to the motor shaft. • Take care not to damage the oil seal lip by the gear attached to the motor shaft. • Bear in mind that when J2 axis motor is removed, J2 axis may move forward or backward depending on the state of the frame balancer.
8	Remove the gear-assembly from the motor. (a) Remove the following bolts, and remove the gear. **6-M5X25, 6-M5X50** (b) Attach the collar, ring X2 and holding plate.	• Do not apply excessive impact to the motor shaft.



Motor gear ASSY (LP210 J2 axis)

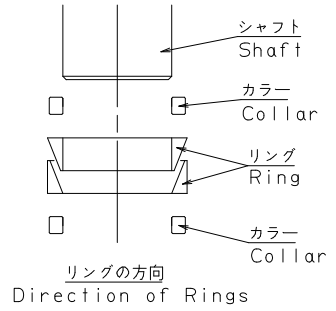
<table>
<tr><th>STEP</th><th>Required work</th><th>Checkpoints</th></tr>
<tr><td>9</td><td>Apply a thin coating of ThreeBond 1801B to the shaft of the new motor and two rings before attaching the gear-assy to the new motor.
Attach the gear-assy, which was removed, to the new motor.

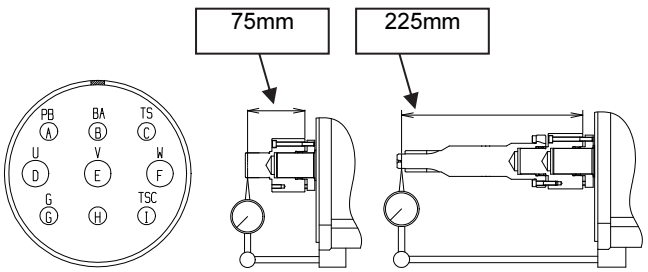
(a) Attach the holding plate, ring X2 and collar.
(b) Using the following bolts, attach the gear.
6-M5X50 (Tightening torque : 9.8 N·m)
(c) Check the run-out tolerance of the gear.

If the run-out tolerance exceeds 0.35 mm, loosen the gear fixing bolts and repeat the steps from (b).</td><td>•When attaching the rings, make sure they are pointing in the proper direction.
 

• Do not to apply excessive impact to the motor shaft.
• Be absolutely sure to use the torque wrench to attach the bolts. Then tighten bolts gradually & uniformly using a torque wrench.</td></tr>
<tr><td>10</td><td>Apply a thin coating of ThreeBond 1801B to the assembled shaft and two rings.
Attach the gear-assy, which was removed, to the new motor.

(a) Attach the holding plate, ring X2 and collar.
(b) Using the following bolts, attach the gear.
6-M5X25 (Tightening torque : 9.8 N·m)
(c) Check the run-out tolerance of the gear.

If the run-out tolerance exceeds 0.11 mm, loosen the gear fixing bolts and repeat the steps from (b).</td><td>•When attaching the rings, make sure they are pointing in the proper direction.
 

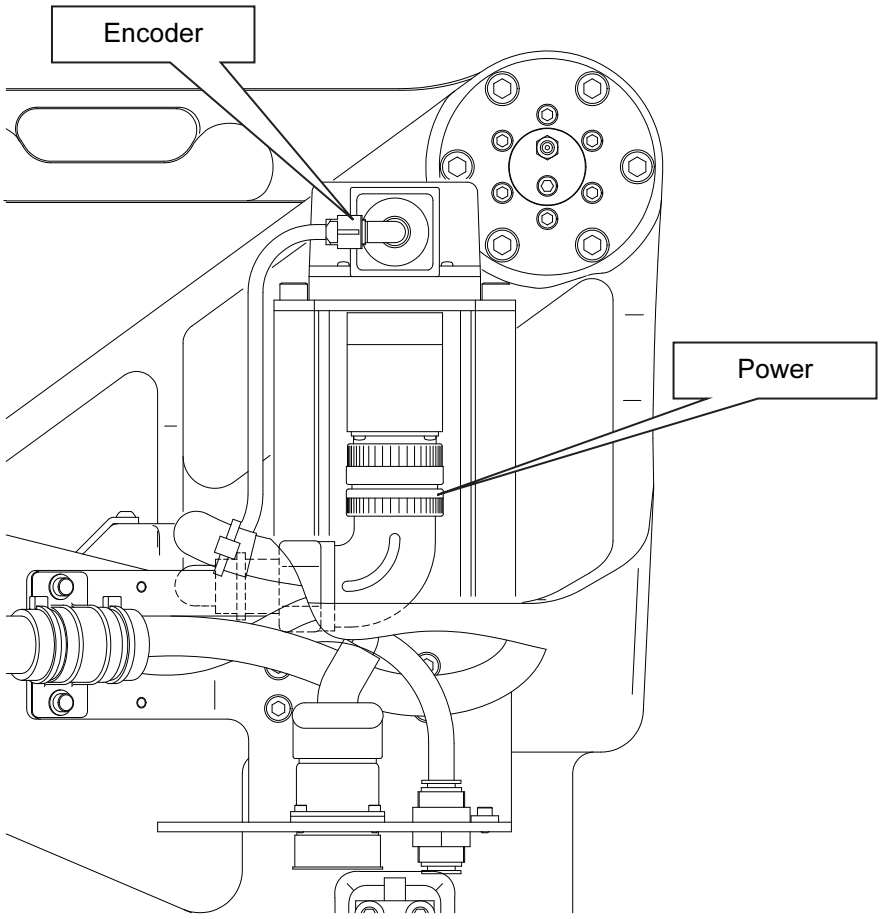
• Do not to apply excessive impact to the motor shaft.
• Be absolutely sure to use the torque wrench to attach the bolts. Then tighten bolts gradually & uniformly using a torque wrench.</td></tr>
<tr><td></td><td colspan="2"><How to measure the run-out tolerance>
- To check the run-out tolerance, it is necessary to release the brake inside the motor and rotate the gear by hand. To release the brake, add DC24V voltage between pin A and pin B in the CNMB* connector.(A:+24V, B:0V)
- The run-out tolerance should be measured on the oil-seal touching surface using a dial gauge like shown as below.
- Please refer to “Chapter 6 Recommended Spare Parts and Special Tools for Maintenance” to know the way for identifying similar gears.
 

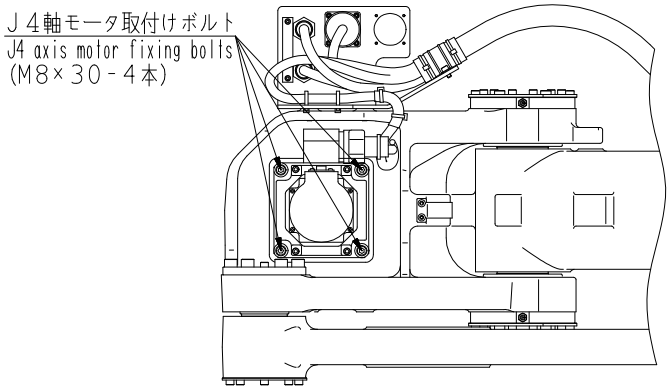
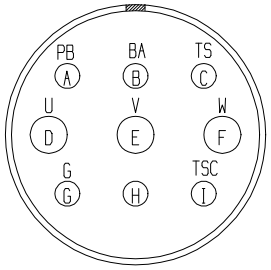
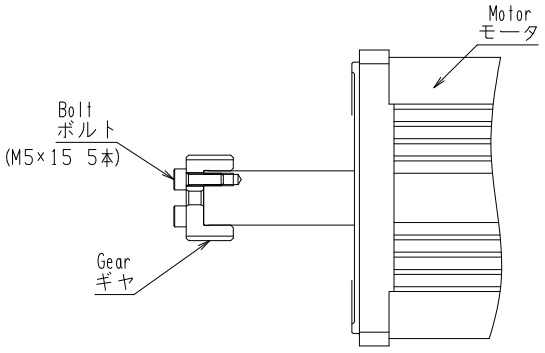
CNBM* Connector
measuring position of step 9
measuring position of step 10</td></tr>
<tr><td>11</td><td>Attach motor with following bolts.
4-M12X30 (Tightening torque : 116 N·m)
If sheet packing of motor is damaged, please replace it to new one.</td><td>• Bear in mind to use torque wrench to fasten the bolts. Fastening should be done equally and gradually.
• Bear in mind not to damage the gear surface when attaching the motor.</td></tr>
<tr><td>12</td><td>Connect the connectors (encoder and power) to the motor.</td><td></td></tr>
</table>

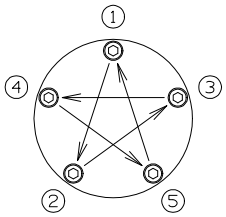
After here, follow “5.2.1 Motor replacement (J1,J2,J3 of LP130/180 and J1,J2 of LP210)” step 13.

5.2.3 Motor replacement (J4)

STEP	Required work	Checkpoints
1	Turn on the power of the controller, select the TEACH mode, and turn the Motors ON.	If Motors cannot be turned ON due to an abnormality or axis operations cannot be performed, start from step 3.
2	Refer to "5.2.5 Encoder correction" to proceed with the axis operation to the position where the zeroing block can be inserted and to insert the zeroing block.	The work to be performed after motor replacement is made easier if the zeroing block is left inserted ahead of time. If the zeroing block cannot be inserted, start from step3.
3	Turn the Motors OFF first, and then turn OFF the power of the controller.	Never use zeroing pin to support wrist.
4	Disconnect the connectors (encoder and power) from the motor.	Bear in mind that the encoder data will be lost when the encoder connector is disconnected.



STEP	Required work	Checkpoints
5	Dismount the motor from the robot by removing the following bolts. **4-M8X30**  (Supplement) In some cases, it may be difficult to pull the motor out from the wrist unit because of a sheet packing (seal) that is tightly adhering to the motor flange. In this case, the motor can be pulled out by releasing the brake of the motor and rotating motor itself to tear the sheet packing off.	• Do not to apply excessive impact to the motor shaft. To release the brake, add DC24V voltage between pin A and pin B in the CNMB* connector. (A:+24V, B:0V) 
6	Follow the steps below to remove the gear attached to the motor shaft. (a) Remove the gear from the motor shaft by removing the following bolts (inner side) **J4 : 5-M5X15**  	• Do not to apply excessive impact to the motor shaft.

STEP	Required work	Checkpoints
7	Attach the gear, which was removed, to the new motor. (a) Attach the gear to the motor shaft using the following bolts. At this point, apply one or two drops of locking agent (ThreeBond 1374) to the threads at the ends of the bolts, and then tighten the bolts. **J4 axis : 5-M5X15 (Tightening torque : 8.1 N·m)**	• Clean the shaft of the new motor. (Remove dusts, redundant oil, etc.) • Do not to apply excessive impact to the motor shaft. • Be absolutely sure to use the torque wrench to attach the bolts. Then tighten bolts gradually & uniformly using a torque wrench. 
8	Apply the appropriate amount of grease (LONGTIME PD2) to the gear teeth (enough to cover the teeth), and attach the motor to the robot using the following bolts. **4-M8X30 (Tightening torque : 30.4 N·m)**	• Be absolutely sure to use the torque wrench to attach the bolts. Then tighten bolts gradually & uniformly using a torque wrench. • Take care not to damage the gear teeth. • If the seal of the motor flange is damaged, please replace it.
9	Connect the connectors (encoder and power) to the motor.	
10	Perform encoder reset on the axis concerned. (☞ "5.2.4 Encoder reset ")	
11	Perform encoder correction the axis concerned. (☞ "5.2.5 Encoder correction ")	• If a motor has been replaced in a posture that prevents the zeroing block from being inserted, proceed with encoder reset and encoder correction to enable axis operation, and then once more move the axis to the position where the zeroing block can be inserted, and proceed with encoder reset and encoder correction again.
12	Remove the zeroing block. And attach the cover using the bolts (2-M8).	• Bear in mind that performing an axis operation by mistake without removing the zeroing block may deform the block and/or the attachment bracket for the zeroing block and make it impossible to remove the block and implement encoder correction properly in the future. • If the zeroing block cannot be removed, move the axis a little at a time at manual speed 2, and then remove the block.
13	Ensure that robot operation presents no problem.	

This now completes the J4 axis motor replacement.

5.2.4 Encoder reset

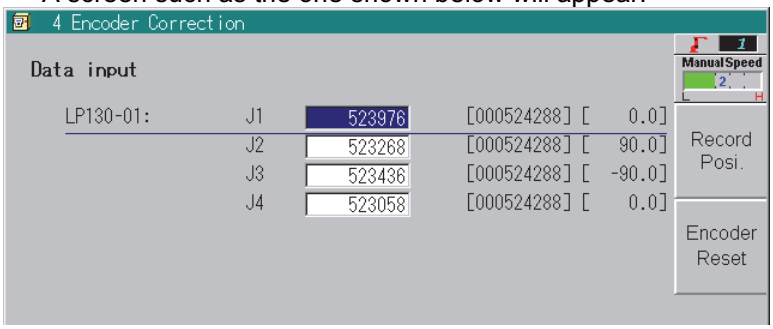
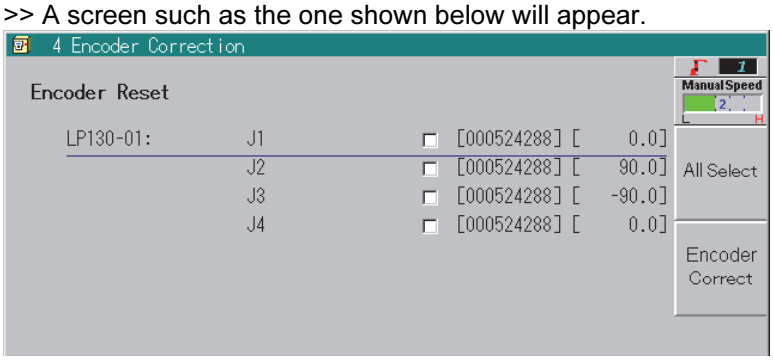
When encoder data has been corrupted due to some problem or motor replacement it is necessary to reset an encoder and compensate for any offset between actual encoder position and pin (reference) position. In cases like this, encoder reset must be performed first so follow the steps below to initiate encoder reset.

