



MANIPULATOR INSTRUCTION MANUAL

MC10S-01 [CFD-3000/FD11]

3rd 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 law 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.

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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 “SETUP” (for FD controller) “Chapter 1 Point on safety”

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

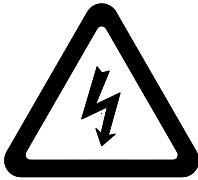


| | |
|--|---|
|  DANGER | Case where a mistake made in handling is likely to cause the user to be exposed to the danger of death or serious injury and where the degree of the urgency (imminence) of the warning given for the danger to occur is at the high end of the scales (including high-level danger).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

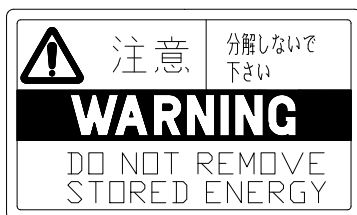
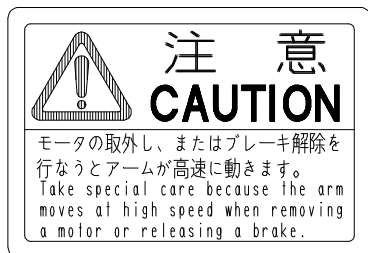
Labels and marks on manipulator

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

| | |
|---|--|
|  | <p>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.</p> <p>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.</p> |
|  | <p>This mark indicates hot parts on the robot.</p> <p>Carelessly touching labeled hot parts may result in serious burns.</p> |
|  | <p>This mark indicates area operators may get caught by the robot.</p> <p>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.</p> |

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 model | | MC10S-01 |
| Construction | | Articulated |
| Number of axis | | 6 |
| Drive system | | AC servo motor |
| Max. working envelope | Axis 1 | $\pm 3.14\text{rad}$ ($\pm 180^\circ$) |
| | Axis 2 | $+1.05 \sim -2.53\text{rad}$ ($+60 \sim -145^\circ$) |
| | Axis 3 | $+4.22 \sim -2.58\text{rad}$ ($+242 \sim -148^\circ$) |
| | Axis 4 | $\pm 3.32\text{rad}$ ($\pm 190^\circ$) |
| | Axis 5 | $\pm 2.09\text{rad}$ ($\pm 120^\circ$) |
| | Axis 6 | $\pm 6.28\text{rad}$ ($\pm 360^\circ$) |
| Max. speed | Axis 1 | 3.49rad/s ($200^\circ/\text{s}$) |
| | Axis 2 | 2.96rad/s ($170^\circ/\text{s}$) |
| | Axis 3 | 2.96rad/s ($170^\circ/\text{s}$) |
| | Axis 4 | 6.98rad/s ($400^\circ/\text{s}$) |
| | Axis 5 | 6.98rad/s ($400^\circ/\text{s}$) |
| | Axis 6 | 13.96rad/s ($800^\circ/\text{s}$) |
| Max. pay load | | 10 kg |
| Allowable static load torque | Axis 4 | 22Nm |
| | Axis 5 | 22Nm |
| | Axis 6 | 11Nm |
| Allowable moment of inertia ^{*1} | Axis 4 | 0.7kgm^2 |
| | Axis 5 | 0.7kgm^2 |
| | Axis 6 | 0.2kgm^2 |
| Position repeatability ^{*2} | | $\pm 0.06\text{mm}$ |
| Reach | | 1420mm |
| Air tube | | $\phi 6 \times 2$ |
| Application wires | | 10 wires |
| Installation | | Floor mount, Inverted mount |
| Ambient conditions | | Temperature: 0 to 45 °C ^{*3} Humidity: 20 to 85%RH (No dew condensation allowed) Vibration to the installation face: Not more than 0.5G (4.9 m/s ²) |
| Dust-proof / Drip-proof performance ^{*4} | | Wrist to fore-arm : IP67 equivalent, Upper-arm to base : IP65 equivalent |
| Robot mass | | 198 kg |

1 [rad] = $180 / \pi$ [°], 1 [N·m] = 1 / 9.8 [kgf·m]

- On controller display, axis 1 to 6 is displayed J1 to J6 for each.

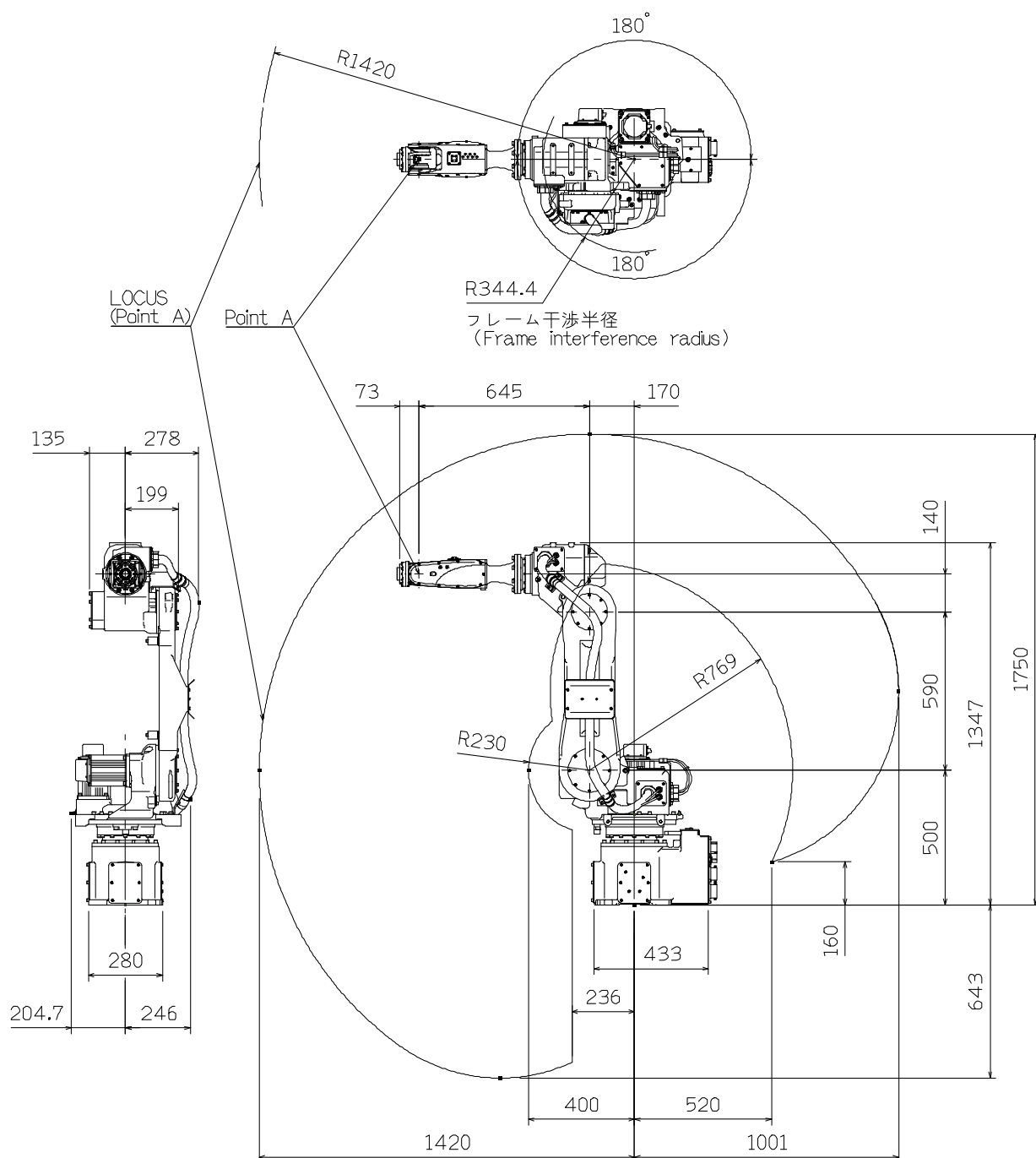
- The specification and externals described in this specifications might change without a previous notice for the improvement.

- Explosion-proof is not available.

*1: The Allowable moment of inertia of a wrist changes with load conditions of a wrist. *2: This value conforms to "JIS B 8432" standard. *3: Permitted height is not higher than 1,000m above sea level. If used in higher place, permitted temperature is affected by height. *4: Liquid such as organic compound, acidity, alkalinity, chlorine or gasoline cutting fluid which deteriorates the seal material are not available to use.

1.2 Robot dimensions and working envelope

[MC10S-01]



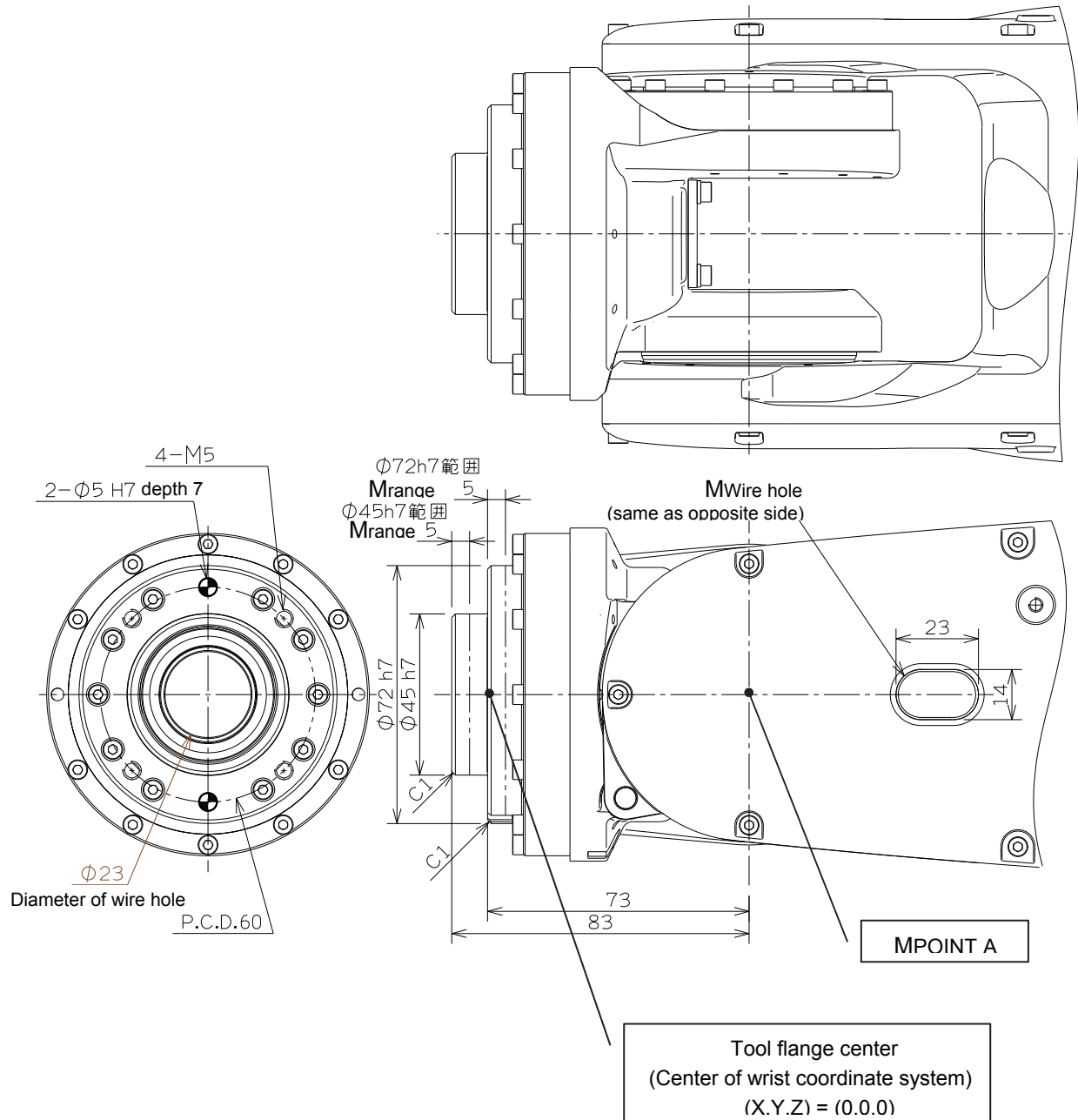
1.3 Details of payload mounting section



CAUTION

Be sure to screw the M5 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.

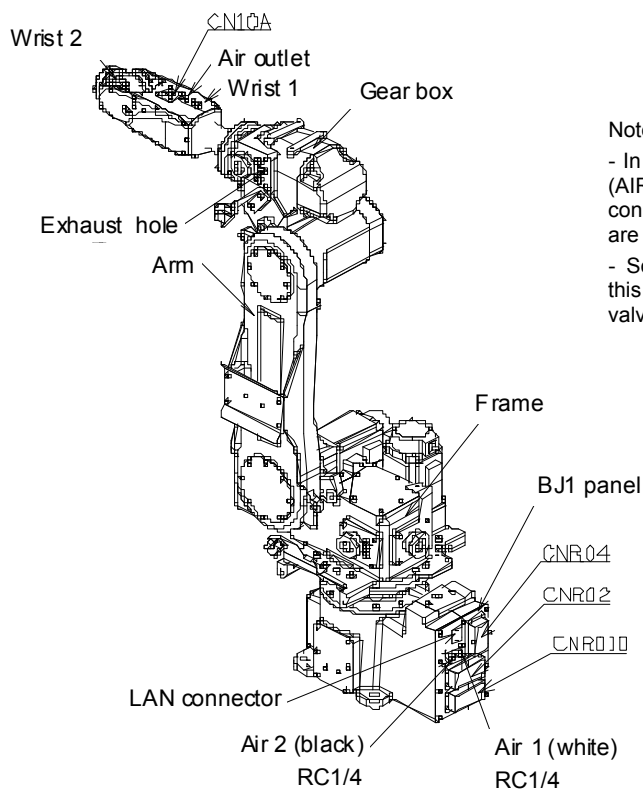
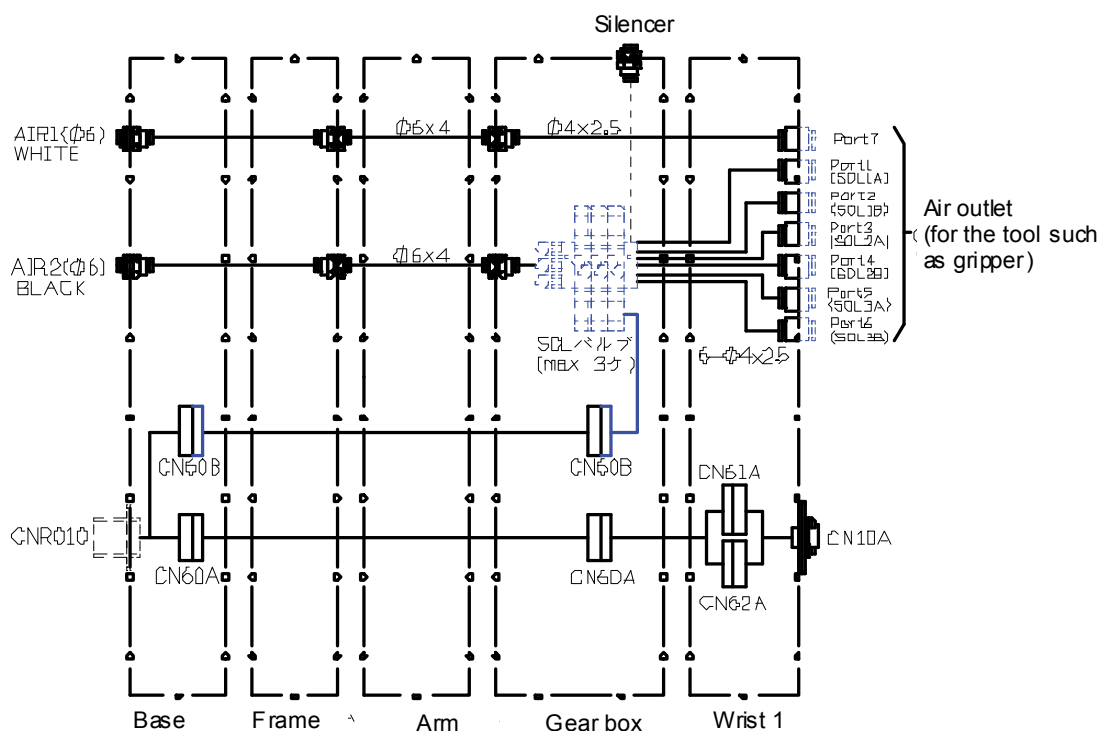
【MC10S-01】



1.4 Application wiring and tube diagram

■ Solenoid valve option

【MC10S-01】



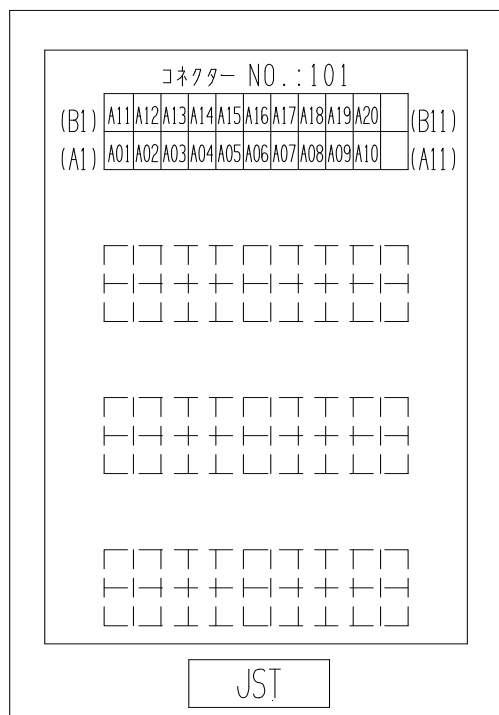
Note)

- In standard specification, only 2 air lines (AIR1 to Port1 and AIR2 to Port7) are connected directly inside gear box. Plugs are attached on air outlet.
- Solenoid valves and silencer written in this figure are mounted when "solenoid valve" option is selected.

■ Detailed diagram of application connectors

【MC10S-01】

(1) BJ1 side (connector)



Connector for application cable

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

or JFM-WSA-4-C (JST)

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

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

Receptacle contact:

(a) SJ2F-01GF-P1.0 (JST) (0.20 ~ 0.50 mm²)

(b) SJ2F-21GF-P1.0 (JST) (0.30 ~ 0.75 mm²)

Manual crimp tool:

for (a), YRS-8861

for (b), YRF-1120

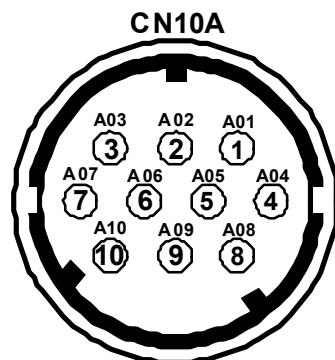
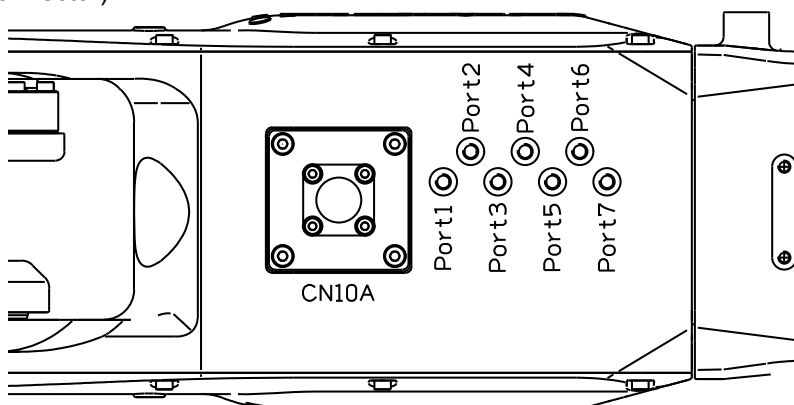
Cable diameter suitable for wire-side shell:

JFM-WSA-4-A (JST) $\phi 26.2 \sim \phi 28.0$

JFM-WSA-4-C (JST) $\phi 15.5 \sim \phi 16.5$

(This figure is drawn seeing from the backside of the robot.)

(2) Wrist side (connector)





Connector CN10A on wrist 1

JAE JN1AS10ML1-R

Partner connector type

JAE JN1DS10SL2


1.5 Operating range adjustment (adjustable stopper option)

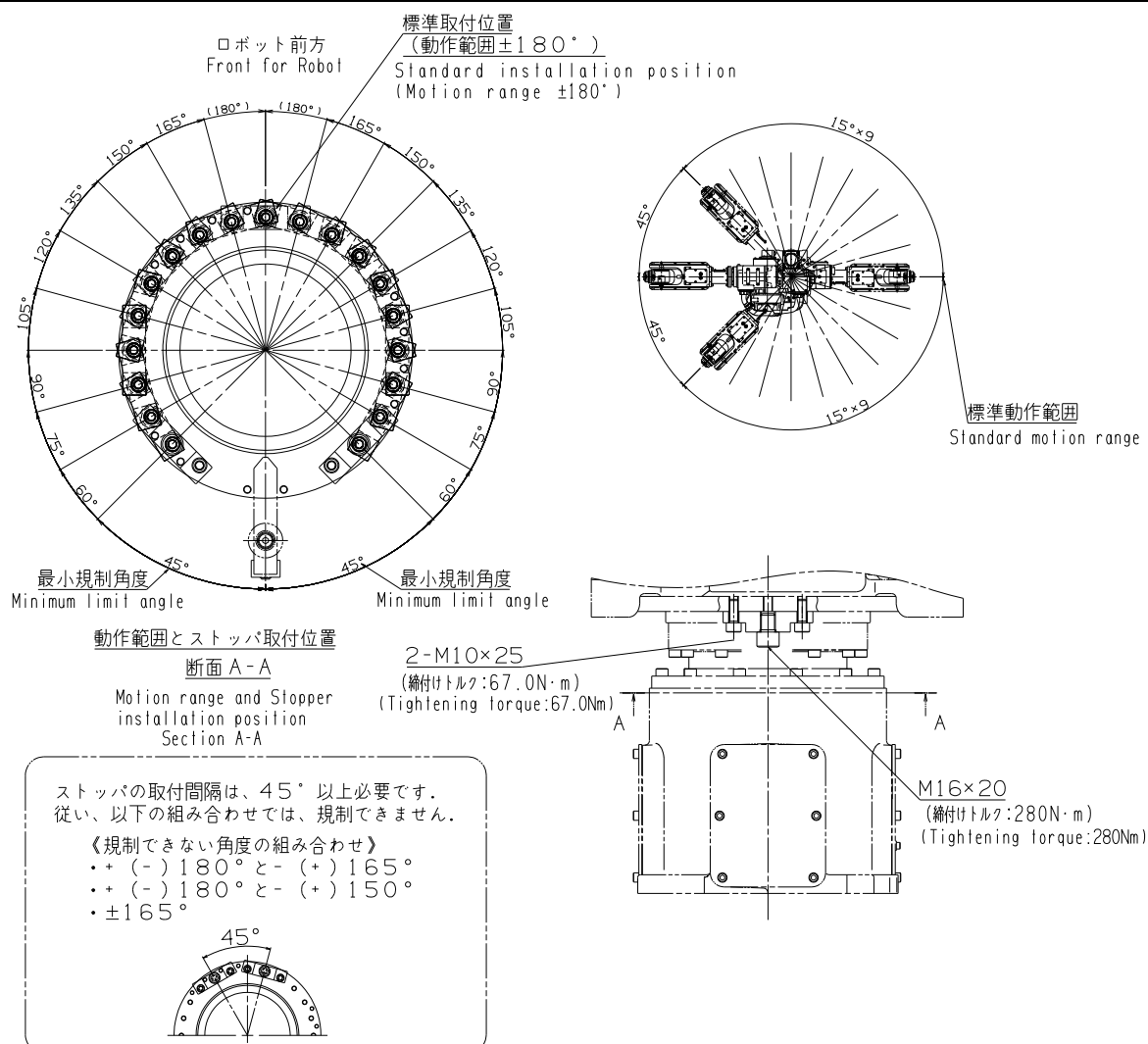
| | |
|---|---|
|  WARNING | <p>With stoppers dismounted, do not operate the robot. Doing so may result in damage to the peripheral equipment and the like, or death or serious injury.</p> |
|  WARNING | <p>If you change the position of the mechanical stopper, change also positions of the software limit and the overtravel limit switch. At this time, mount the mechanical stopper out of the operating ranges defined by the software limit and the overtravel limit switch.</p> |

■ Axis 1 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 axis 1 in steps of 15°. In this case, a maximum operating range of axis 1 comes to $\pm 180^\circ$.

1. Dismount the stopper from the standard mounting position, and then mount it to angles to be adjusted. (Fixing bolt: M10 X 25, 2 bolts / Stopper bolt: M16 X 20, 1 bolt)
2. Adjust the software limit according to the angle adjusted. (Refer to Instruction manual "SETUP")

| | |
|---|--|
|  IMPORTANT | <p>The end of a mechanical stopper is provided in a position exceeding the specified operating range (software limit) of axis 1 by 1°.</p> |
|---|--|




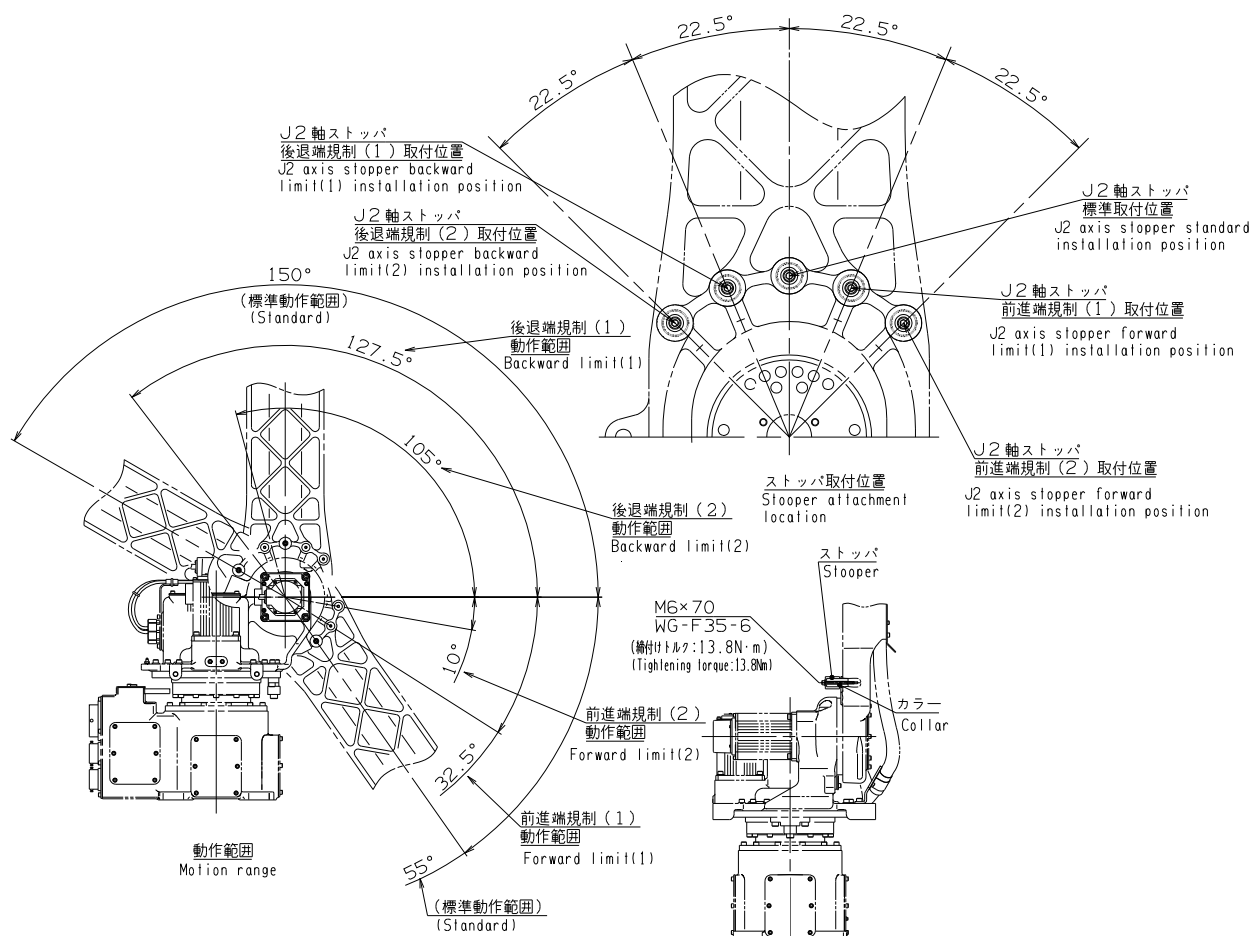
■ Axis 2 adjustable stopper (option)

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 axis 2 in steps of 22.5°.