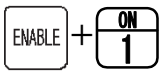
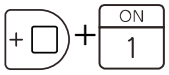
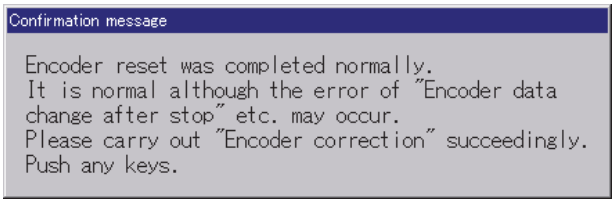
WARNING	The encoder data will be initialized when encoder reset is performed so the robot will no longer move properly. Upon completion of encoder reset, therefore, be absolutely sure to use the zeroing pin / zeroing block to perform encoder correction. If the work program is played back without encoder correction having been performed correctly, the robot may act incorrectly so that the operator may be caught or sandwiched by the robot parts, possibly resulting in death or serious injury.
CAUTION	After performing the motor connections, the following errors may arise due to the discharge of the super capacitor inside the encoder. (Example: In cases where, for instance, a new motor whose super capacitor is charged has been connected) E0050: Encoder counter overflow/underflow E0052: Encoder battery charge low In a case like this, supply power to the controller for at least 10 minutes, and then reset the encoder. After this, turn the controller power off and then back on to restore the normal state.

Encoder reset procedure

Tools required

No special tools are necessary for encoder rest procedure.

	1	After supplying the power to the controller for at least 10 minutes, proceed with the following procedures.
	2	Select [Teach] mode.
	3	Switch the operator class to ***EXPERT*** or higher.
	4	Select [Constant Setting] [3 Machine Constants] [4 Encoder Correction]. >> A screen such as the one shown below will appear. 
	5	Press f9 [Encoder Reset]. >> A screen such as the one shown below will appear. 

AX  FD  	6	Align the cursor with the axis for which encoder reset is to be performed, and press [ENABLE] + [ON/1]. >> The check mark for the axis concerned is now set to ON.  Point • To clear the check mark, press [ENABLE] + [OFF / 2]. • To set the check mark for all the axes at the same time, press f8 [All Select].
 	7	After the axes have been selected, press f12 [Execute]. >>The following message will be displayed by axis for which the checkmark is placed. Then, press the [OK].  Encoder resetting will be executed.
	8	If the encoder reset is normally complete, the following message will be displayed. 

This now completes the encoder reset procedure. Refer to the next section, and proceed with "Encoder correction".

5.2.5 Encoder correction

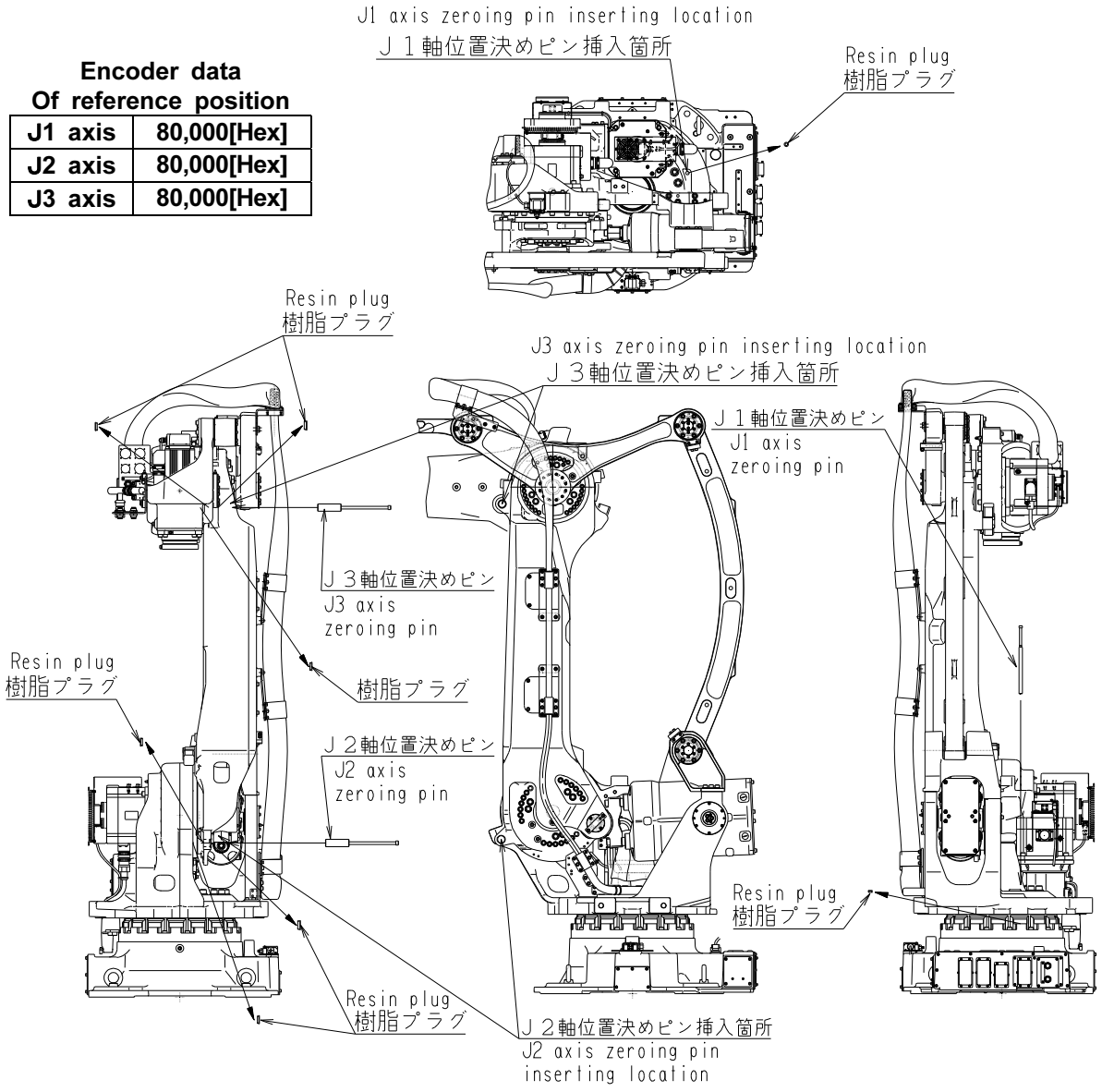
After performing encoder reset procedure, encoder correction must be implemented. This is to registering the “encoder correction value” so that encoder data becomes the pre-determined value at the pre-determined position (this is called **reference position**, zeroing pin / block can be inserted here).

IMPORTANT	**Reference position** (zeroing pin / block position) and its encoder data are explained in following pictures. These encoder data are very important to check the successful procedure of encoder correction.

[LP130-01] [LP180-01] [LP210-01]

Encoder data Of reference position

J1 axis	**80,000[Hex]**
J2 axis	**80,000[Hex]**
J3 axis	**80,000[Hex]**

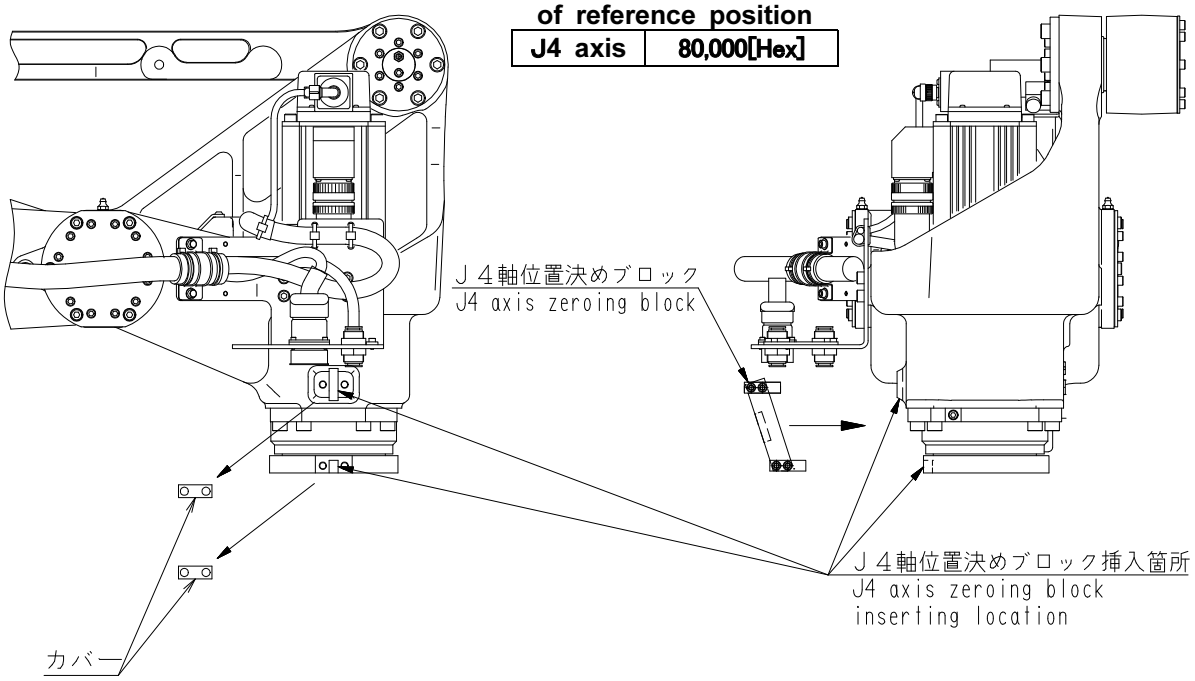


Reference position of J1,J2,J3 axis (Zeroing pin position)

[LP130-01] [LP180-01] [LP210-01]

Encoder data of reference position

J4 axis	**80,000[Hex]**



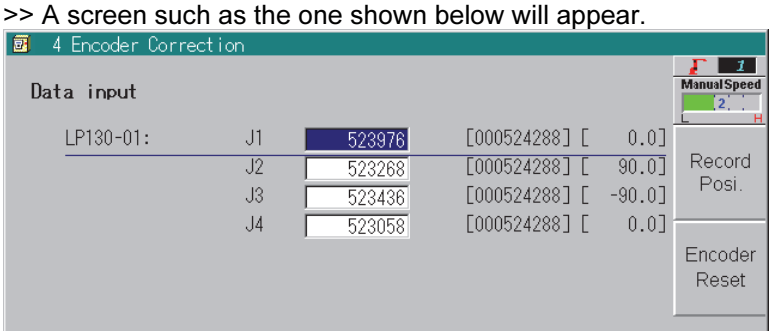
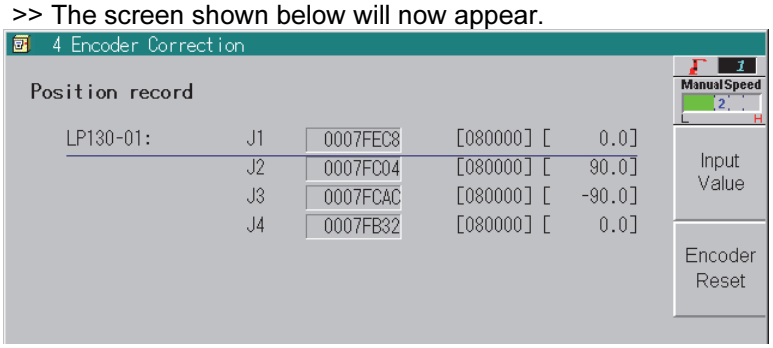
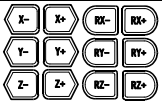
Reference position of J4 axis (Zeroing block insertion position)

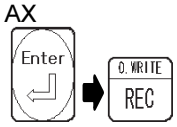
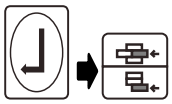
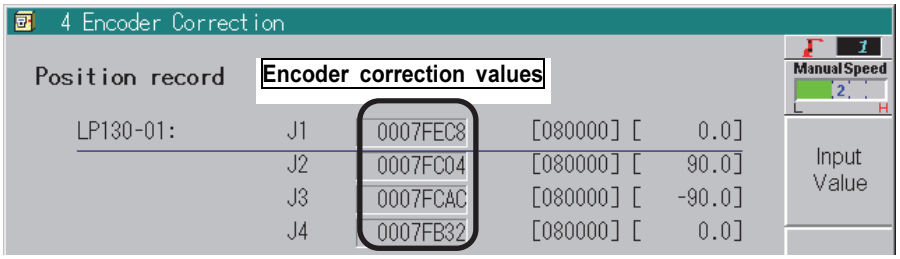
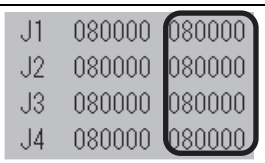
CAUTION	In cases where a motor has been damaged while the robot was moving, for instance, it may be necessary to replace the motor and implement encoder reset **at a position where the zeroing pin/zeroing block cannot be inserted**. In such a case, an error may occur during axis operation, making it impossible to move the robot any further. At times like this, robot movement can be resumed by provisionally implementing encoder correction at the position concerned so move the axis to the position where the zeroing pin / zeroing block can be inserted, and proceed with encoder reset and encoder correction again.
CAUTION	If encoder correction of J2 and J3 axes were performed in wrong position (that is not the reference position) J3 angle limitation between the ground can not be correctly checked. Unexpected collision may occur between the wrist (wrist attitude is kept) and J3 axis and this may cause the serious damage to the robot arm.
WARNING	Some of this work is done while power is supplied to the motor. Therefore, perform pinning in pairs. One person must stand guard and ready to press an emergency stop button. The other person must work quickly and carefully within the robot operating area. An escape route should be determined before starting pinning work. If these actions are neglected, the robot may act incorrectly so that the operator may be caught or sandwiched by the robot parts, possibly resulting in death or serious injury.
CAUTION	Before performing axis operations, be absolutely sure to remove the zeroing pins/ zeroing block. Performing axis operation with the zeroing pins / zeroing block still in place may bend the pins/block, damage the pin holes / attachment bracket for the zeroing block or cause other problems. Bear in mind that if any of these problems has arisen, it will no longer be possible to perform encoder correction accurately and corrections will have to be made to the work program.