In this case, a maximum operating range of axis 2 comes to + 150° ~ - 55°.

1. Dismount the stopper from the standard mounting position, and then mount it to angles to be adjusted. (Fixing bolt: M6 X 70, 1 bolt)
2. Adjust the software limit according to the angle adjusted. (Refer to Instruction manual "SETUP")

| | |
|--|---|
|  IMPORTANT | The end of a mechanical stopper is provided in a position exceeding the specified operating range (software limit) of axis 2 by 1°. |
|--|---|



■ Axis 3 adjustable stopper (option)

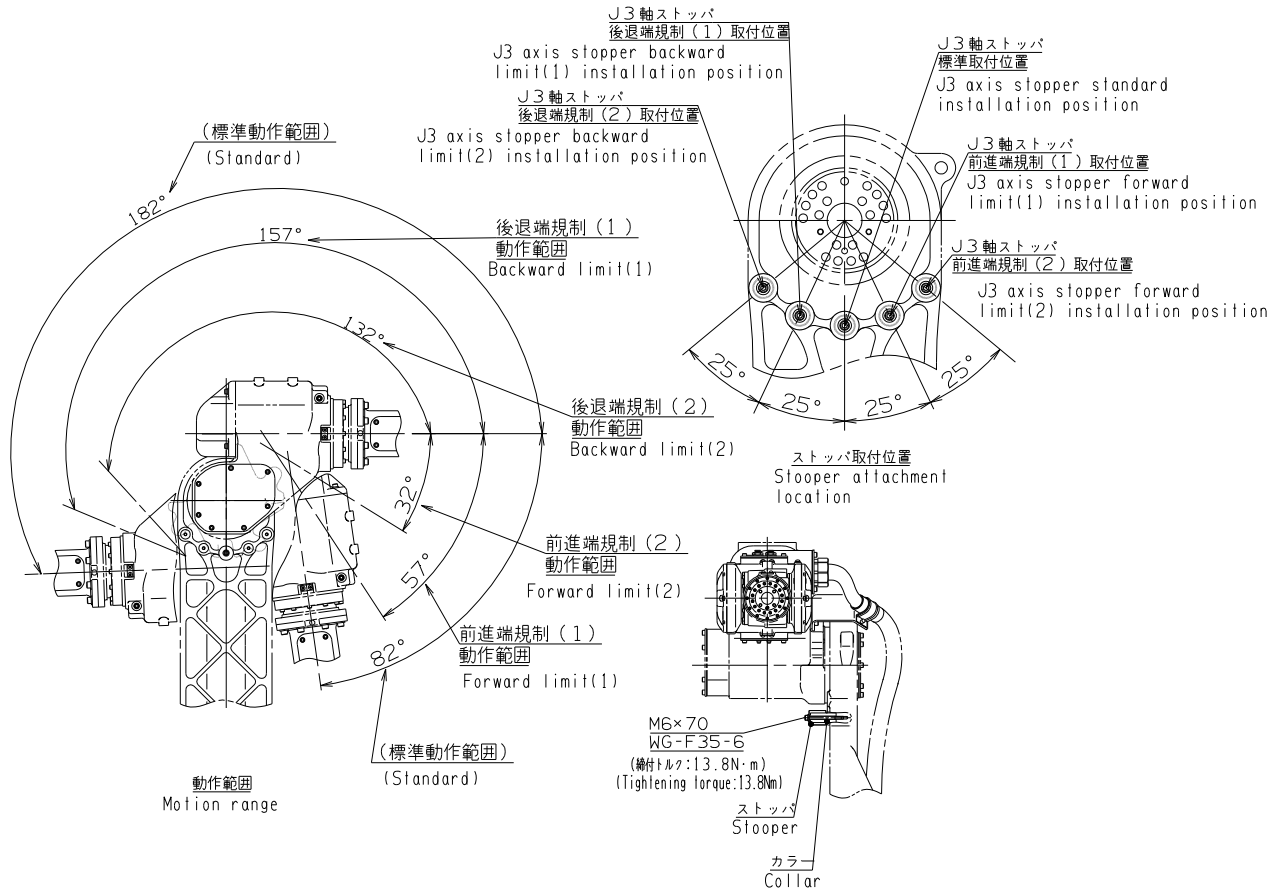
Mounting the standard stopper and the additional stopper (option) of the same shape as that of the standard stopper makes it possible to adjust the operating angle of axis 3 in steps of 25°. In this case, a maximum operating range of axis 3 comes to + 182° ~ - 82°.

1. Dismount the stopper from the standard mounting position, and then mount it to angles to be adjusted. (Fixing bolt: M6 X 70, 1 bolt)
2. Adjust the software limit according to the angle adjusted. (Refer to Instruction manual "SETUP")



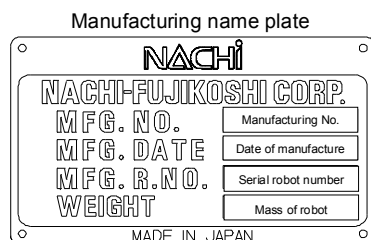
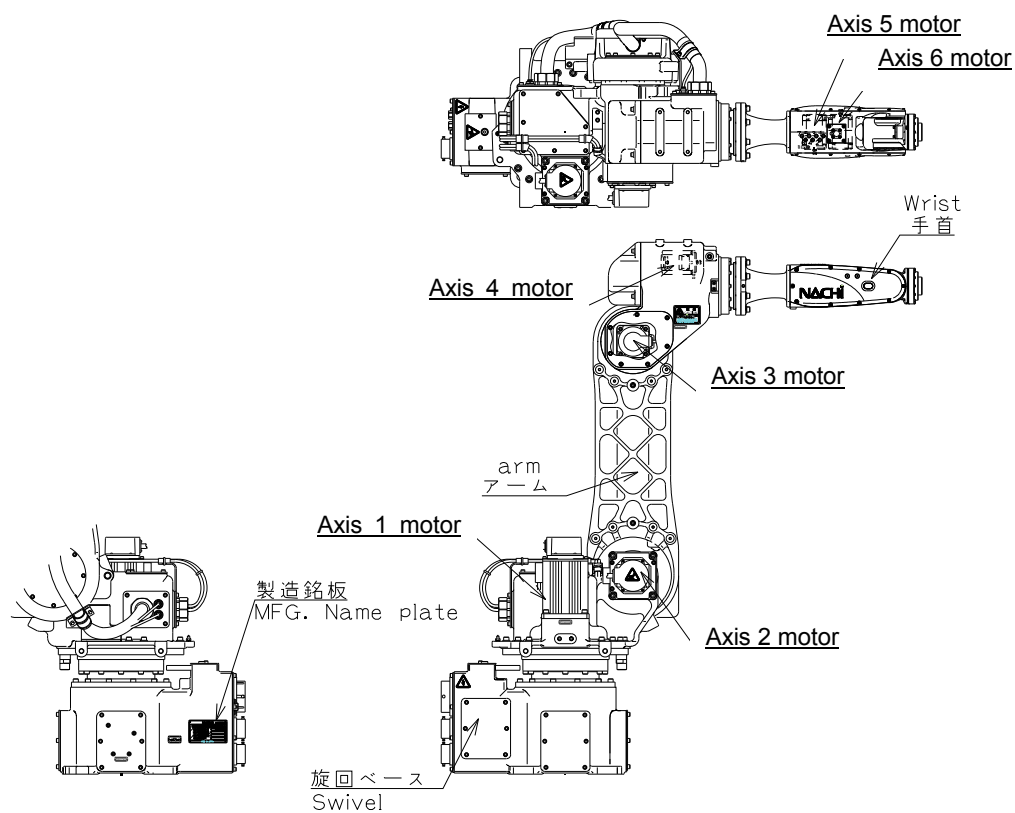
IMPORTANT

The end of a mechanical stopper is provided in a position exceeding the specified operating range (software limit) of axis 3 by 1°.

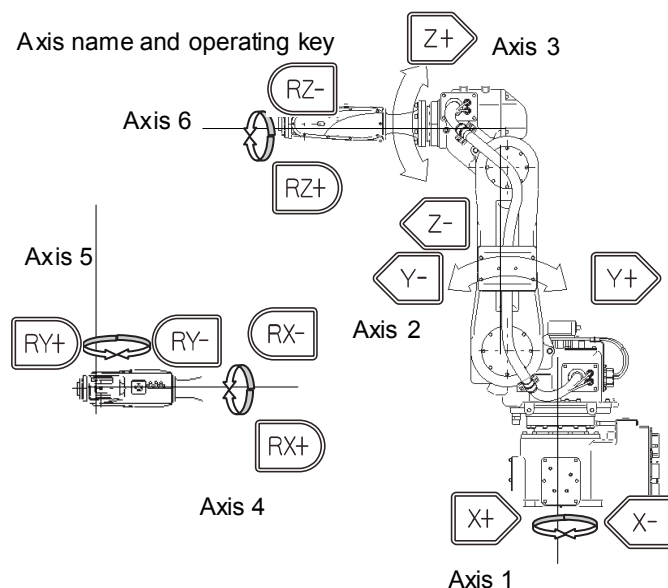


Chapter 2 Precautions for handling





2.1 Names of robot components



(Mass of robot is only for CE specification)



2.2 Transport procedure

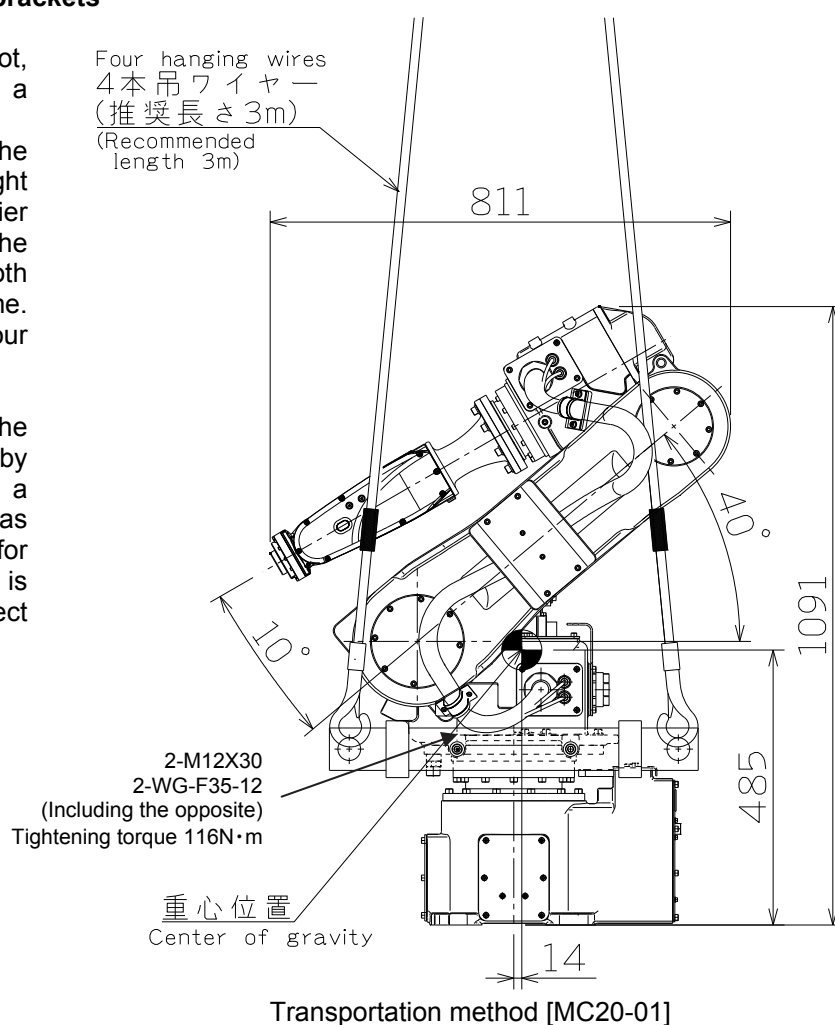
| | |
|--|--|
|  WARNING | The robot and controller must be transported by personnel who have licenses required for slinging work, crane operation, forklift truck operation, and others. |
|  WARNING | Before transporting the robot and the controller, be sure to check the weight of them and the transportation procedures which are described in the Maintenance Service Manual of the robot. |
|  WARNING | When hanging the robot or the controller, please follow the instructions described in the maintenance manual of them. If the work is done by following the other methods, the robot or the controller may fall down and results accidents. |
|  WARNING | During transport of the robot and controller, pay utmost care not to cause damage to wirings. Furthermore, after installing the robot, take protective measures such as using protective covers so that the wirings will not be damaged by workers or other persons, or forklift trucks or else. |


■ Using a transportation brackets

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

Put the robot into the configuration shown right and mount the two carrier brackets dedicated to the transport of the robot to both sides of the robot frame. Then, lift the robot using four hanging wires.

Protect the part where the robot contacts the wire by inserting the wire through a protect cover hose such as a rubber hose. See figure for the part where the wire is inserted through the protect cover hose.



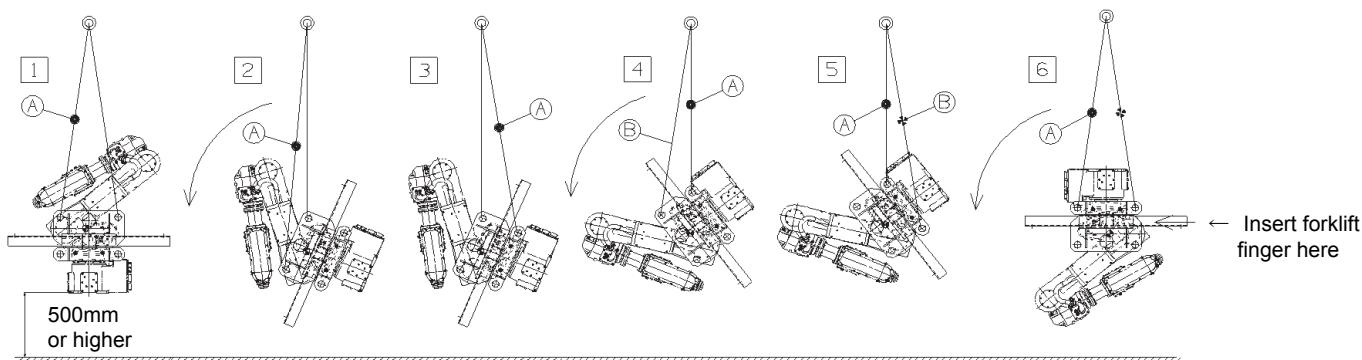
| | |
|--|---|
|  CAUTION | After installing the robot, remove the transportation brackets. |
|--|---|

■ Installation procedure for inverted mounting spec. robot

In case of inverted mounting specification, a special jig shown as below is necessary. (Option)

- (1) Hang the robot at 4 points as shown in the 1 in the figure. (Attach chain blocks at the A side.)
- (2) Loosen the chain blocks A to make a posture of 2.
- (3) Remove the chain blocks A and re-attach them like 3.
- (4) Wind up the chain blocks A to make a posture of 4.
- (5) Remove the wires B and re-attach them like 5.
- (6) Loosen the chain blocks A to make a posture of 6.

After that, lift the robot up using a hand lifter or a forklift, and install the robot.



CAUTION

The shipping posture of the robot is common to both of the floor mounting type and the inverted mounting type. However, when changing the mounting posture (e.g. From the floor mounting to the inverted mounting), please be sure to change the robot posture to the standard (original) shipping posture in advance to align the position of the center of gravity to the proper location.



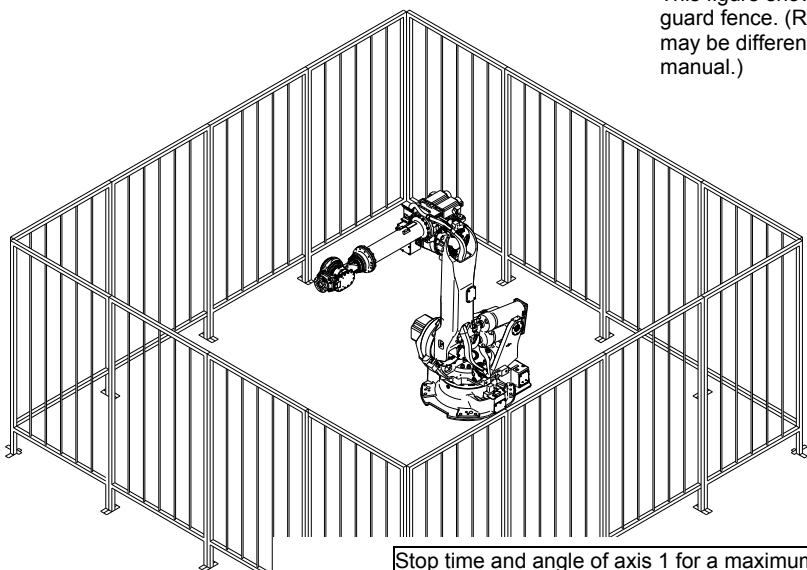



2.3 Installation procedure




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 | <p>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.</p> | | | | | | |
|  DANGER | <p><u>Guard fence</u></p> <p>Refer to information in ISO13857: Safety of machinery – Safety distances to prevent hazard zones being reached by upper and lower limbs</p> <div data-bbox="363 936 1173 1503">  <p>This figure shows the image of the guard fence. (Robot appearance may be different from that of this manual.)</p> </div> <p><u>Stop time and angle of axis 1 for a maximum travel</u> ((After emergency stop signal occurred under maximum speed))</p> <table border="1" data-bbox="651 1529 1347 1615"> <tr> <td></td><td>MC10S-01</td></tr> <tr> <td>Stop time</td><td>0.37 [sec]</td></tr> <tr> <td>Stop angle</td><td>0.59 [rad]</td></tr> </table> | | MC10S-01 | Stop time | 0.37 [sec] | Stop angle | 0.59 [rad] |
| | MC10S-01 | | | | | | |
| Stop time | 0.37 [sec] | | | | | | |
| Stop angle | 0.59 [rad] | | | | | | |
|  WARNING | <p>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.</p> | | | | | | |
|  WARNING | <p>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.)</p> | | | | | | |
|  WARNING | <p>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.)</p> | | | | | | |

| | |
|--|---|
|  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.

■ 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 | MC10S-01 |
| Thickness of floor concrete | Not less than 150 mm |
| Installation parts *1 | 4 bolts of M16 X 45 (JIS: Strength class 12.9) 4 plain washers of not less than 4.5 mm in thickness and HRC35 in hardness |
| Tightening torque *2 | 287 ± 30 N·m |
| Allowable repeated tensile *3 | Approximately 10,512 N |

*1 : Installation parts are not accessory of robot.

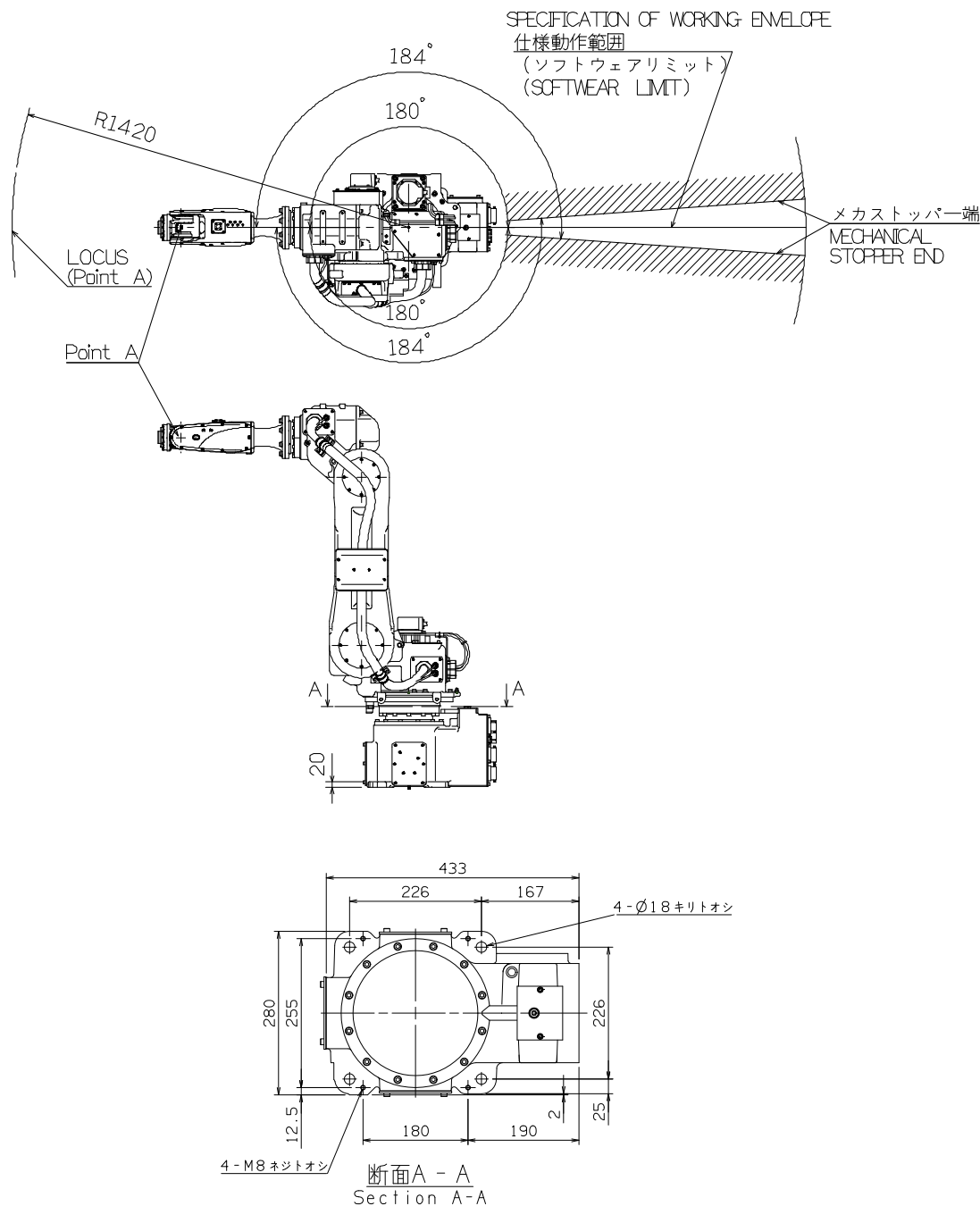
*2 : Apply a coating of lubricating oil to the threaded parts of bolts, and then tighten bolts by using torque wrench to the specified tightening torque.

*3 : This tensile is per installation bolt when robot is installed with all bolts written in table above.

■ Installation space

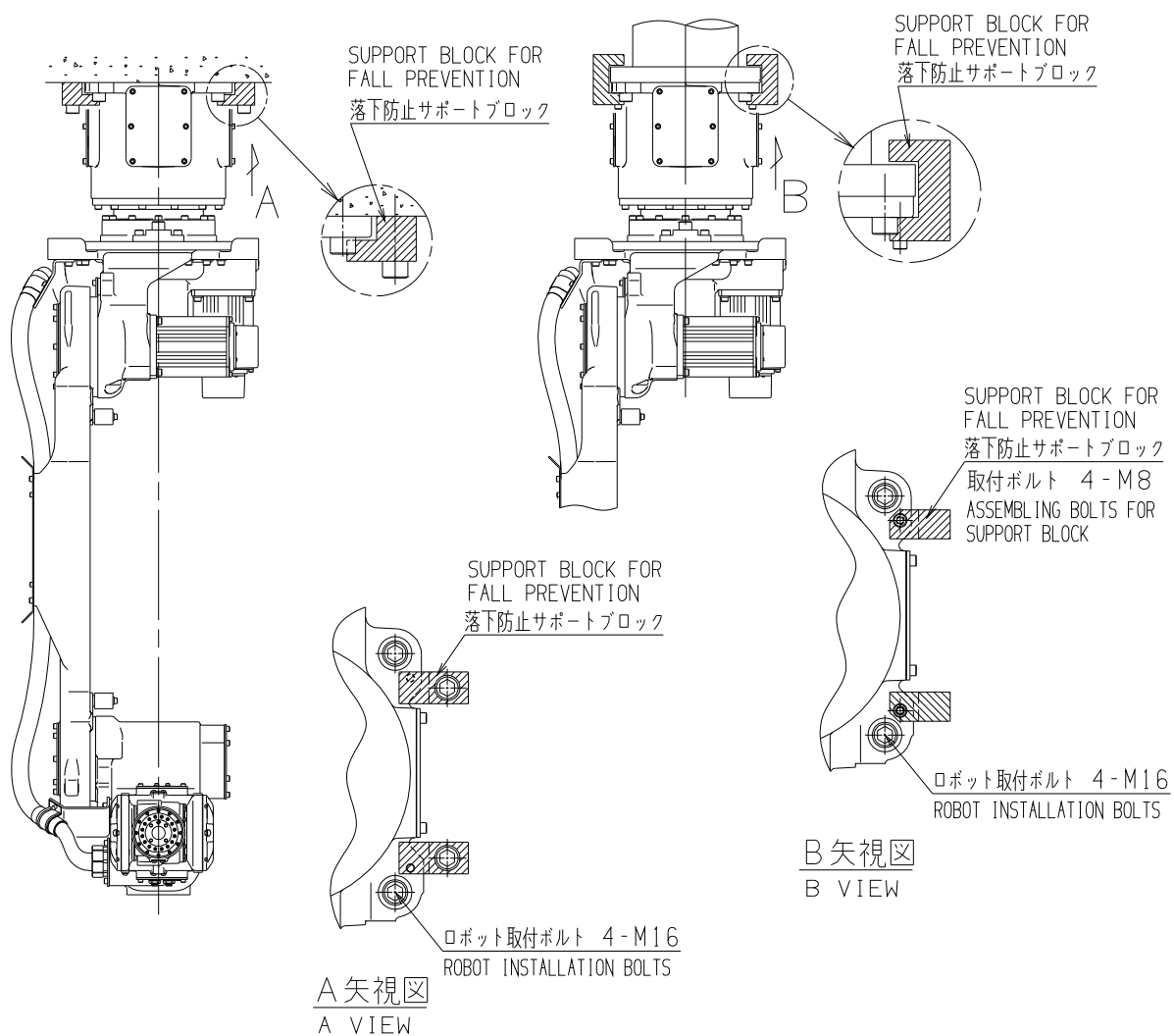
| | |
|---|---|
|  WARNING | A mechanical stopper is mounted over the axis 1 working envelope (software limit). When installing a guard fence (safety fence), please make sure to consider the motion range, wrist posture, and the shape of the end effector. |
|  WARNING | To operate safely, range of the motion can be restricted in axis 1, axis 2 and axis 3 (Option). Because the option parts are always necessary to restrict the motion range, do not move the standard parts (mechanical stopper block etc.) alone. |

【MC10S-01】



■ Treatment for fall prevention

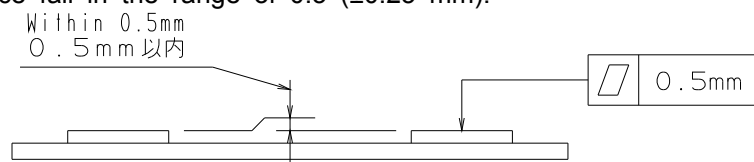
In case of inverted mounting specification, a treatment for fall prevention shown as below is necessary. Shape of arm differs from that of MC10S.