Encoder correction procedure

Tools required

For this procedure, zeroing pin and block (OP-T2-*** ; option) is necessary.
Please prepare these tools by referring to “Chapter 6 Recommended Spare Parts and Special Tools for Maintenance”.

	1	Select the [TEACH] mode, and turn the Motors ON.
	2	Switch the operator class to ***EXPERT*** or higher.
	3	Select [Constant Setting] [3 Machine Constants] [4 Encoder Correction]. >> A screen such as the one shown below will appear. 
	4	Press the f8 [Record Posi.] key. >> The screen shown below will now appear. 
	5	As for J1,J2 and J3 axis Remove the resin plug in the zeroing pin insertion hole. As for J4 axis Remove the covers for the zeroing block installation.
	6	Move the axis at manual speed 2 or 3 to the reference position, and insert the zeroing pin in the pin hole (for J1,J2,J3) or insert the zeroing block in the attachment bracket (for J4). At this point, the encoder correction value is still incorrect so exercise sufficient caution in operating the robot. **(Caution)** **At this point, J3 angle limitation between the ground can not be correctly checked. Unexpected collision may occur between the wrist and J3 axis, and this may cause the serious damage to the robot arm. Please operate robot carefully.**

AX  FD 	7	Align the cursor with the axis whose reference position is adjusted (zeroing pin / zeroing block is inserted), press the [ENTER] key followed by the [O.WRITE/REC] key. >> The [Encoder correction value] is now adjusted so that the current machine position will be set as the **encoder data of reference position**.  If encoder correction is required for other axes as well, repeat steps 5) and 7) for the axes concerned.
	8	Upon completion, remove the zeroing pin and zeroing block. Attach the resin plug and the cover which covers the zeroing block attachment points to its original position.
	9	Press the Emergency Stop button on the teach pendant to turn OFF the motor power.
 	10	Press f12 [Complete]. >> The adjusted encoder correction value is saved in the internal memory. **(Caution)** **Until [Complete] is pressed, the encoder correction value will not be saved into the internal memory. This point should be borne in mind.**
 	11	Using [Service Utilities] [2 Monitor 1] [1 Axis Data Monitor], check that the current value of the axes for which encoder correction was performed is **encoder data of reference position.** 

This now completes the encoder correction procedure. After checking that the zeroing pin and zeroing block have been removed, move the axes by operating them manually to check that their movements are problem-free.

5.3 Encoder replacement

Since encoder is separated from motor on all axes of this robot, the encoder is replaceable.
This section describes the procedure when the robot is in good posture where encoder can be replaced.

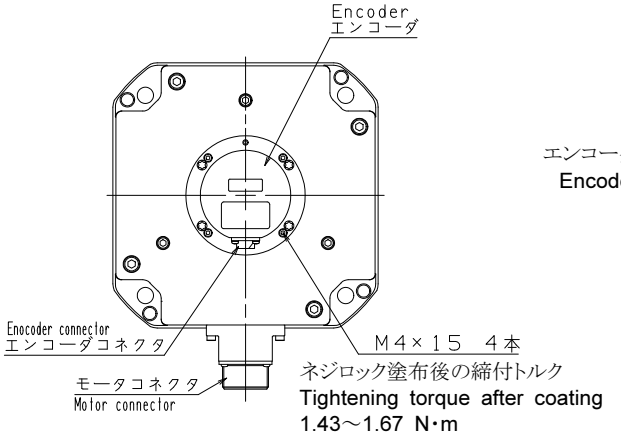
Tools Required (Prepared by customer)

Part name	Axis	Part No. (Model)	Remark
Torque wrench	J1,J2,J3	M4 torque wrench	*2
Torque screwdriver	J4	M3 torque screwdriver	which meets the tightening torque of 0.59 to 0.88 N·m
		M3 setscrew torque screwdriver	which meets the tightening torque of 0.59 to 0.88 N·m
Locking agent	All axes	Threebond 1374	

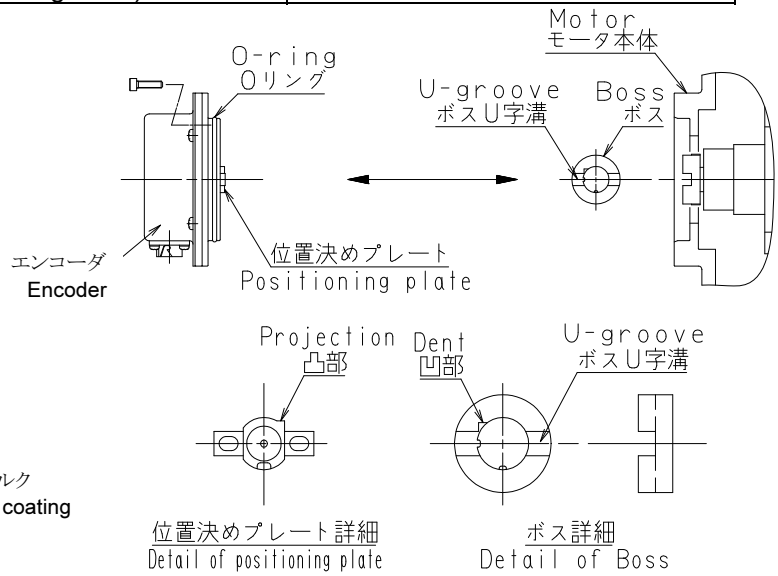
It is rarely difficult to insert tool due to the robot posture.
In this case, replace the whole motor unit by referring to “5.4 Motor Replacement”.

Encoder replacement procedure (J1,J2,J3 of LP130/180 and J1,J2 of LP210)

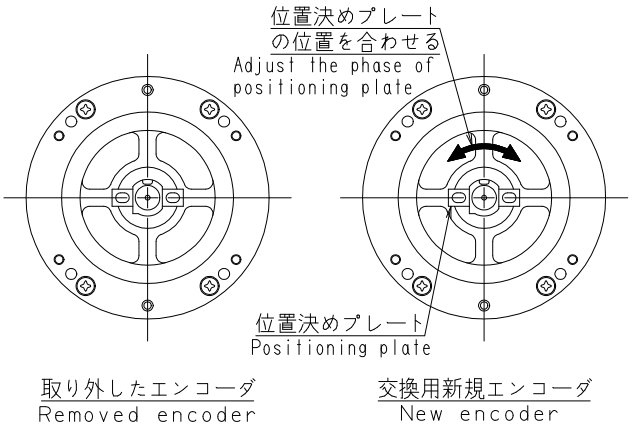
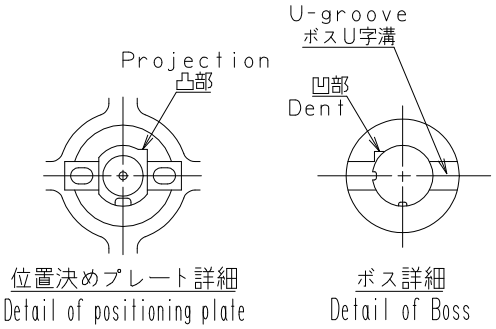
STEP	Required work	Checkpoints
1	Turn ON the primary power of the controller, select the TEACH mode, and turn Motors ON.	If the Motors cannot be turned ON or axis operations cannot be performed due to an abnormality, start the procedure from step 3.
2	If axis operations can be performed, refer to "5.2.5Encoder correction" to proceed with the axis operation to the position where the zeroing pin can be inserted, and to insert the zeroing pin.	The work to be performed after encoder replacement is made easier if the zeroing pins are inserted ahead of time.
3	After making Motors OFF status, turn OFF the primary power supply of the controller.	
4	Disconnect the encoder connectors.	
5	Remove two encoder plug cover. Refer the following drawing. ☞ Refer to “5.2.1Motor replacement (J1,J2,J3 of LP130/180 and J1,J2 of LP210)” step 6 drawing.	
6	Dismount the encoder from the motor. (a) Dismount the encoder cover by removing the following bolts. **J1,J2,J3 4-M4X15** (b) Pull out the encoder unit straightly. Do not rotate the encoder unit while pulling out it. (Remove the boss and the encoder together.)	

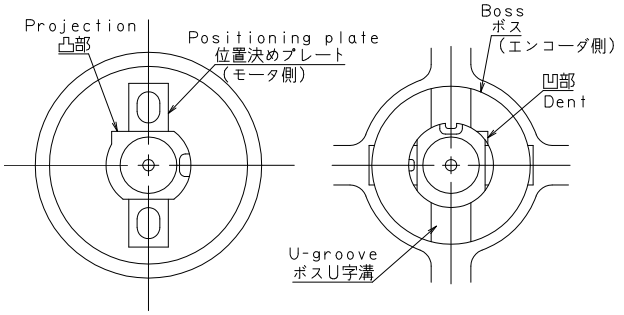
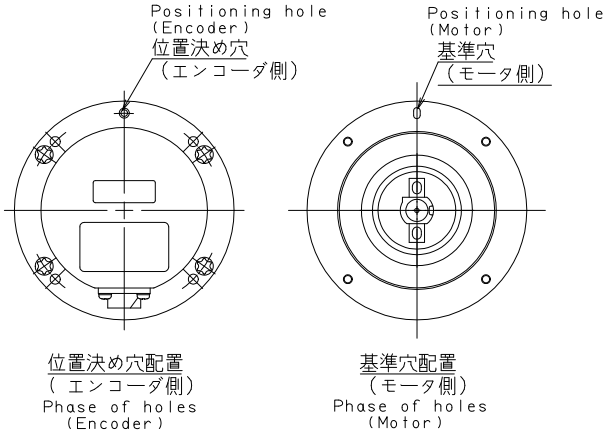
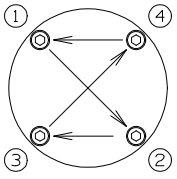


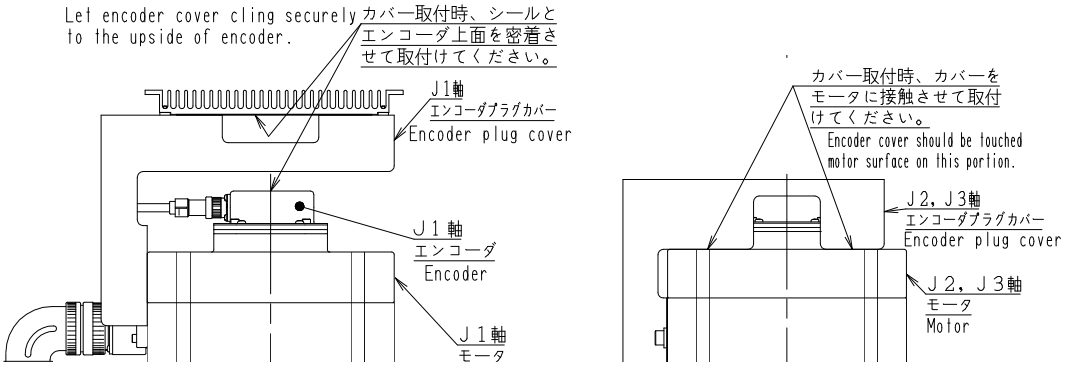
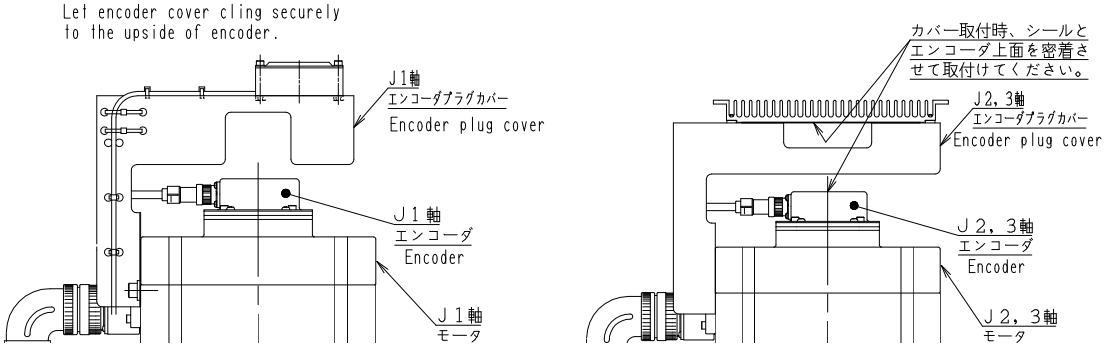
Outline of the encoder unit



Encoder removal

STEP	Required work	Checkpoints
7	Attach the boss to the encoder aligning the phase of .the positioning plate. (a) Remove the boss from the encoder unit that was pulled out from the motor. (b) Adjust the angle of the positioning plate of the new encoder so that the angle becomes the same with that of the old encoder.  Adjusting the angle of the positioning plate (c) Attach the boss to the encoder unit matching its angle to the positioning plate.  Attaching the boss to the encoder	If the boss is sticking to the motor shaft, remove it from the shaft.

STEP	Required work	Checkpoints
8	Fix the encoder to the motor. (a) After aligning the direction of the motor connector and the encoder connector, insert the encoder unit so that the U-groove of the boss and the positioning plate shape fit in each other and the projection portion and the dent of the boss also fit in each other.  Positioning plate, and the boss (b) Insert the positioning pin (attached to the encoder unit) into the positioning hole on the encoder unit and then rotate the angle of the encoder to left/right a little so that the edge of the pin goes thorough to the positioning hole on the motor side  Positioning holes (c) With the positioning pin is inserted, fix the encoder unit to the motor with the following bolts. Concerning the position of the bolts. **J1,J2,J3** **4-M4X15 (Tightening torque : 1.43 to 1.67 N･m)** After tightening the bolts, pull out the positioning pin.	Pay attention not to damage the O-ring of the encoder when installing the encoder unit. If the positioning pin enters the positioning hole on the motor side, the angle of the encoder unit will be locked. Confirm that the angle is securely locked. • At this point, apply one or two drops of locking agent (ThreeBond 1374) to the threads at the ends of the bolts, and then tighten the bolts. • Be absolutely sure to use the torque wrench to attach the bolts. Then tighten bolts gradually & uniformly using a torque wrench. 