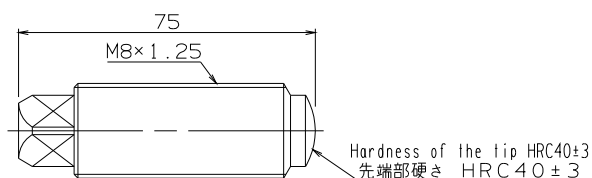
■ Accuracy of installation surface

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 0.5 mm.
- (2) Make the deviation in height between the four robot installation surface plates and the installation surface fall in the range of 0.5 (± 0.25 mm).

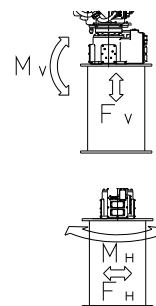


- (3) If the two precautions above cannot be observed, use jack bolts to bring the four plates into even contact with the installation surface.




■ Maximum robot generative force

| Robot model | Maximum vertical generative force F_v | Maximum horizontal generative force F_H | Maximum Vertical generative moment M_v | Maximum horizontal generative moment M_H |
|-------------|--|--|---|---|
| MC10S-01 | 6,400 N | 4,200 N | 4,700 N·m | 4,000 N·m |

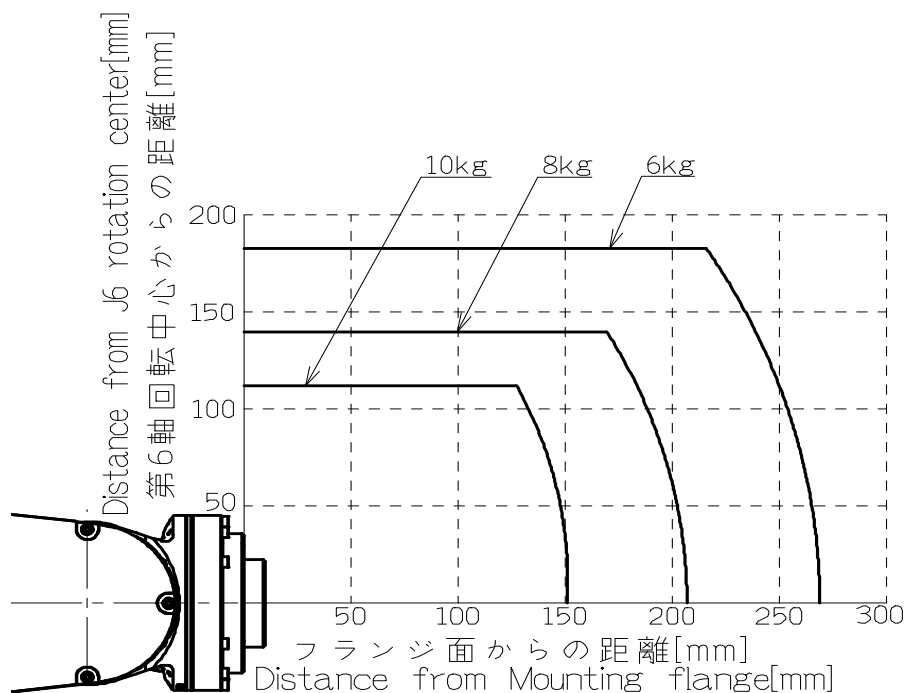


2.4 Allowable wrist load

| | |
|---|--|
|  CAUTION | <p>A load fixed to the tip of the robot wrist is regulated by the allowable payload mass, allowable static load torque, and allowable moment of inertia. Strictly keep the wrist load within each allowable value. If wrist load exceeds the allowable value, this robot is out of guarantee.</p> <p>For detail, please refer to "1.1 List of basic specifications" and following figures.</p> |
|---|--|

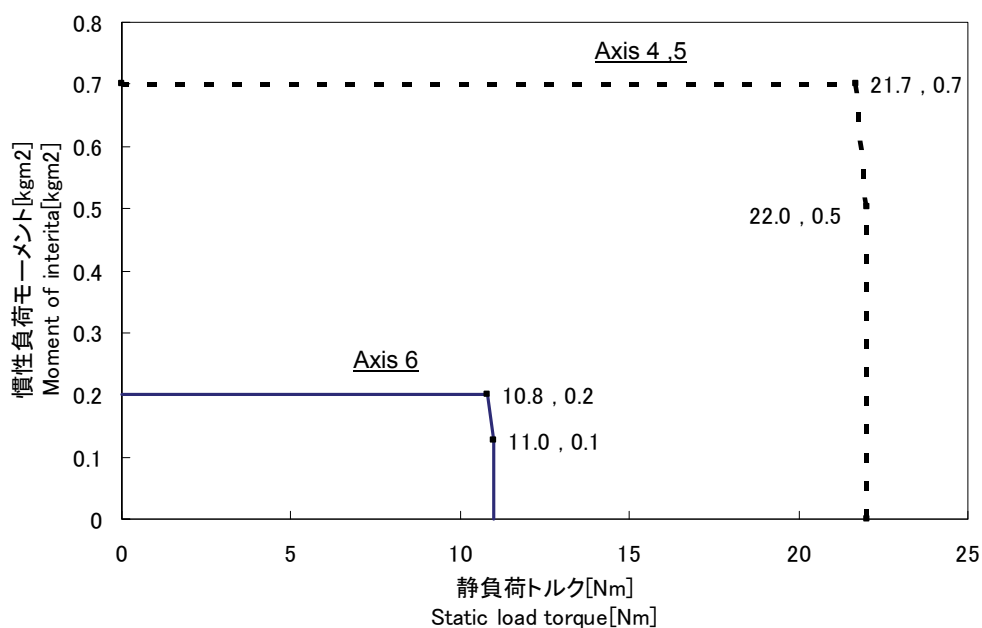
■ Torque map


C.O.G. of wrist load should exist inside the range shown below.





■ Moment of inertia map for the wrist load

Static load torque and moment of inertia of wrist load should exist inside the range shown below.



| | |
|---|---|
|  IMPORTANT | <p>If the moment of inertia exceeds the specification, maximum speed is automatically limited by the software to protect the robot.</p> |
|---|---|

2.5 Execution of encoder correction

| | |
|--|--|
|  CAUTION | <p>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 <u>after all of the load are mounted on wrist and arm, before starting the teaching procedure,</u> by referring to information in “5.2.5 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.</p> |
|  CAUTION | <p>Also encoder correction is necessary when motor / encoder is replaced.</p> <p>At this time, encoder correction must be performed under the <u>same load condition and same robot posture as the first time encoder correction that is performed immediately after the loads are mounted,</u> 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. (👉 “5.2.5 Encoder Correction”)</p> |

NOTE

Chapter 3 Inspection



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".

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 should create and implement the inspection program. For inspection items, refer to following table.

Perform inspection **every 20,000 operating hours or every 4 years, whichever comes earlier**. Inspect parts listed below and replace them if necessary. Should you have any questions about the inspection, contact our Service Department.

Furthermore, perform overhauls **every 40,000 operating hours or every 8 years, whichever comes earlier**.

Table 3.1.1 Inspection items and periods

| No. | Period | | | Inspection Items | Inspection Method | Criterion | Remark |
|-------------------------------------|-----------------------|-----------------------|-----------------------|-----------------------------|--|---|----------------------------------|
| | Daily | Quarterly | Yearly | | | | |
| Common to whole robot and each axis | | | | | | | |
| 1 | <input type="radio"/> | | | Cleaning of robot | • Wiping of dirt or the like | | |
| 2 | | <input type="radio"/> | | Related to internal wirings | • Visual check for cable for damage • Visual check of the cable clamp fixing bolts for the coating of paint • Visual check for cable cover for damage | | 3.4 |
| | | | <input type="radio"/> | | • Refasten the fixing bolts, and then apply a coating of paint lock to them | | |
| 3 | | <input type="radio"/> | <input type="radio"/> | Major bolts | • Visual check of the coating of paint • Refasten the fixing bolts, and then apply a coating of paint lock to them | | 3.2 |
| 4 | <input type="radio"/> | | | Motors | • Check for abnormal heat generation • Check for any abnormal sounds | | |
| 5 | | | <input type="radio"/> | 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 effector does not drop | Motors with a brake for all axes |
| Related to axis 1, 2 and 3 | | | | | | | |
| 6 | <input type="radio"/> | | | Reduction gear | • Check by hearing for any abnormal sounds • Visual check for any vibration or shaking | | |
| Related to axis 4, 5 and 6 | | | | | | | |
| 7 | | <input type="radio"/> | | Reduction gear | • Check by hearing for any abnormal sounds • Visual check for any vibration or shaking | | |
| 8 | | <input type="radio"/> | | End effector fixing bolts | • Visual check of the fixing bolts for paint coating conditions | | 3.2 |
| | | | <input type="radio"/> | | • Refasten the fixing bolts, and then apply a coating of paint lock to them | | |
| 9 | | <input type="radio"/> | | 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 | 3.2 |
| 10 | | <input type="radio"/> | | Belt tension | • Measure the tension (using a tension meter) • Adjust the tension | | 3.5 *1, *2 |
| | | <input type="radio"/> | | Belt | • Visual check of wear on the belt teeth | | |

*1 Do not change the belt tension if it is in the range of reference value.

*2 Perform inspections by referring to "3.5 Inspection and adjustment of belt".

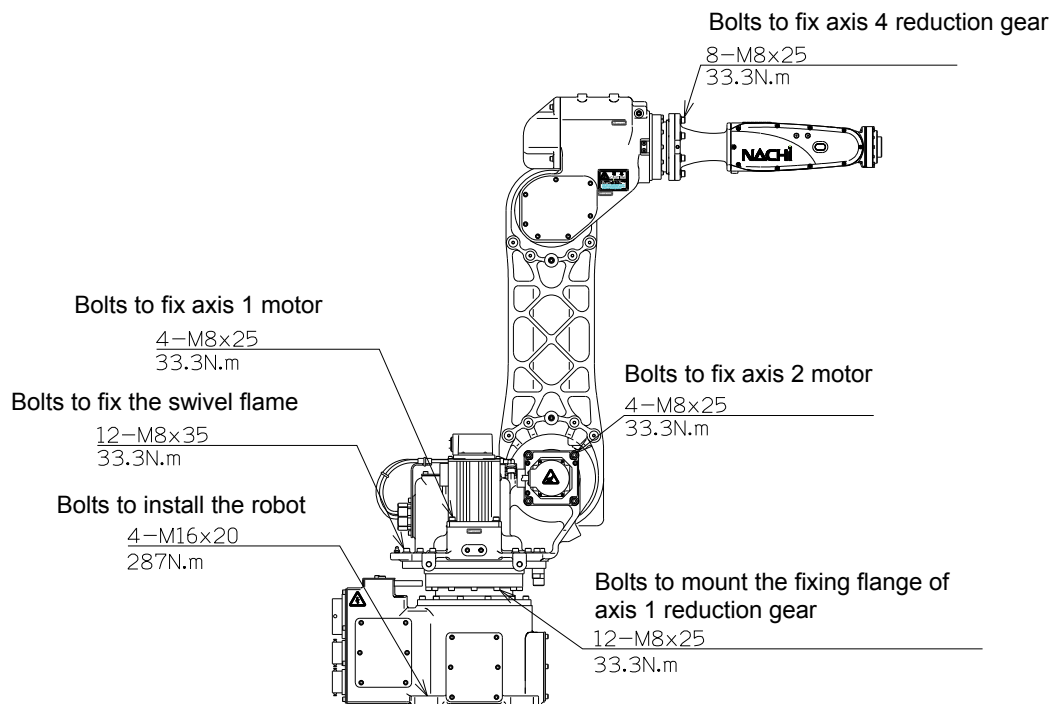
<Notes> Brake release switch is option.

3.2 Inspection of major bolts



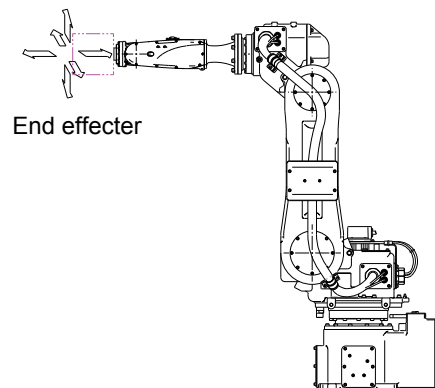
CAUTION

Be sure to use a torque wrench to fasten the bolts to proper torque, and then apply a coating of paint lock to them.
It is not necessary to needlessly refasten the bolts that are not unfastened.



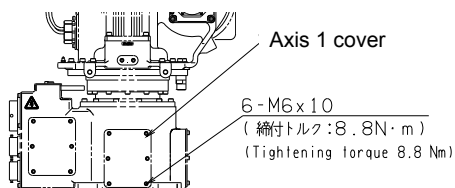
3.3 Inspection of wrist

Apply loads to the end effector (e.g. a spot gun or hand unit) 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 wiring

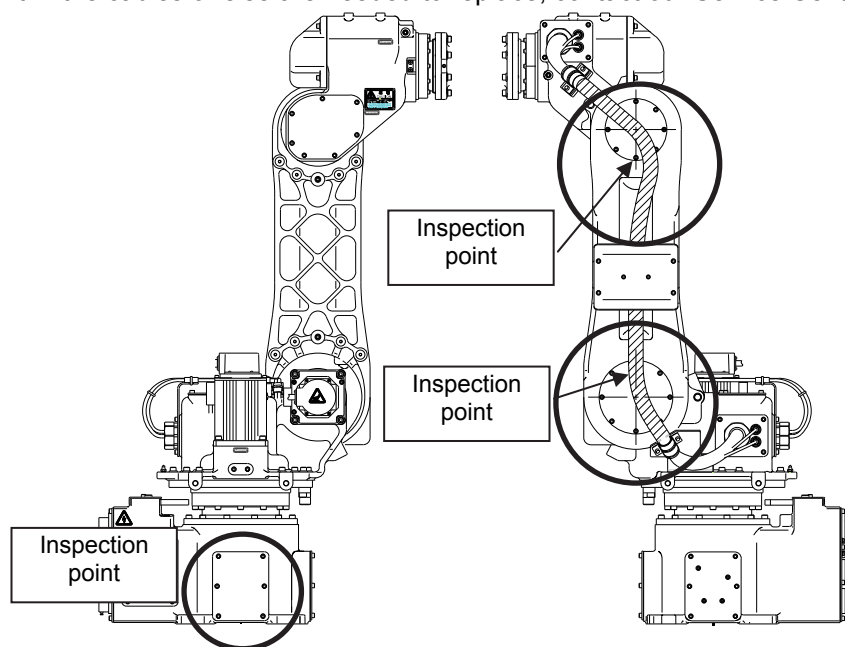
- (1) Remove cover.