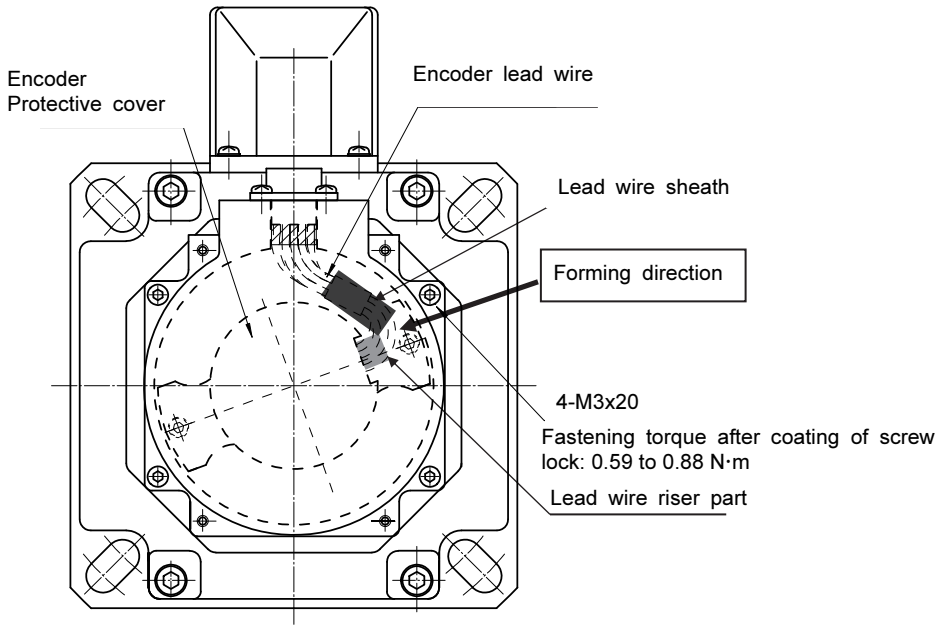
STEP	Required work	Checkpoints
9	Attach the removed encoder plug cover to the new motor. **J1,J2,J3** Attach the encoder plug cover with the following bolts. At this point, apply one or two drops of locking agent (ThreeBond 1374) to the threads at the ends of the bolts, and then tighten the bolts. **2-M8X15 (Tightening torque : 22.8 N･m)** **2-washers for M8** **[Robots shipped on July 2012 or before]**  **[Robots shipped on August 2012 or after]** 	
10	Connect the connector to the encoder.	
11	Perform encoder reset on the axis concerned. (☞ "5.2.4 Encoder reset ")	
12	Perform encoder correction the axis concerned. (☞ "5.2.5 Encoder correction ")	• If a motor has been replaced in a posture that prevents the zeroing block from being inserted, proceed with encoder reset and encoder correction to enable axis operation, and then once more move the axis to the position where the zeroing block can be inserted, and proceed with encoder reset and encoder correction again.
13	Ensure that robot operation presents no problem.	

CAUTION	If encoder correction of J2 and J3 axes were performed in wrong position (that is not the reference position) J3 angle limitation between the ground can not be correctly checked. Unexpected collision may occur between the wrist (wrist attitude is kept) and J3 axis and this may cause the serious damage to the robot arm. If angle limitation error occurs before inserting the zeroing pin, once perform encoder correction and proceed with encoder correction again.

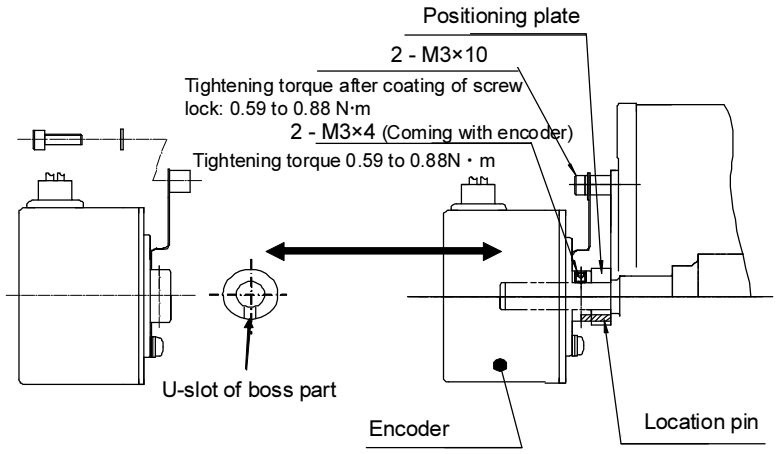
Now completes the encoder replacement for J1, J2, and J3.

Encoder replacement procedure (J4 of LP130/180/210 and J2 of PL210)

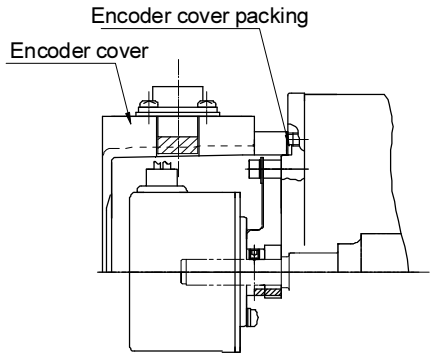
STEP	Required work	Checkpoints
1	Turn ON the primary power of the controller, select the TEACH mode, and turn Motors ON.	If the Motors cannot be turned ON or axis operations cannot be performed due to an abnormality, start the procedure from step 3.
2	If axis operations can be performed, refer to "5.2.5 Encoder correction" to proceed with the axis operation to the position where the zeroing block can be inserted, and to insert the zeroing block.	The work to be performed after encoder replacement is made easier if the zeroing block is inserted ahead of time.
3	After making Motors OFF status, turn OFF the primary power supply of the controller.	
4	Disconnect the encoder connectors.	
5	Remove the encoder unit from the motor. (a) Dismount the encoder cover removing the following bolts. **J4** **4-M3X20** (b) Remove the bolts that fix the encoder fixing spring. **2-M3X10** (c) Remove the two set screws that fix the encoder boss part, and then pull out the encoder assembly from the motor shaft. **2-M3X4**	At this time, dismount the encoder cover in order not to cause tension to the encoder lead wire.



Overview of the encoder unit (J4)



Dismounting of encoder unit



Cross-section of encoder cover

STEP	Required work	Checkpoints
6	Fix the encoder to the motor. (a) Insert the encoder so that the U-slot of the encoder boss part is aligned with the positioning pin on the motor side. (b) Insert the encoder until the encoder boss part hits the positioning plate of the motor shaft, and then torque the set screws of the boss part **2-M3X4 (tightening torque: from 0.59 to 0.88 N·m)** (c) Fix the encoder fixing spring by the following 2 bolts. **2-M3X10 (tightening torque: from 0.59 to 0.88 N·m)** (d) Form the lead wire riser part so that the encoder lead wire will follow the outer circumference of the protective cover. Then, with the sheath of the lead wire pulled to the riser part, put the encoder cover in place. After that, torque the following bolts. **J4** **4-M3X20 (tightening torque : 0.59 to 0.88 N·m)** **4-washers for M3**	For this purpose, be sure to use the new setscrews with screw lock that come with the encoder. At this time, apply one or two drips of locking agent (ThreeBond 1374) to the bolts. At this time, put the encoder packing in place.
7	Connect the connector to the encoder.	
8	Perform encoder reset on the axis concerned. (☞ "5.2.4 Encoder reset ")	
9	Perform encoder correction the axis concerned. (☞ "5.2.5 Encoder correction ")	
10	Ensure that robot operation presents no problem.	

Now completes the encoder replacement for J4 axis.

NOTE

Chapter 6 Recommended spare parts and special tools for maintenance

Recommended spare parts are listed below. To purchase any parts, check the manufacturing No. and date of the robot, and then contact our Service Department.

Classification A: Periodical maintenance parts B: Spare parts

Recommended spare parts

Classification	Name	Part No. (Model)	In use/unit	Recommended/unit	Robot model			Remark
					LP130-01	LP180-01	LP210-0	
A	GREASE	PM/W-16KG	—	1	○	○	○	MOLYWHITE RE No. 00 (*1)
A	GREASE	LONGTIME-PD2-18KG	—	1	○	○	○	Tribol GR 100-2 PD (*1) (*7) (Old name:LONGTIME PD2)
A	BATTERY	ER17505V-2C38	4	4	○	○	○	(*2)
A	BATTERY UNIT	KP-ZA-009	1	1	○	○	○	4pcs of battery (*3)
A	COVER SET	SP-CS-004	1	1	○ J1	○ J1	○ J1	
B	AC SERVO MOTOR	R2AA22500HCPF0	3	1	○ J1, 2, 3	○ J1, 2, 3	○ J1, 3	
B	AC SERVO MOTOR	MSMA302D7V3	1	1	○ J4	○ J4	○ J4	
B	AC SERVO MOTOR	MDMU602S2V3	1	1			○ J2	
B	ENCODER	PA035-017BC20L-S	3	1	○ J1, 2, 3	○ J1, 2, 3	○ J1, 3	(*4),(*8)
B	ENCODER	DVOP3560	1	1	○ J4	○ J4	○ J2, 4	(*4)
B	COUPLING GEAR SET	KP-ZH-239	1	1	○ J1	○ J1	○ J1	(*6)
B	COUPLING GEAR SET	KP-ZH-231	1	1	○ J2	○ J2		
B	COUPLING GEAR SET	KP-ZH-166	1	1			○ J2	
B	COUPLING GEAR SET	KP-ZH-230	1	1	○ J3	○ J3	○ J3	
B	COUPLING GEAR SET	KP-ZH-139	1	1	○ J4	○ J4	○ J4	
B	BJ1 UNIT ASSY	SP-BJ1-142	1	1	○	○		Cables from BJ1 to the fore arm (for the robots shipped on November 2012 or before)
B	BJ1 UNIT ASSY	SP-BJ1-177	1	1	○	○	○	Cables from BJ1 to the fore arm (for the robots shipped on December 2012 or after)
B	BJ3 UNIT ASSY	SP-BJ3-019	1	1	○	○	○	From the fore arm to the wrist unit
B	SEAL	037-0572-000	1	1	○	○	○	Sheet packing for battery unit fitting plate
B	FAN MOTOR ASSY	SP-E5-021	1	1	○	○		J1 axis motor cooling fan (*5) (for the robots shipped on November 2012 or before)
B	FAN MOTOR ASSY	SP-E5-022	1	1	○	○	○	J1 axis motor cooling fan (for the robots shipped on December 2012 or after)

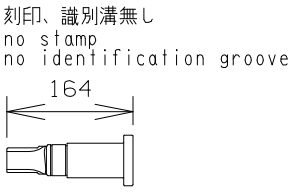
(*1) If MSDS (Material Safety Data Sheet) for chemical material such as grease is necessary, customer needs to require it to the chemical material supplier.
(*2) This battery is compatible with ER17/50H used before 2021 March.
In case of purchasing this in China, please order NSER18505-2. This is compatible with ER17/50H and ER17505V-2C38.
(*3) In case of purchasing this in China, please order KP-ZA-009CN. This is compatible with KP-ZA-009. When replacing all batteries in robot, please order battery unit which consists of all needed batteries.
(*4) When encoder cover is damaged, encoder itself may be damaged already. Please replace not only encoder cover but also encoder itself.
(*5) As for the robots shipped on July 2012 or before, this part is for the option OP-P6-004 (cooling fan).
(*6) This part is compatible both upper and lower with KP-ZH-109 that used to be shipped on February 2016 or before. After March 2016, only KP-ZH-239 is spare part to be shipped.
(*7) In this manual, this grease uses the old name LONGTIME PD2.
(*8) This encoder is compatible with PA035-017BC00L.

<Reference 1>
Following seals and O rings are necessary for the motor replacement procedure. “COUPLING GEAR SET” include these parts. This list is just the reference when ordering them individually.

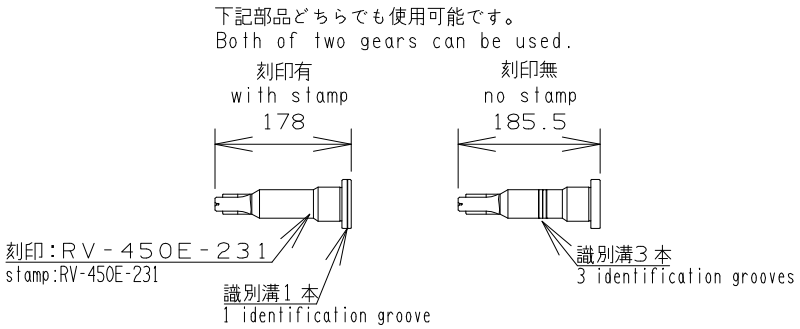
Usage	Name	Type	Notes
Sheet packing for J1 motor replacement	SEAL	037-0623-000	Applicable to all robot
Sheet packing for J2 and J3 motor replacement	SEAL	037-0566-002	
Sheet packing for J4 motor replacement	SEAL	037-0600-001	

<Reference 2>
These gears are included in COUPLING GEAR SET of J1-J3 axis. Please refer to the following notes to identify similar gears.

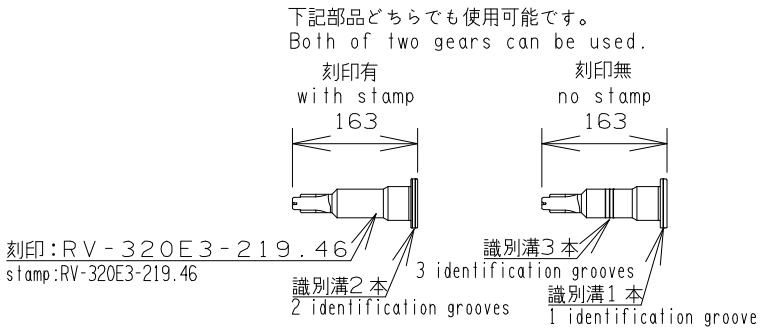
KP-ZH-239 (J1 axis)



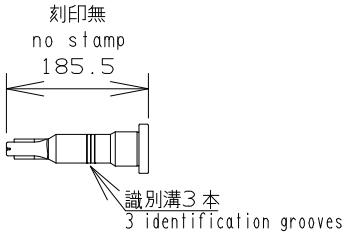
KP-ZH-231 (J2 axis)



KP-ZH-230 (J3 axis)



KP-ZH-166 (J2 axis)

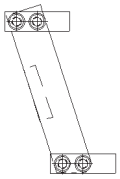


The fixtures listed below are required fixture for maintenance work or for efficient work.
When purchasing these tools, please contact to your local service center while confirming the robot manufacturing no. and manufactured date.

Special tools for maintenance (option)

Name	Part No. (Model)	Robot model			Remark
		LP130-01	LP180-01	LP210-01	
ACCESSORY	OP-T2-059	○	○	○	Zeroing pin & zeroing block
CONTROLLER	BCUNIT20-40	○	○	○	Bypass cable unit
H-AXIS FIX JIG SET	KP-ZD-004	○	○	○	J2 axis Fixing jig set

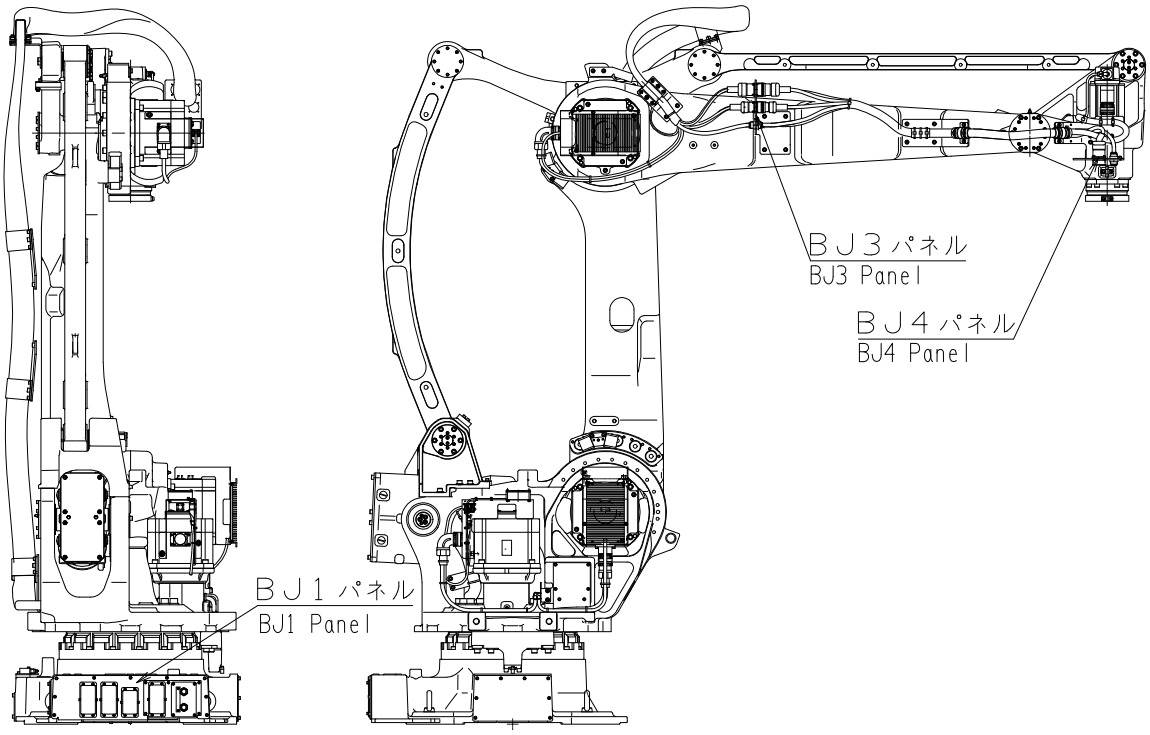
Contents of OP-T2-059 (Zeroing pin & zeroing block) (option)

Applied Robot model	Name	Marking	Appearance, etc
LP130-01 LP180-01 LP210-01	J1 Zeroing pin		
	J2,J3 Zeroing pin		
	J4 Zeroing block	LP J4	 Hex. socket head cap screw 4-M6X20

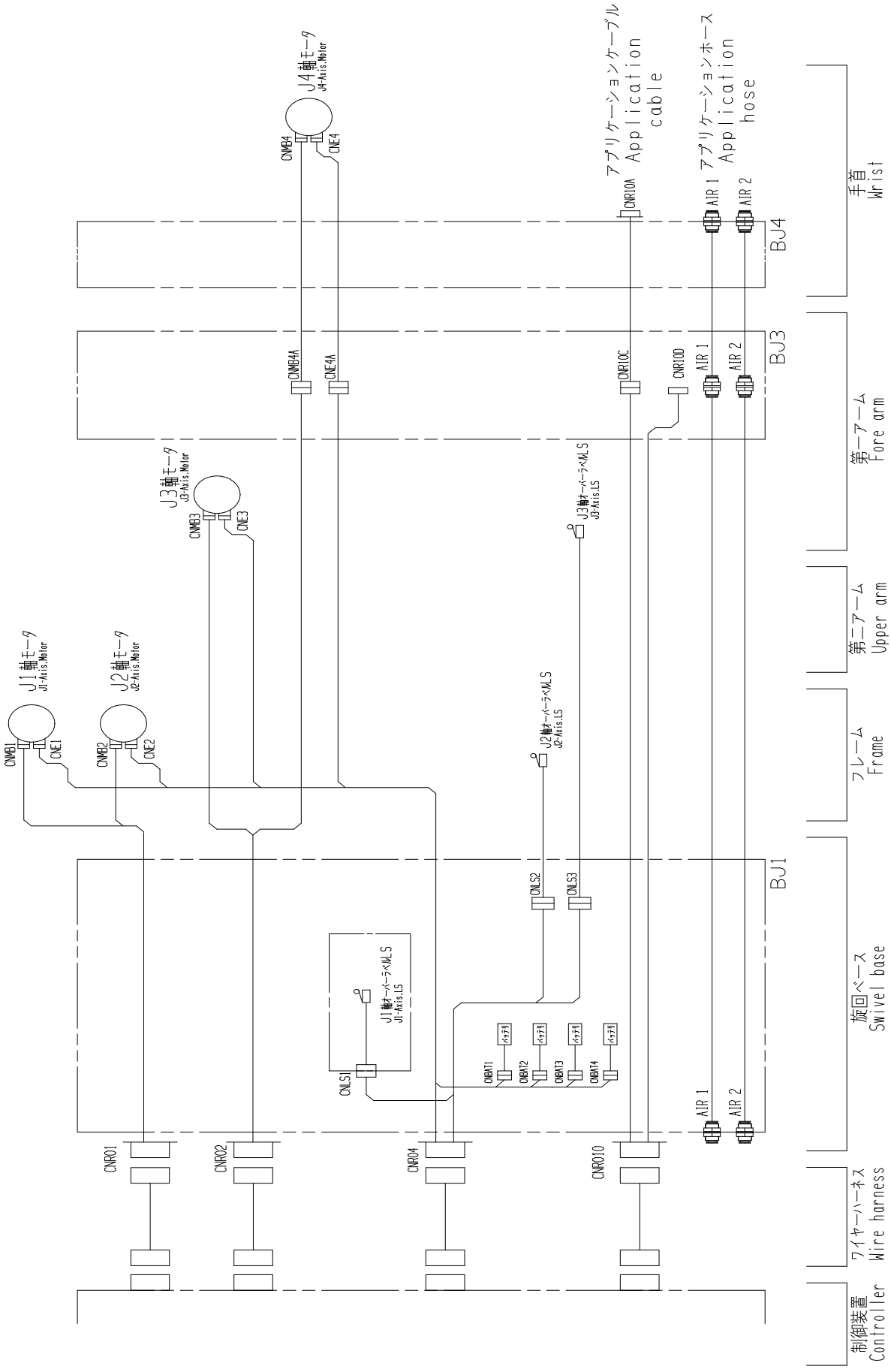
The tightening torque for M6 bolt is 13.8 N•m
These parts such as pins and blocks can not been purchased one by one.