- (2) At the locations shown below, inspect the cable, hose, and through-tube (cover for protecting a cable) as follows:

- Whether or not any through tube (a cover for protecting a cable) has scratches or fractures.
- Whether or not any cable or hose sharply bends over or gets crushed.
- Whether or not any cable shield and hose surface has scratches or fractures.

If any part is damaged, immediately repair or replace the part. (If the clamp part is loose, refasten it. If the cables or else are needed to replace, contact our Service Center.)



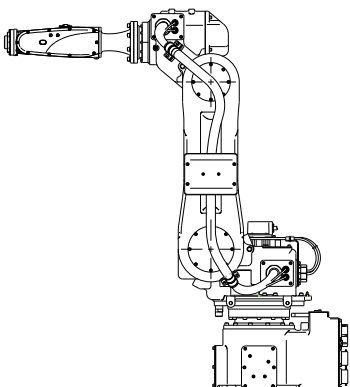
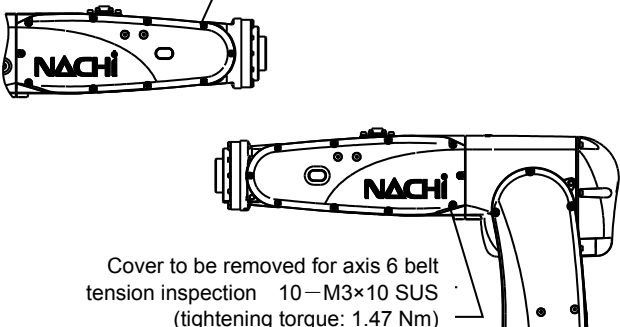


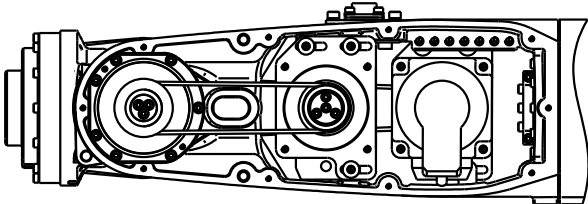
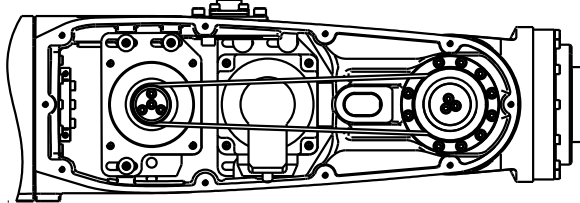
- (3) Mount the removed cover with the specified torque.

3.5 Inspection and adjustment of belt

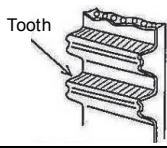
Tools required (prepared by customer)

| Name | Specification | Q'ty |
|----------------|---|------|
| Tension Meter | (Reference) TSUBAKIMOTO CHAIN Type BDTM101 | 1 |
| Spring measure | can measure force up to approximately 50N (5Kg) | 1 |

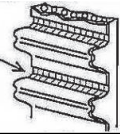
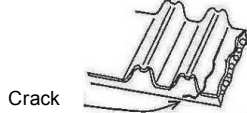
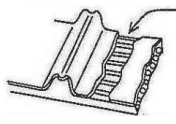
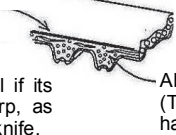
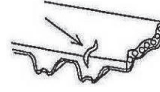
3.5.1 Inspection of belt

| STEP | Work performed | | | | | | | | | | | | |
|--------------------------------|--|--------------------------------|--------------|------|-----------|------|--------------|--------------------------------|--------------|------|-----------|------|--------------|
| 1 | Turn ON the motor power to get ready for manual operation. | | | | | | | | | | | | |
| 2 | Make the robot posture shown below. (If tool is mounted, rotate axis 5 and 6 manually to adjust the belt so that the tension is applied to the belt evenly.) | | | | | | | | | | | | |
| 3 | Press the emergency stop button. | | | | | | | | | | | | |
| 4 | Remove the covers. <div style="display: flex; justify-content: space-around; align-items: center;"> <div style="text-align: center;">  Belt inspection posture </div> <div style="text-align: center;">  Cover locations Cover to be removed for axis 5 belt tension inspection 10-M3×10 SUS (tightening torque: 1.47 Nm) Cover to be removed for axis 6 belt tension inspection 10—M3×10 SUS (tightening torque: 1.47 Nm) </div> </div> | | | | | | | | | | | | |
| 5 | While operating the wrist manually, visually check for the belt tooth wear, the belt tooth dedendum cracks, or the belt back cracks. (Refer to  Table of next page) If damaged is found on a belt, replace the belt. (Refer to  “4.4 Replacement of belt”) | | | | | | | | | | | | |
| 6 | Check the belt for looseness using a tension meter. If looseness is found, adjust the belt. <div style="display: flex; justify-content: space-around; align-items: center;"> <div style="text-align: center;">  </div> <table border="1"> <tr> <td>Initial tension of Axis 6 belt</td><td>29 to 40 [N]</td></tr> <tr> <td>SPAN</td><td>0.110 [m]</td></tr> <tr> <td>MASS</td><td>0.013 [kg/m]</td></tr> </table> </div> <div style="display: flex; justify-content: space-around; align-items: center; margin-top: 20px;"> <div style="text-align: center;">  </div> <table border="1"> <tr> <td>Initial tension of Axis 5 belt</td><td>29 to 40 [N]</td></tr> <tr> <td>SPAN</td><td>0.179 [m]</td></tr> <tr> <td>MASS</td><td>0.013 [kg/m]</td></tr> </table> </div> | Initial tension of Axis 6 belt | 29 to 40 [N] | SPAN | 0.110 [m] | MASS | 0.013 [kg/m] | Initial tension of Axis 5 belt | 29 to 40 [N] | SPAN | 0.179 [m] | MASS | 0.013 [kg/m] |
| Initial tension of Axis 6 belt | 29 to 40 [N] | | | | | | | | | | | | |
| SPAN | 0.110 [m] | | | | | | | | | | | | |
| MASS | 0.013 [kg/m] | | | | | | | | | | | | |
| Initial tension of Axis 5 belt | 29 to 40 [N] | | | | | | | | | | | | |
| SPAN | 0.179 [m] | | | | | | | | | | | | |
| MASS | 0.013 [kg/m] | | | | | | | | | | | | |

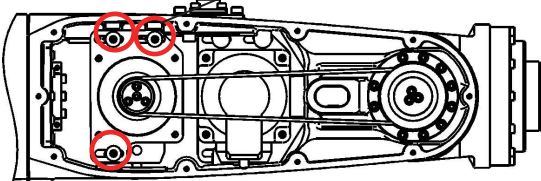
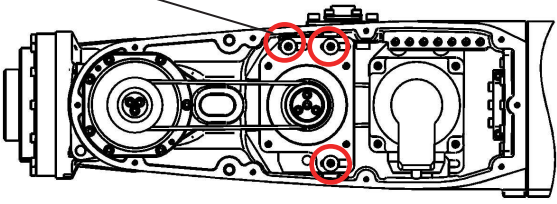


Inspection of belt

| Type of abnormalities | External appearance |
|---|---|
| Abnormal wear of tooth (Early stage) | <p>If the tooth doth is worn, replace the belt.</p> <p>In such a case, the fiber of the tooth doth is become fluffy, and the rubber is removed. Consequently, the belt bleaches, and the texture of the tooth dose becomes ambiguous.</p>  |

Check the appearance of the belt, and if any of the abnormalities as follows is observed, replace the belt.

| Type of abnormalities | External appearance |
|---------------------------------|---|
| Abnormal wear of tooth | <p>The tooth cloth is worn out, and the rubber is exposed. (The face width becomes thinner.)</p>  |
| The bottom of tooth is cracked. |  |
| Tooth is missing. |  |
| Abnormal wear | <p>The corner is rounded.</p> <p>Note: The side is normal if its edge remains sharp, as if it was cut with a knife.</p>  |
| Belt side is tore. |  |

3.5.2 Adjustment of belt

| STEP | Work performed |
|------|--|
| 1 | <p data-bbox="268 271 1385 331">Loosen motor flange fixing bolts and move motor itself. Tighten bolts temporary and measure tension by using tension meter.</p> <div data-bbox="268 353 1244 952"> <div data-bbox="268 353 343 392">Axis 5</div> <div data-bbox="829 353 1244 407"> Motor flange fixing bolts 3-M4×10 SUS (tightening torque: 3.63 Nm) </div>  <div data-bbox="268 654 343 692">Axis 6</div> <div data-bbox="422 676 829 730"> Motor flange fixing bolts 3-M4×10 SUS (tightening torque: 3.63 Nm) </div>  </div> |
| 2 | Adjust tension and tighten motor flange fixing bolts with specified torque. Then fix covers. |
| 3 | <p data-bbox="268 1055 829 1081">Perform encoder reset and encoder correction.</p> <div data-bbox="268 1081 646 1142">  "5.2.5 Encoder Reset"  "5.2.6 Encoder Correction" </div> |

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".

4.1 Lubrication

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.

| No. | Lubrication point | Lubrication | Lubrication frequency | Applicable grease | Lubrication amount | Remark |
|-----|-------------------|--|-----------------------|-------------------|--------------------|--------|
| [1] | Axis 1 gear box | Lower part of axis 1 motor | 12 months | ALVANIA RA-J | 10^{+1}_0 cc | |
| [2] | Axis 4 gear box | Side part of axis 4 gear box on the front side | // | // | // | |

- In order to prevent the internal pressure from rising due to pressure caused by the lubrication, unplug the air vent plug. If the pressure is applied to the oil seal part, leakage of grease will result.
- 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: PT1/8 (1) 12.7 N·m / (2) 8.33 N·m)



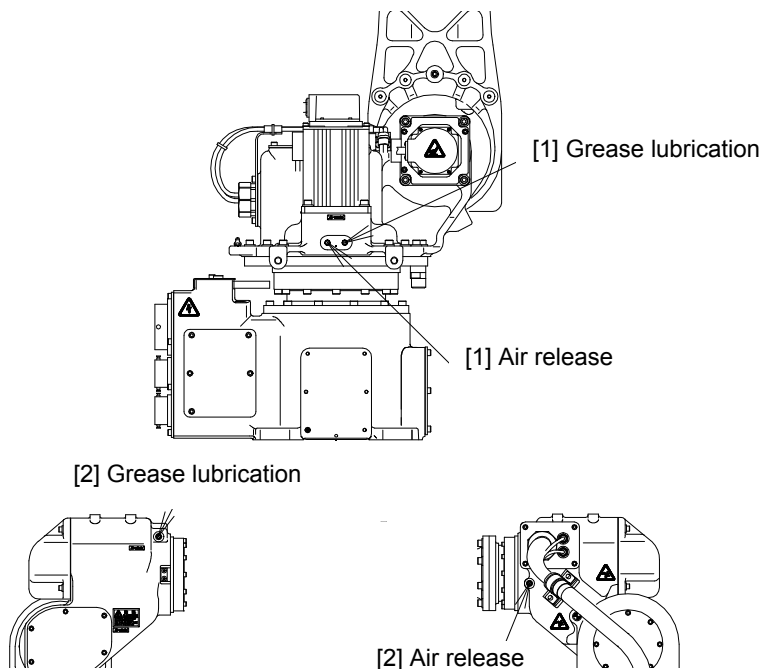
CAUTION

For lubrication, use a grease gun. Use a grease gun with a nozzle of not more than 17 mm in diameter. Furthermore, for lubrication points with an air vent hole specified, unplug the plug, 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




Replace the grease every 10,000 operating hours or every 2 years, whichever comes earlier.

| No. | Replacement point | Applicable grease | Lubrication amount | Application | Lubrication port | Size | Tightening torque | Remark |
|-----|--------------------------|-----------------------|--------------------|-------------|------------------|--------|-------------------|--------|
| [1] | Axis 2 Reduction gear | MOLYWHITE RE No.00 | 630±30 cc | Lubrication | Plug | Rc-1/8 | 12.7 N·m | |
| | | | | Discharge | Plug | Rc-1/8 | 12.7 N·m | |
| [2] | Axis 3 Reduction gear | MOLYWHITE RE No.00 | 580±20 cc | Lubrication | Plug | Rc-1/8 | 12.7 N·m | |
| | | | | Discharge | Plug | Rc-1/8 | 8.33 N·m | |

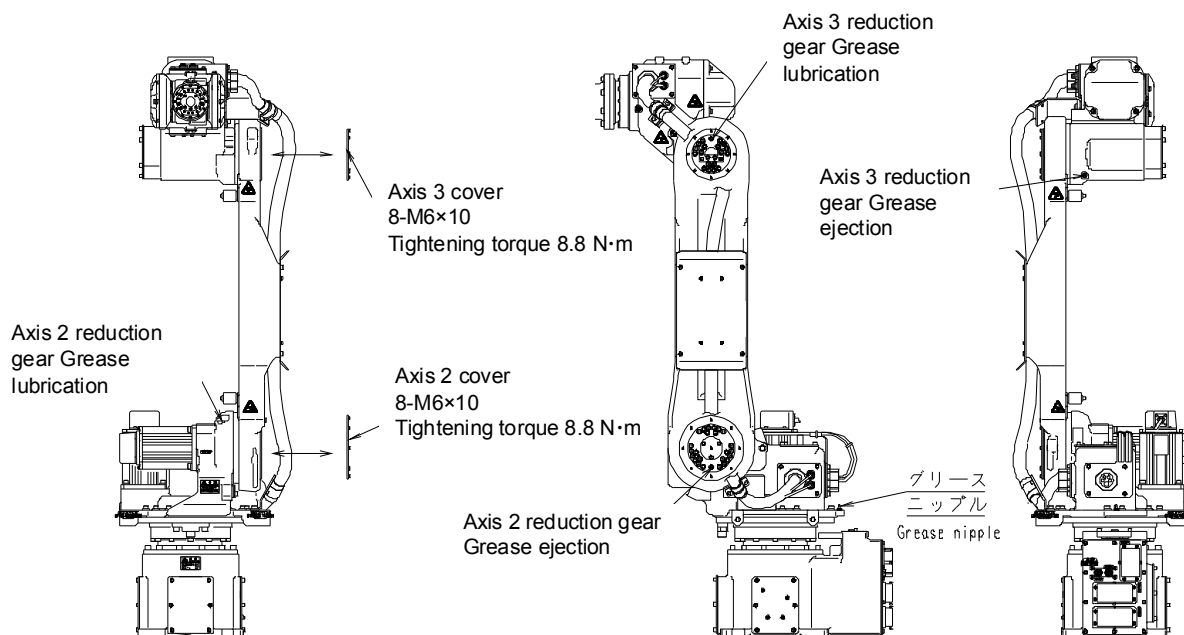
Density of grease: MOLYWHITE RE No. 00 (from Nabtesco) 0.87g/cc