NOTE

Chapter 7 Wiring diagrams

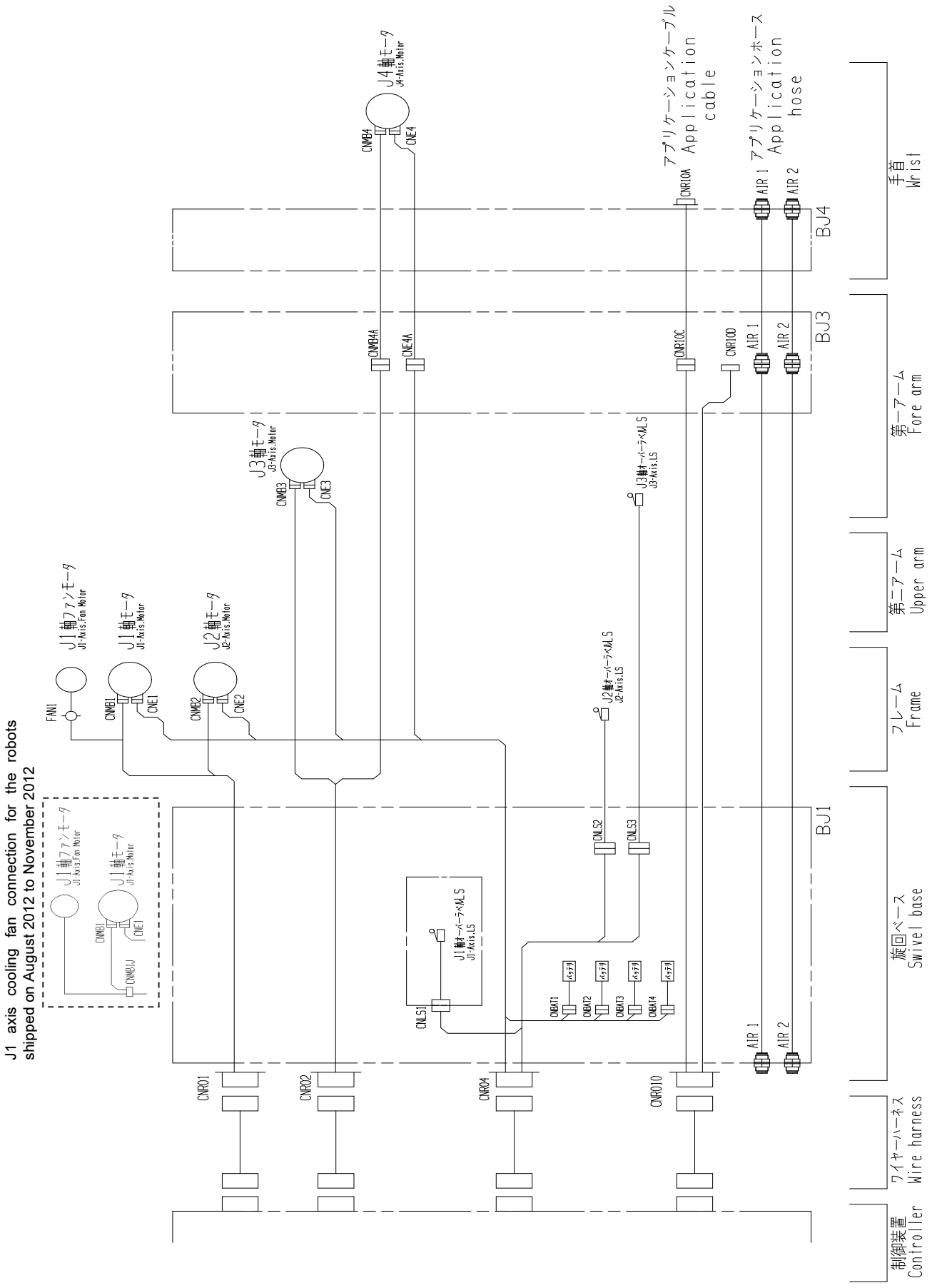


Robot parts layout



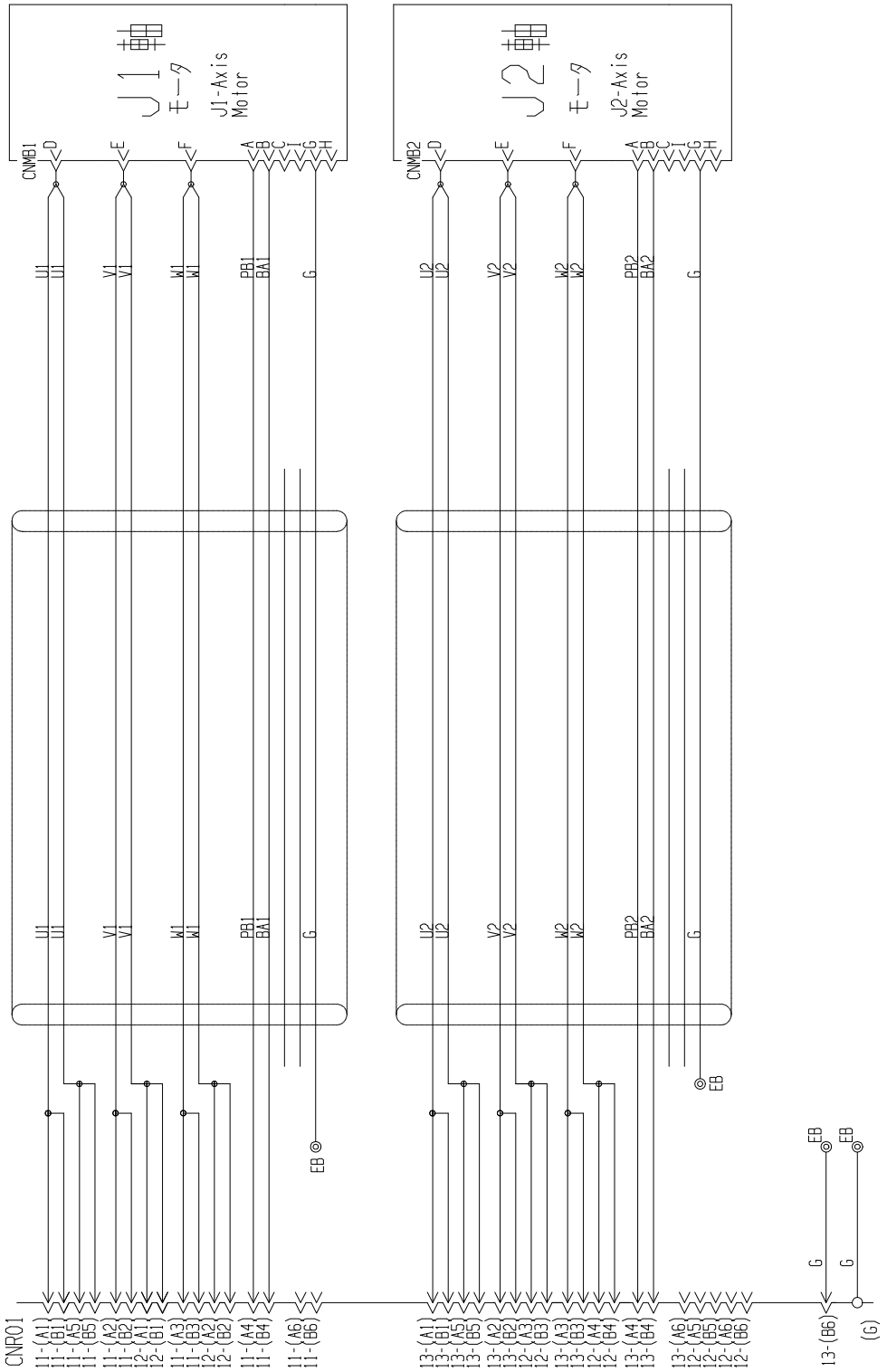
Wiring/piping connection diagram

[Robots shipped on November 2012 or before]

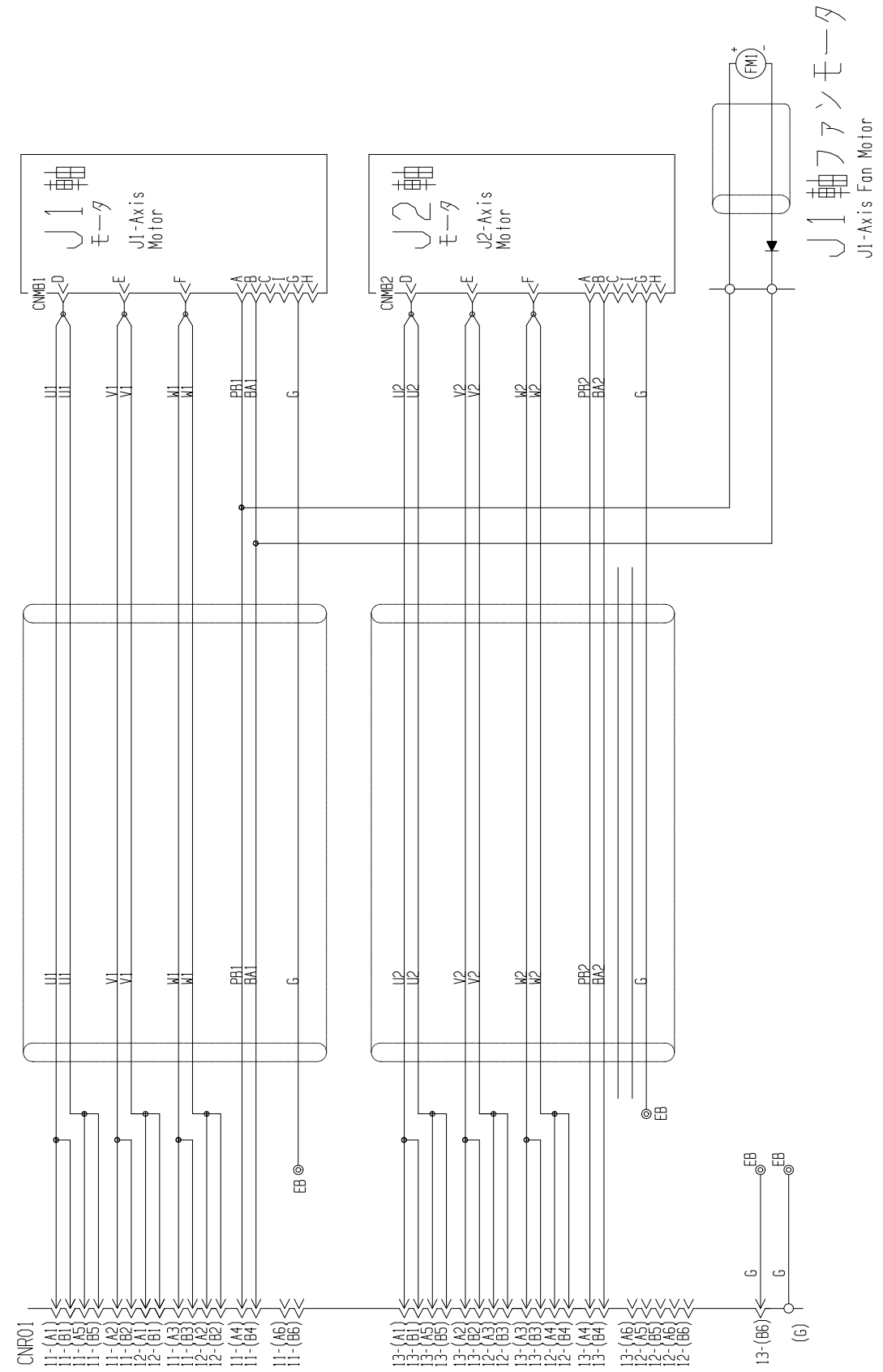


Wiring/piping connection diagram

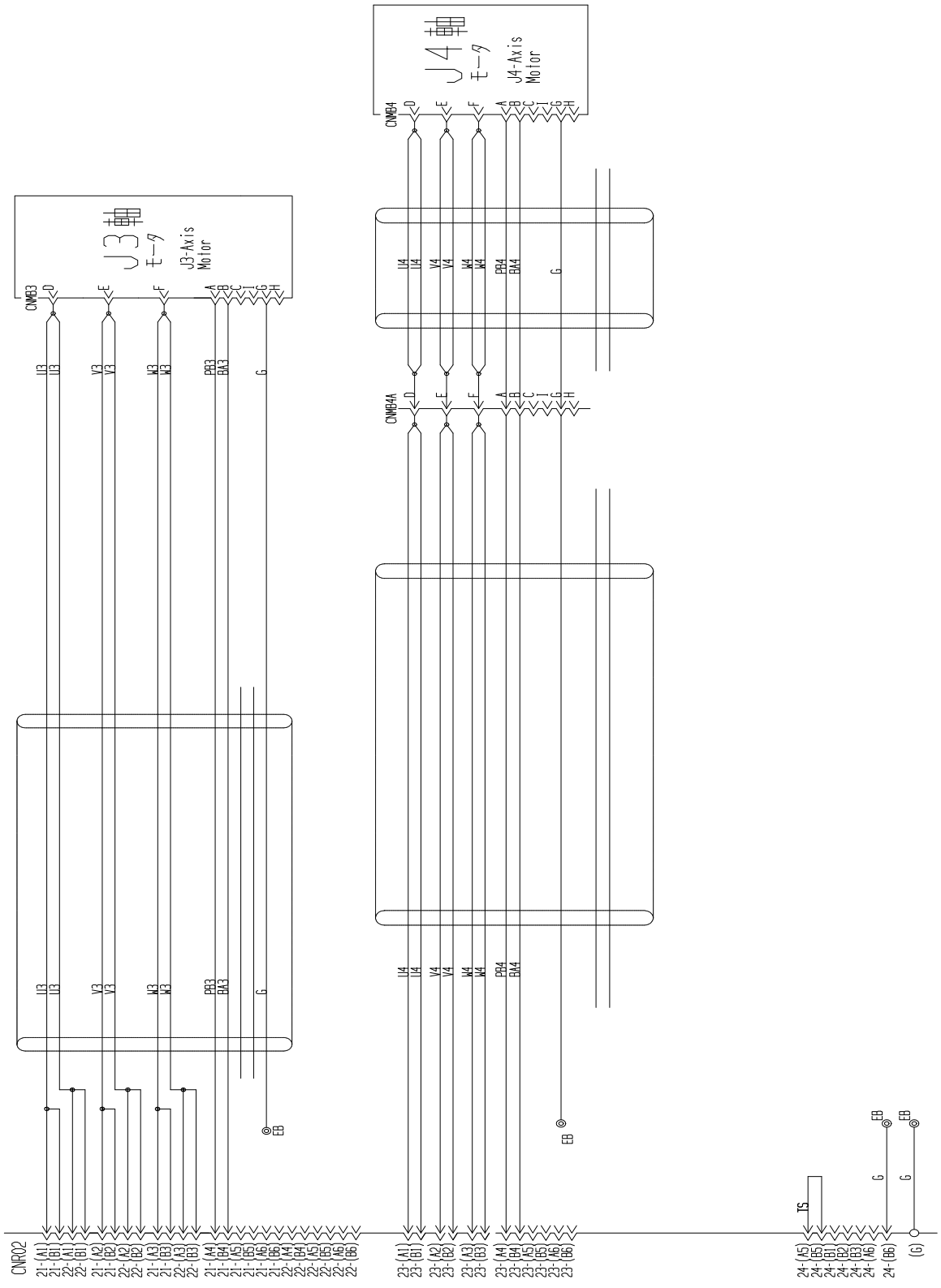
[Robots shipped on December 2012 or after]



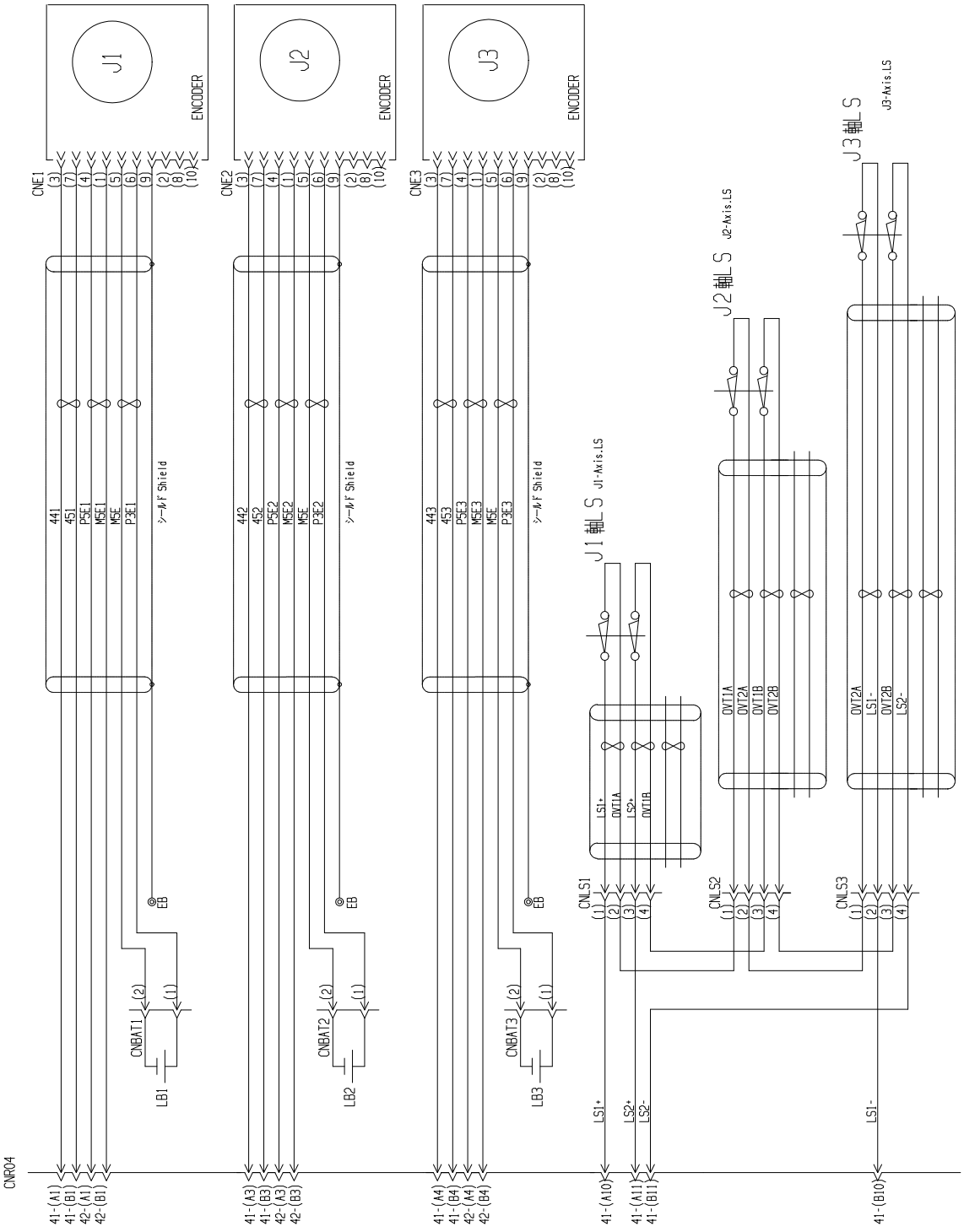
Wire connection diagram for motor and brake (1)
[Robots shipped on November 2012 or before]



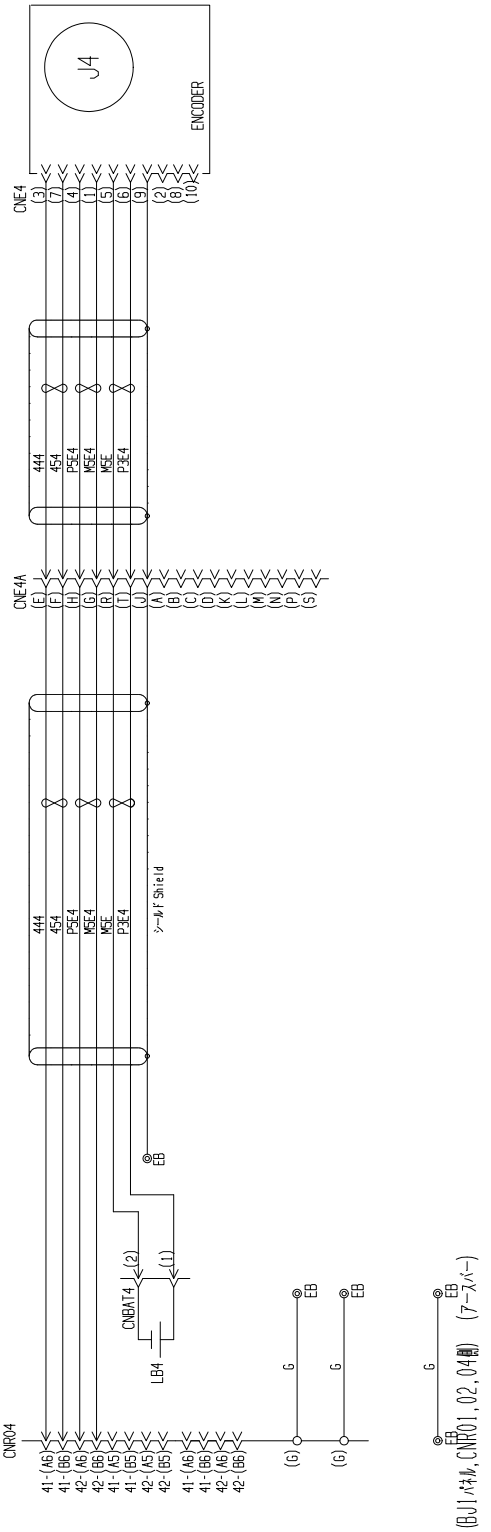
Wire connection diagram for motor and brake (1)
[Robots shipped on December 2012 or after]



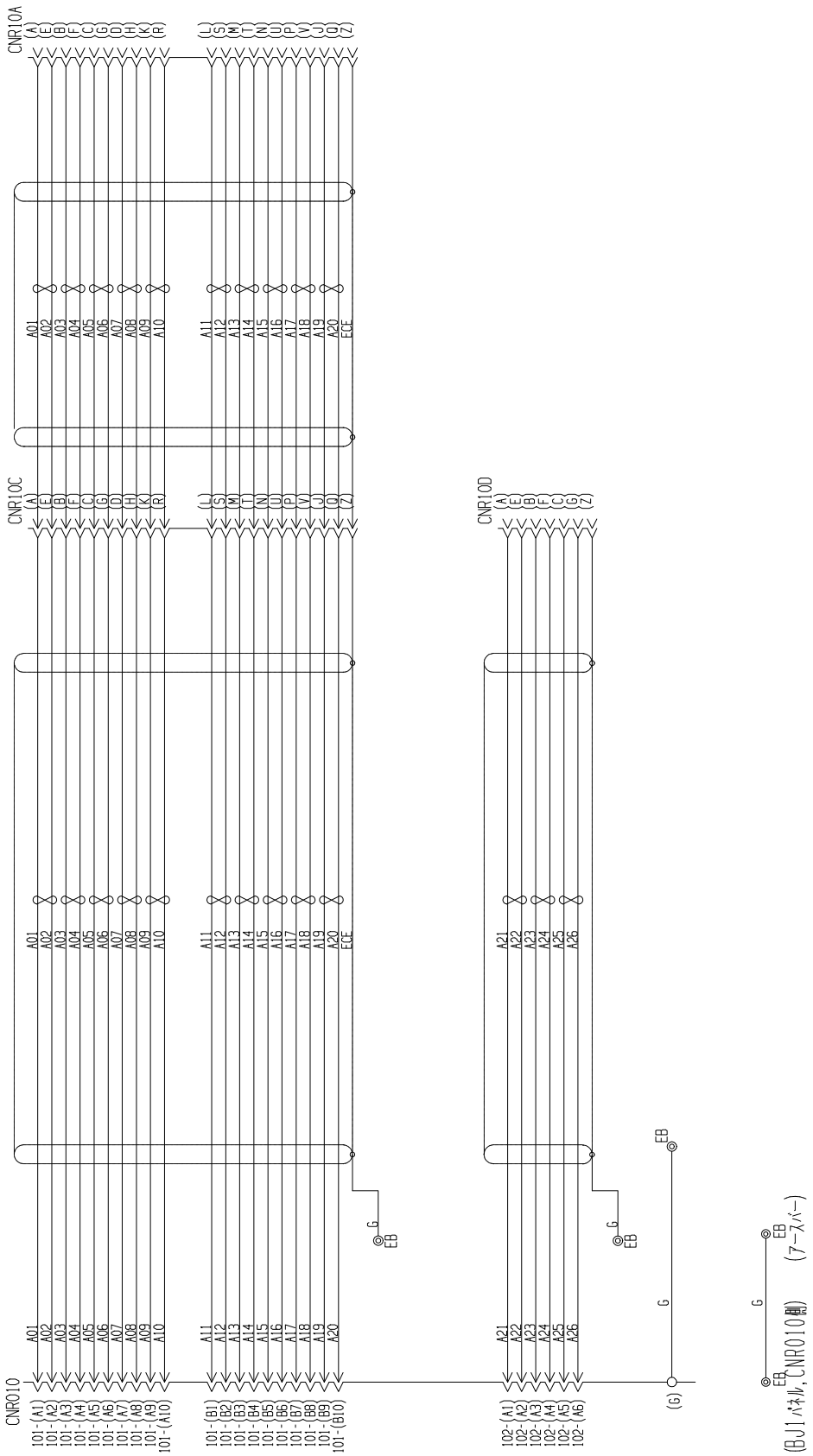
Wire connection diagram for motor and brake (2)



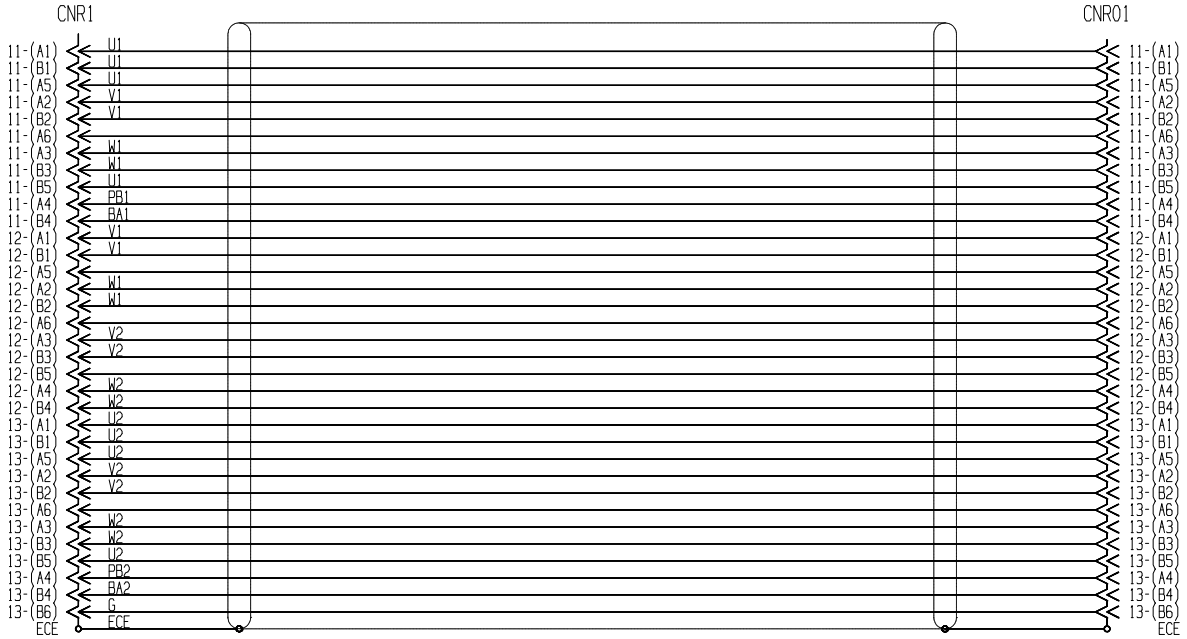
Wire connection diagram for encoder (1)

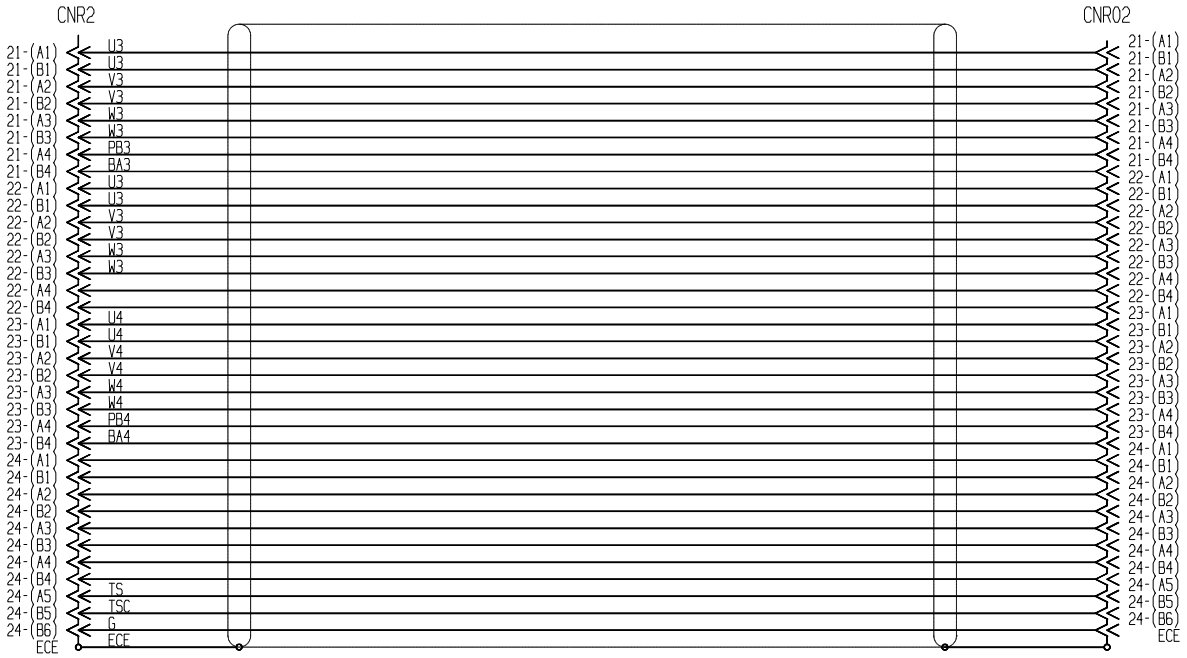


Wire connection diagram for encoder (2)