Grease replacement procedure

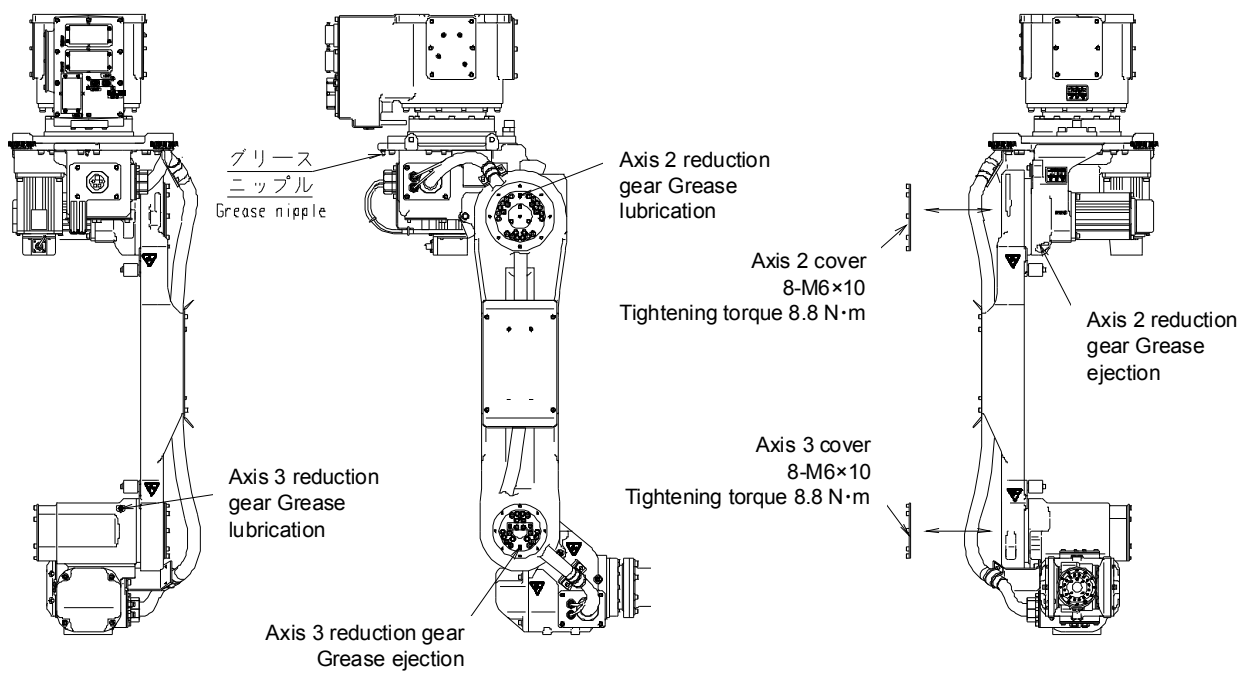
1. Remove the cover mounted to the reduction gears for axis 2 and 3.
2. Unplug the socket head plugs from the lubrication ports of axis 2 and 3, and then mount a grease nipple that is mounted to the frame.
3. Place a container to receive grease discharged under the discharge outlets. (The amount of grease to be discharged is to be the same as that of grease to be lubricated.)
4. Unplug the socket head plug from the discharge outlet.
5. Use a grease gun to feed grease (listed in table) from the grease nipples.
6. After the completion of grease lubrication, plug the discharge outlet with the socket head plug.
7. Dismount the grease nipples from the lubrication ports, and 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 then plug them with the socket head plug.
8. Mount the cover.

| | |
|---|---|
|  CAUTION | <p>For lubrication, use a grease gun. Use a grease gun with a nozzle of not more than 17 mm in diameter.</p> <p>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.</p> <p>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.</p> |
|  CAUTION | <p>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.</p> |
|  CAUTION | <p>Immediately after removing the drain plug, grease may splash, because internal pressure is still high, for example soon after robot stops,</p> |

Floor mounting type




Inverted mounting type



4.3 Battery replacement

The robot uses lithium batteries for the backup of encoder data.

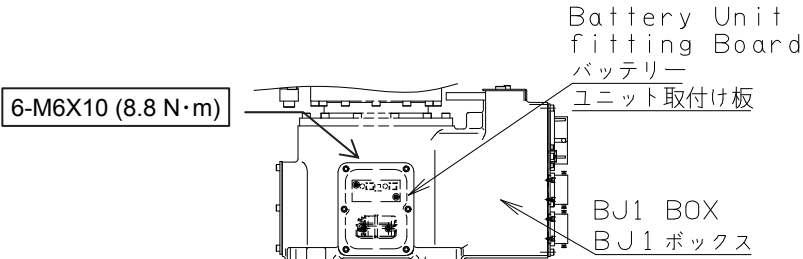
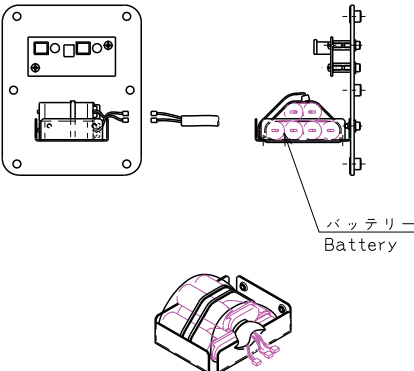
If the battery voltage drops below the given limit, the data will not be kept normal.

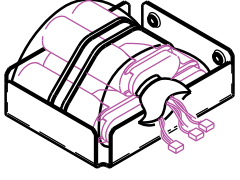
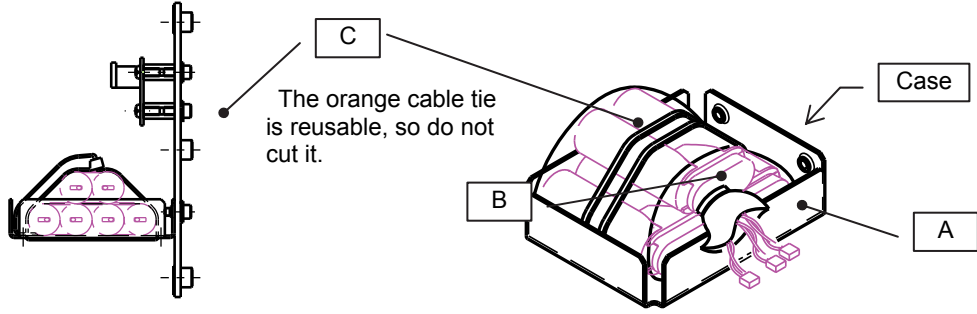
| | |
|------------------|--|
| IMPORTANT | Replace batteries every 5 years , under the condition that operation time length is 8h/day and shut down the power 16h/day. |
| IMPORTANT | The replacement period varies with use environments (mainly temperatures). If the battery voltage drops below the given 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 | <p>Discarding lithium batteries according to your local trash separation rule</p> <p>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”.</p>  |

Tools required

- M6 torque wrench (Tightening torque: 8.8 N·m)
- Double-sided adhesive tape
- Nipper, Cable tie


Battery replacement procedures



| No. | Contents of operation |
|-----|---|
| 1 | Turn ON the power supply of the controller. |
| 2 | Press the emergency stop button. |
| 3 | <p>Remove the following bolt that fix the battery unit mounting plate on the left side panel of the BJ1 box.</p>  |
| 4 | <p>Pull out the battery unit from the BJ1 box.</p>  |

| No. | Contents of operation |
|-----|---|
| 5 | <p>Disconnect the connectors CNBAT1, CNBAT2 and CNBAT3 from the battery.</p>  <p>An error (the drop in the encoder battery voltage) occurs, but this is not an operational issue.</p> |
| 6 | <p>Dismount cable tie C and remove the battery unit from the case.</p>  <p>The orange cable tie is reusable, so do not cut it.</p> |
| 7 | <p>Mount a new battery unit using cable tie C on the case.</p> <p>When replacing each battery independently (the two batteries at a time);</p> <ol style="list-style-type: none"> (1) Put the battery in a plastic bag, and tighten cable tie A. (2) Tie the plastic bag with cable tie B. (3) Mount a battery unit using cable tie C on the case. |
| 8 | Connect the connectors CNBAT1, CNBAT2 and CNBAT3 to the new battery. |
| 9 | Reinstall the battery unit mounting plate, and then fix it with the following bolt. |
| 10 | Turn OFF the power of the controller once, and turn ON it again. |

4.4 Belt replacement


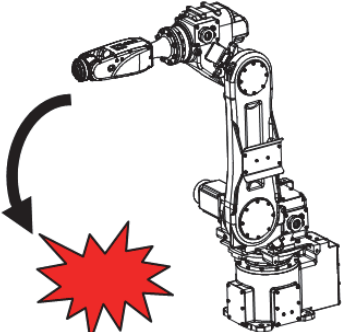
When belt needs to be replaced, follow the procedure written below.

| | |
|---|--|
|  WARNING | Never forget to hold robot arm or wrist/tool in advance. If belt is dismounted without supporting them, wrist and tool will fall down or will rotate quickly in case of wrist axes, possibly resulting in serious injury. |
|---|--|

| No. | Contents of operation | Points |
|-----|--|--|
| 1 | Turn ON the motor power to get ready for manual operation. | |
| 2 | Lower or raise the wrist axis to a position where belt can be replaced easily. | If tool is mounted, rotate axis 5 and 6 manually to adjust the belt so that the tension is applied to the belt evenly. |
| 3 | Turn OFF the power supply of controller. | |
| 4 | Hold robot arm or wrist/tool. | |
| 5 | Remove the cover. | |
| 6 | Loosen 3 motor flange fixing bolts, and move motor position. | |
| 7 | Remove the belt from the two pulleys. | |
| 8 | Attach a new belt to the two pulleys. | |
| 9 | By moving motor position, adjust the belt tension to the specified tensions: After finishing it, fix the motor flange fixing bolts by specified torque. At last, fix cover.  Refer to "3.5 inspection and adjustment of belt" | |
| 10 | Release robot arm or wrist/tool. Then turn ON the power supply of controller. | |
| 11 | Perform the encoder correction.  Refer to "5.2.6 Encoder Correction" | |
| 12 | Check the robot has no problem with the movement. | |

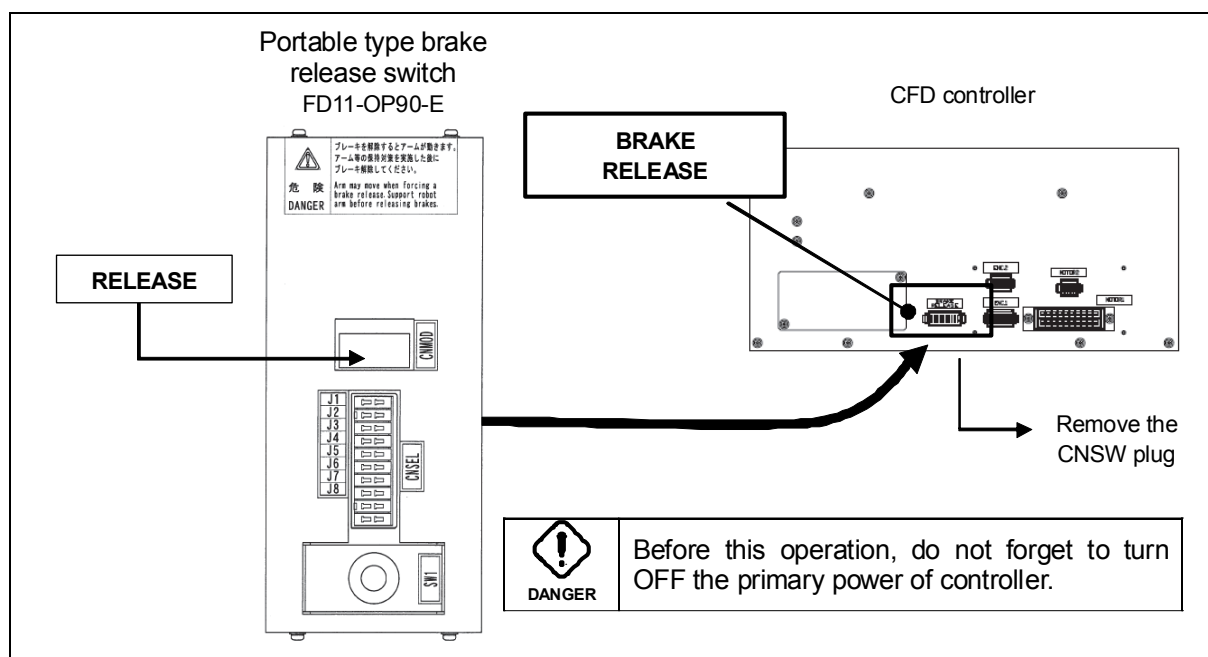
4.5 Forcible brake release (option)

Brake release switch (option) can be used to release the brake in one motor. This is useful for the situation such as that motor power cannot be turned ON because of servo error, or operator is pinched by robot arm. Please operate this switch by following to the procedure written below.