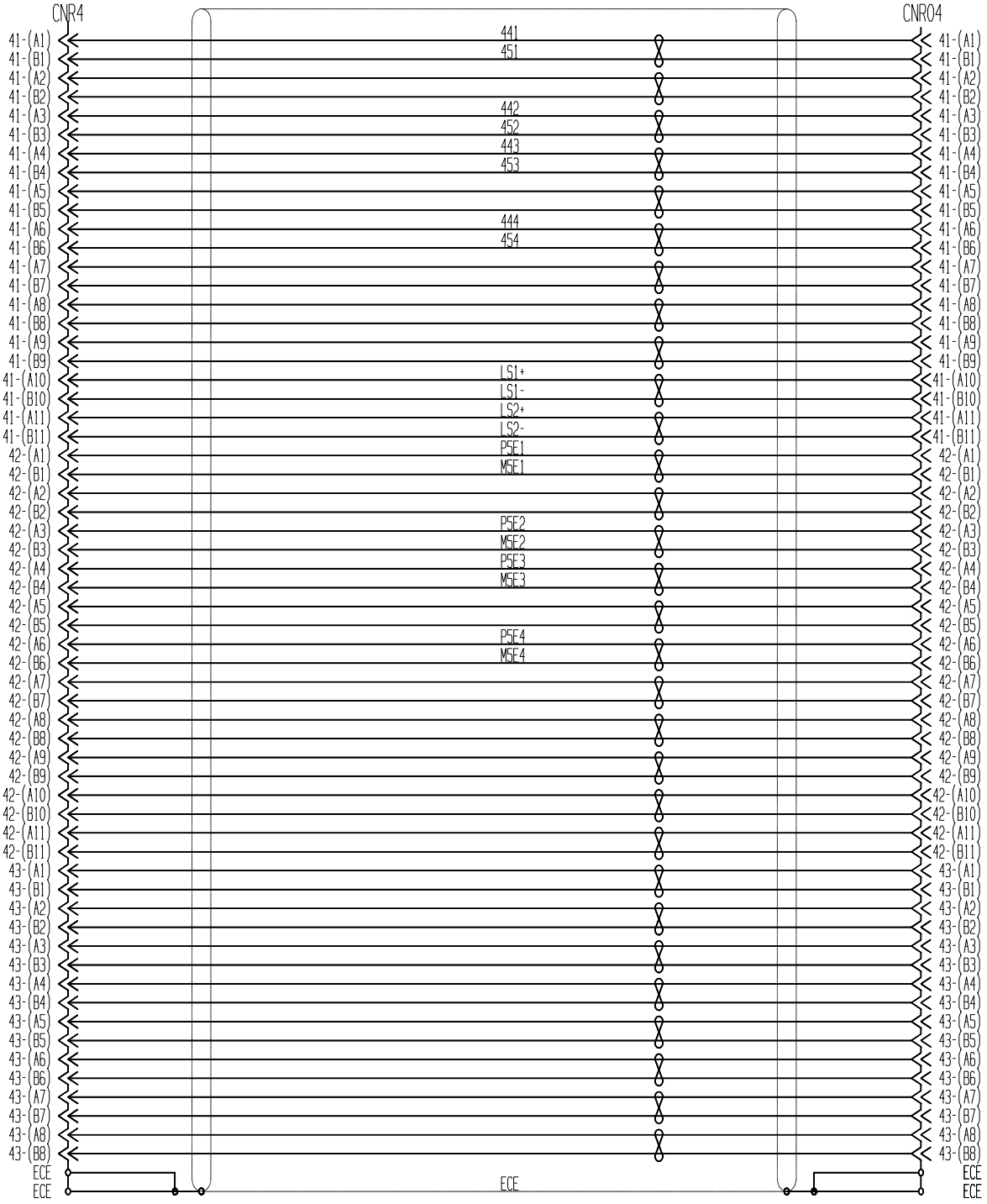


Wire connection diagram for application

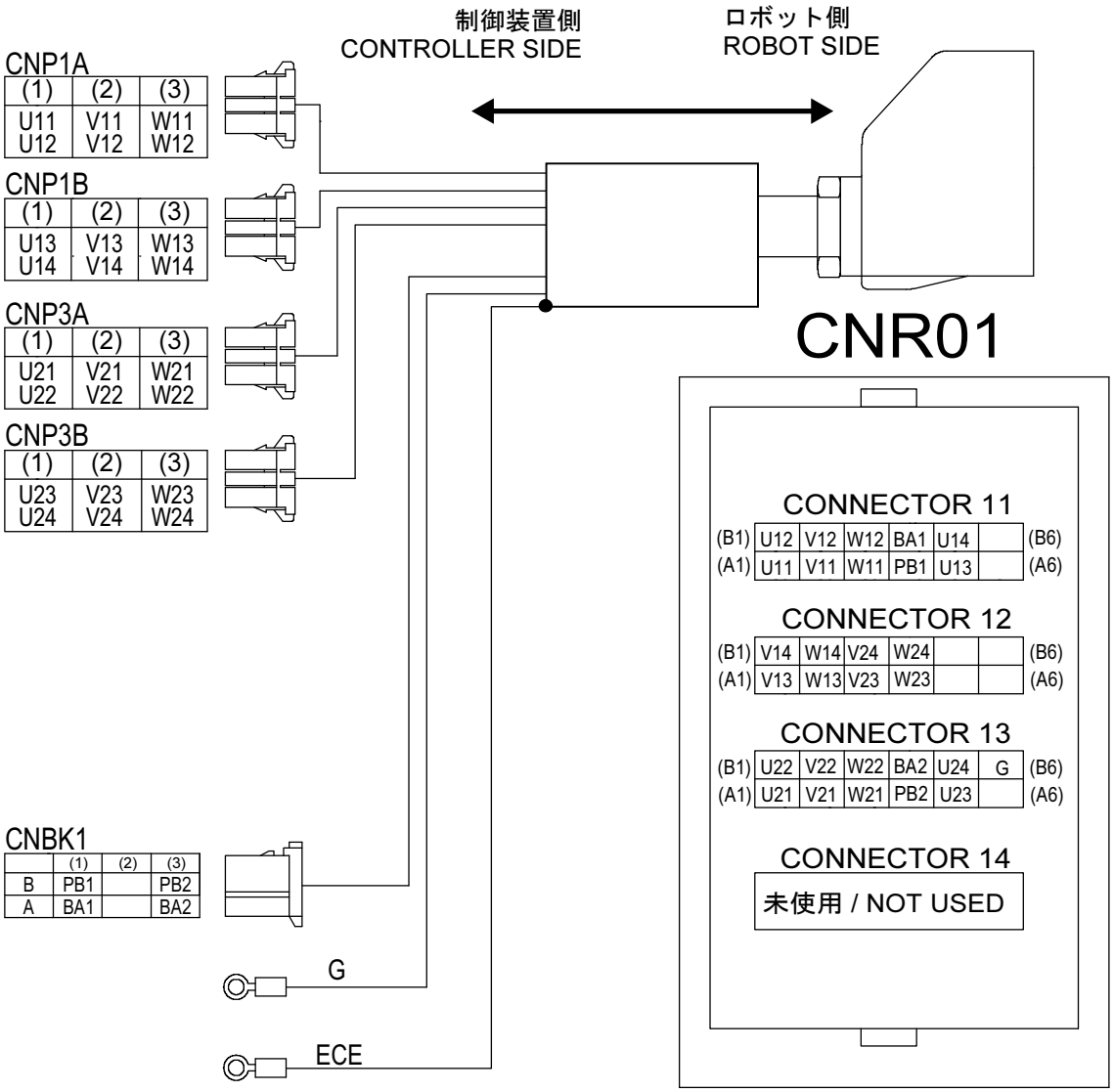




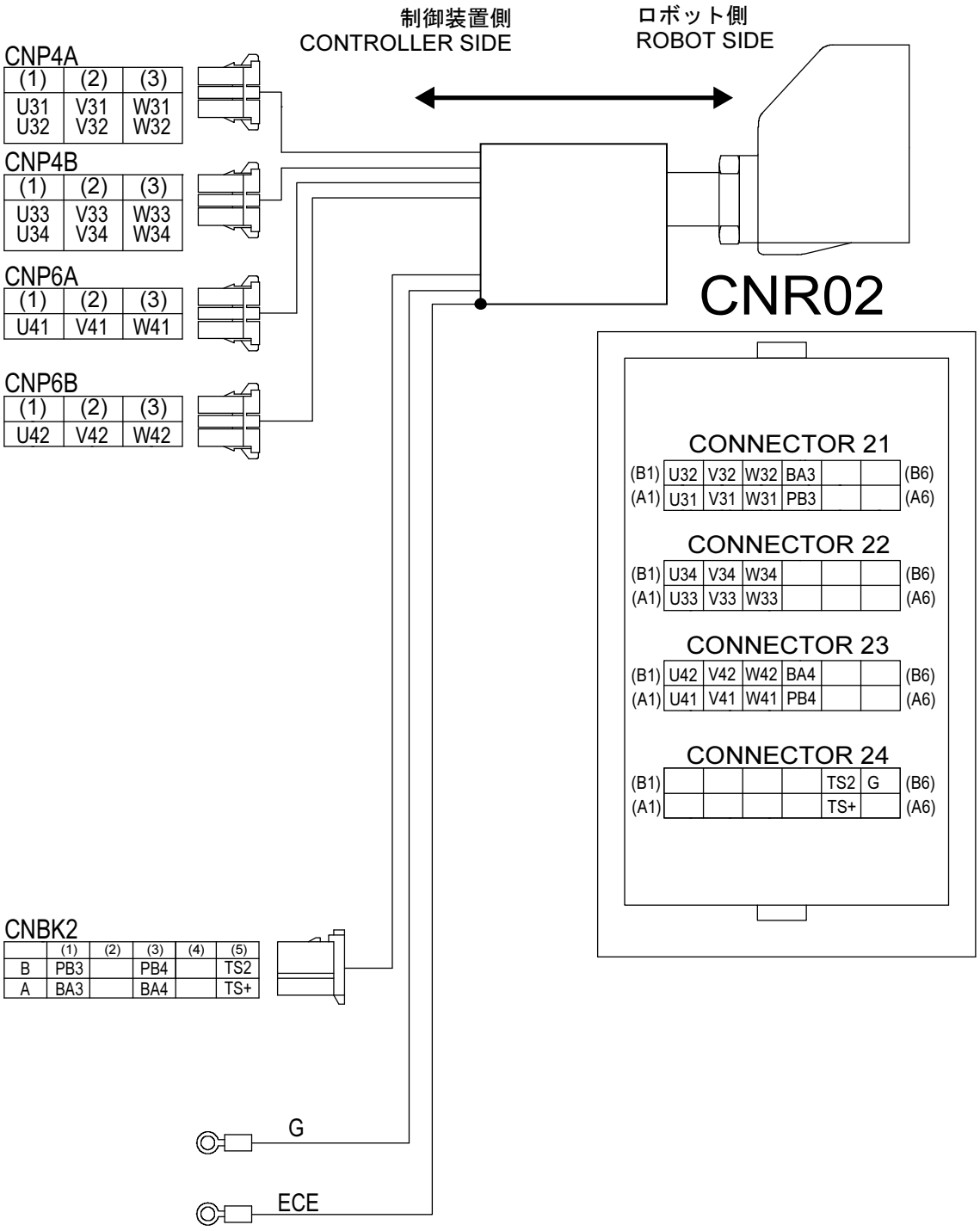
AX20 controller Wire harness connection (1)



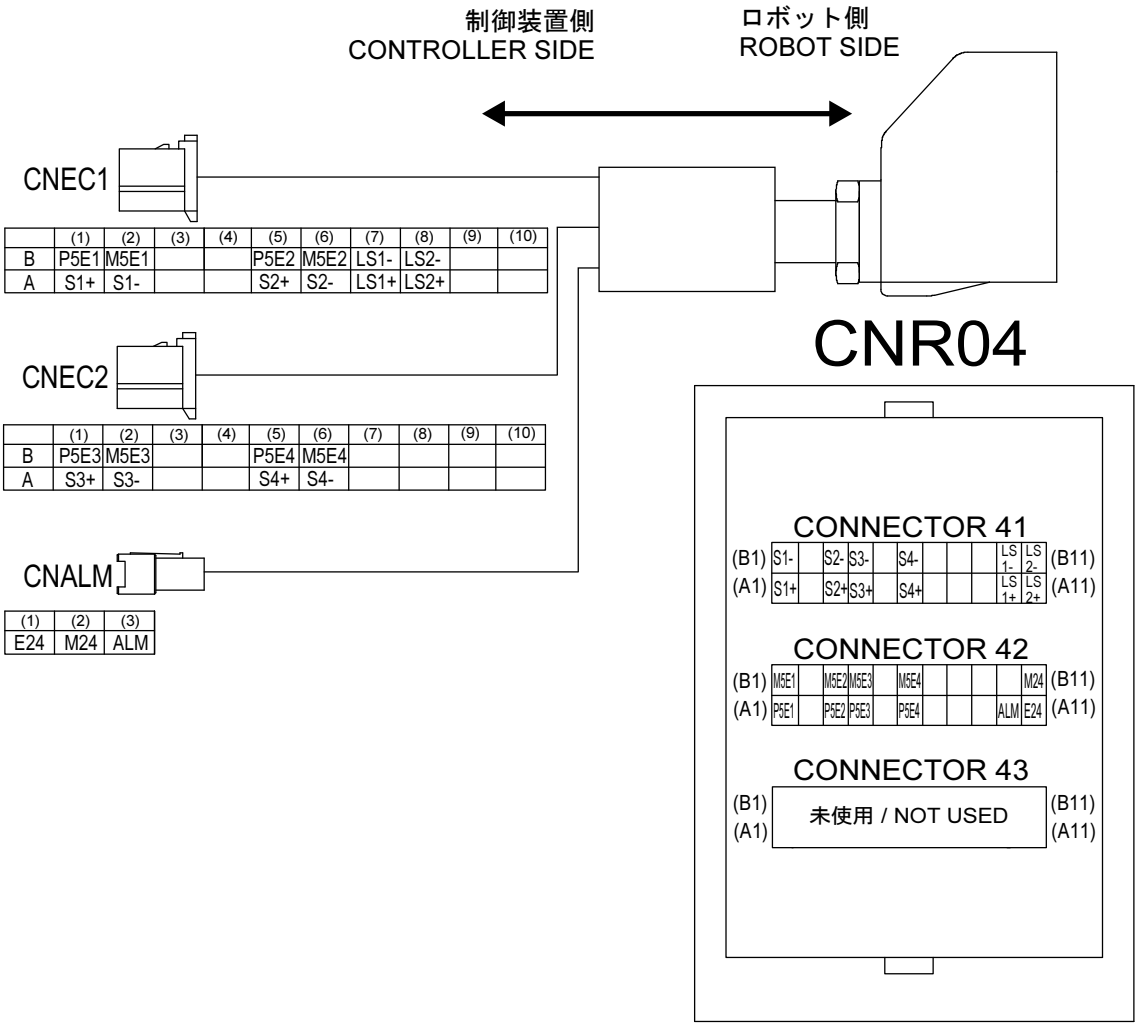
AX20 controller Wire harness connection (2)



FD11 controller Wire harness connection (1)



FD11 controller Wire harness connection (2)



FD11 controller Wire harness connection (3)

Connector “CNALM” is not used for this robot.

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NACHI-FUJIKOSHI (CHINA) CO., LTD.	***www.nachi.com.cn***	
NACHI ROBOTIC SYSTEMS, INC. (NRS)	***www.nachirobotics.com***	
NACHI EUROPE GmbH	***www.nachi.de***	

- Concerning the Contact list, please refer to ***"Contact list (TFDJP-254)"***.
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- In case that an end user uses this product for military purpose or production of weapon, this product may be liable for the subject of export restriction stipulated in the Foreign Exchange and Foreign Trade Control Law. Please go through careful investigation and necessary formalities for export.
- This is an original instruction.