| | | |
|--|---|---|
|  DANGER | <p>When releasing a brake, the robot arm may fall down or move fast towards unexpected direction. Therefore, this releasing operation must be performed after confirming the axis number to be released and fixing the robot arm securely via cranes etc. Death or serious injury may result if you make contact with the robot arm or are squeezed between the robot arm and another part.</p> <p>In case of an axis that falls down because of the gravity, please release the brake after taking steps to hold or support the robot arm and any other parts. The longer the brake release switch is pressed, the larger the shock of falling down may get. Therefore, the pressing time should be short.</p> |  |
|--|---|---|

■ In case of CFD controller

| No. | Contents of operation |
|-----|---|
| 1 | Turn OFF the power of this controller. |
| 2 | Remove the jumper plug CNSW that is in the BRAKE RELEASE connector on the back side panel and insert the CNSW of this option's cable instead. (Please keep the jumper plug until finishing this brake releasing operation because this plug is necessary) |
| 3 | Check that RELEASE plug is in the CNMOD connector. |
| 4 | Pull out an axis selection connector from the CNSEL bottom side and then insert it to the desired position (axis number). |
| 5 | Turn ON the power of this controller. |
| 6 | Only while pressing the SW1, the brake of the selected axis number will be released. (At this time, the robot arm may fall down or move fast. Please do not forget to take a preventive measure before pressing the SW1.) |
| 7 | After finishing the brake release operation, insert the connectors to their original positions. Do not forget to put the jumper plug CNSW to the BRAKE RELEASE on the backside of this controller again. |




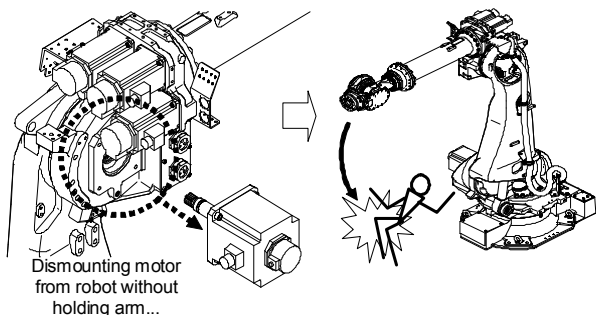



■ In case of FD controller

Please refer to the chapter 2 of the
“FD CONTROLLER INSTRUCTION MANUAL CONTROLLER MAINTENANCE”.

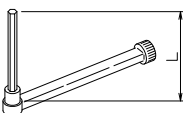
4.6 Oil seal replacement

In axis 2 and axis 3 axis, oil seal is used so that grease does not ooze out from reduction gear input shaft portion. If this oil seal is damaged, oozed grease may flow into motor and resulted in serious trouble.

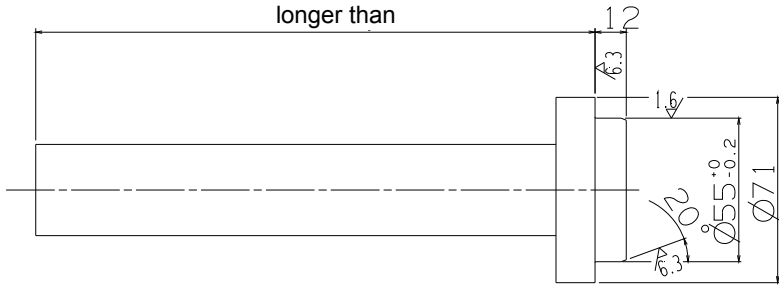
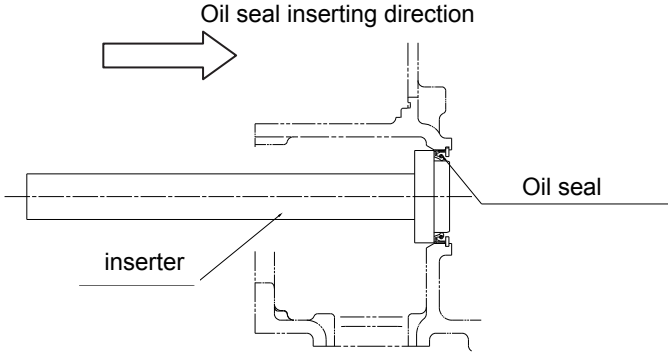
In case this robot is used for palletizing application, .replace this seal every 2 years.

|  WARNING | <p>Never forget to hold robot arm or wrist/tool in advance. If motor is dismantled without supporting them, forearm will fall down or will jump up (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.</p> <p>To hold robot arm, use a crane or chain block etc. In case of 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.</p>  <p>Dismounting motor from robot without holding arm...</p> | | | | | | |
|--|---|------------|--------|--------|-----|--------|--------|
|  CAUTION | <p>When touching the motor immediately after robot stops, check that motor is not hot and then touch it with care.</p> | | | | | | |
|  CAUTION | <p>The motor mass is listed below. Consequently, handle the motor with care.</p> <table><tr><th>Robot type</th><th>Axis 2</th><th>Axis 3</th></tr><tr><td>all</td><td>7.8 kg</td><td>3.1 kg</td></tr></table> | Robot type | Axis 2 | Axis 3 | all | 7.8 kg | 3.1 kg |
| Robot type | Axis 2 | Axis 3 | | | | | |
| all | 7.8 kg | 3.1 kg | | | | | |
|  CAUTION | <p>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 stay on guard to press an Emergency Stop button at any time, while the other person must promptly finish the work with thorough attention paid to the robot operating area. Furthermore, prior to starting the work, check for safe corridors.</p> | | | | | | |

Tools required (prepared by customer)

| Tool name | Axis name | Part No. (Model) | Remark |
|---|-----------|--|--------|
|  | Axis 2 | M8 torque wrench (Long type: Not less than 200 mm in length) | |
| | Axis 3 | M5 torque wrench (Long type: Not less than 180 mm in length) | |
| Grease | Axis 2~3 | ALVANIA RA-J | |
| Lubricator | Axis 2~3 | Three bond 1801B | |



Oil seal replacement procedure (axis 2 and 3)

| No. | Contents of operation | Points |
|-----|---|---|
| 1 | Dismount motor from robot body by referring to “5.2.1 Motor replacement (axis1, 2 and 3)” No.1～9. | |
| 2 | Remove oil seal. | Do not hurt housing when removing oil seal. Damaged housing may cause oil oozing. |
| 3 | <p>Apply grease (molywhite RE00) thinly on rip portion of new oil seal. Attach new oil seal on robot body with bewareing its direction. When attaching oil seal, do not incline it and insert it surely to the end. If following inserter is not used, prepare the flat panel and push all of seal equally so that it is not inclined. (Seal diameter is $\phi 72\text{mm}$)</p> <p style="text-align: center;">Axis 2, 3 axis Oil seal inserter (option) longer than</p>  <p style="text-align: center;">Oil seal inserting direction</p>  | <p>For this procedure, adequate jig is recommended. (refer to figure written below) NACHI prepares this inserter as option. (👉 “6 Recommended spare parts and special tools for maintenance”)</p> |
| 4 | Mount motor to robot body by referring to “5.2.1 Motor replacement (axis 1, 2 and 3)” No.12～20. | |
| 5 | <p>Perform encoder reset and encoder correction. 👉 “5.2.5 Encoder Reset” 👉 “5.2.6 Encoder Correction”</p> | |

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.

| Symptom \ Defective part | 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.

| | |
|---|--|
|  CAUTION | <p>To drive a robot without supplying power to the motor, the brake release switch must be operated.</p> <p>Since the arm may move forward, backward or drop when the brake is released, support the arm by a crane or chain block prior to beginning the operation. Especially in case of axis 2, forearm will fall down or will jump up due to the payload and robot posture. So after supporting arm, release brake by inching operation to see the moving direction of forearm and to secure that supporting method is adequate.</p> |
|---|--|

■ Fulcrum bearing

If a fulcrum bearing is damaged, vibration or abnormal sounds will be produced, thus resulting in overload. Furthermore, if a bearing lock nut gets unfastened, the bearing will cause backlash and play, thus resulting in damage to the bearing.

- | | |
|-------------|---|
| Diagnostics | <ul style="list-style-type: none"> • Check whether there is any backlash or play in the bearing by applying loads on the wrist or the arm. (If a chain block or the like is available, hold the configurations of the wrist and arm with the chain block so as to apply no loads to the reduction gear.) • Check whether or not the robot hits against the peripheral equipment or else before an abnormality occurs. |
| Resolutions | <ul style="list-style-type: none"> • Bearings need to be replaced. 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 may completely stop or cause displacement.

Main Axes (Axis 1, 2 and 3)

- | | |
|-------------|---|
| Diagnostics | <ul style="list-style-type: none"> • 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 or scratch with the brake release switch (option) of axis 1 set to "ON". Check whether or not any abnormality is felt by hand through holding the forearm to swivel the robot. • 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. |
| Resolutions | <ul style="list-style-type: none"> • Reduction gear needs to be replaced. Contact our Service Department. |

Wrist axes (Axis 4, 5 and 6)

- | | |
|-------------|--|
| Diagnostics | <ul style="list-style-type: none"> • 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 tool. • Check whether or not the axis can be moved by hand with the brake release switch (option) set to "ON". If the axis cannot be moved, the reduction gear has 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. |
| Resolutions | <ul style="list-style-type: none"> • Reduction gear or whole wrist part need to be replaced. Contact our Service Department. |

| | |
|---|---|
|  IMPORTANT | <p>The replacement of the reduction gear needs time and equipment. Replacing the whole wrist part enables prompt and reliable remedy.</p> |
|---|---|

■ Brakes

If any brake causes an abnormality, an axis may drop when motor power OFF. Furthermore, when motor power ON, the brake may remain locked, thus resulting in overload or noises.

- | | |
|-------------|---|
| Diagnostics | <ul style="list-style-type: none"> • Check whether or not the brake produces clicking sound through setting the brake release switch (option) to ON and OFF. If no operating sounds, it is assumed that the brake has a broken wiring. |
| Resolutions | <ul style="list-style-type: none"> • Check for brake wirings. Since the motor with an integrated brake for all axes is used, if no wirings are broken, replace the motor. (👉 "5.2 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.

- Diagnostics •Check for any abnormal sounds, or abnormal heat generation.
 Resolutions •Replace the motor. (👉 "5.2 Motor replacement")

■ Encoder

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.

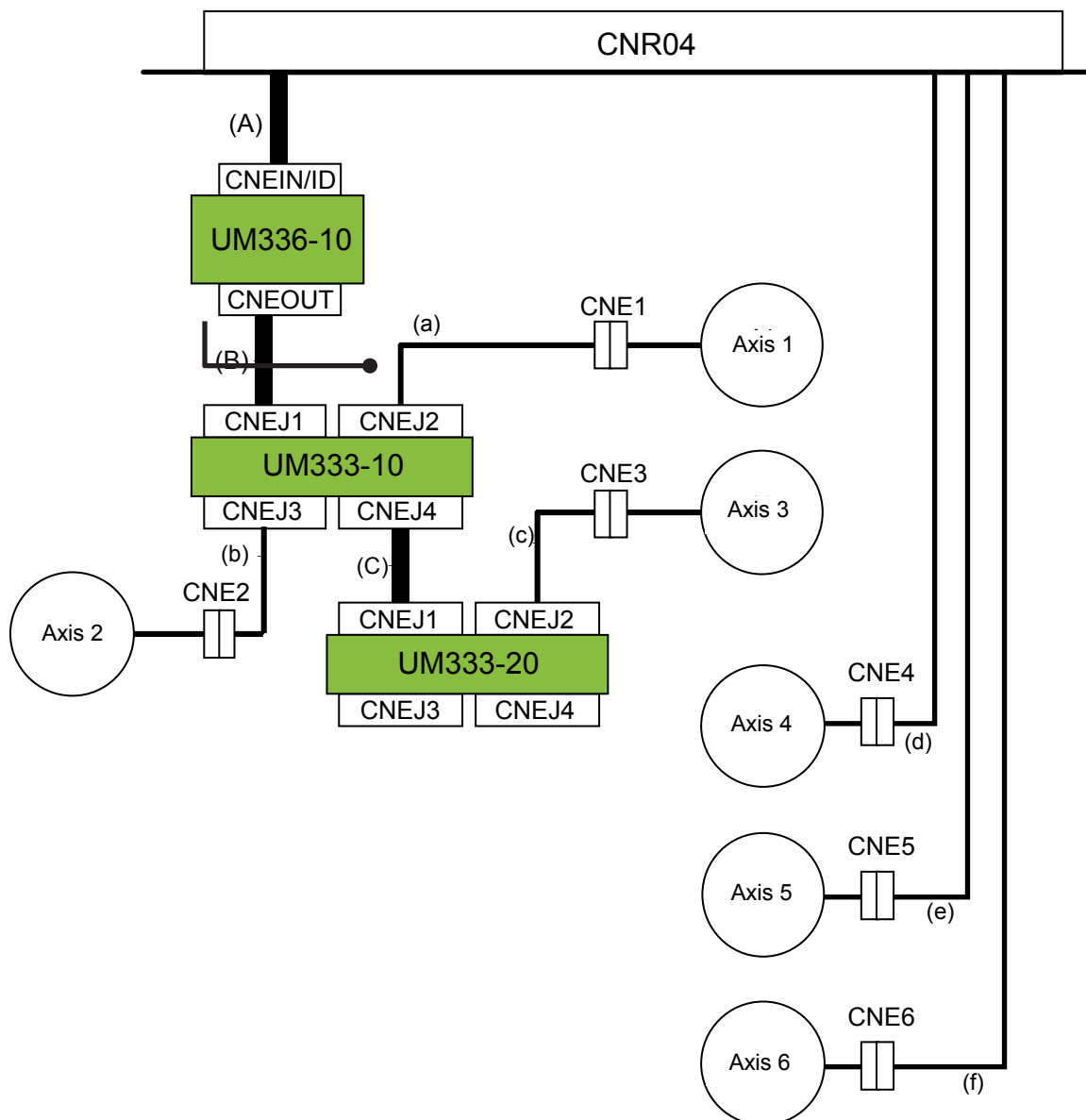
- Diagnostics **If an abnormality occurs on a single axis**
 Check the items listed as below. (👉 See figures on next page)
 •The encoder units (From axis1 to 6).
 •Wiring between the encoder branch board (UM333) and motor (From (a) to (f)).

| Axis names in which the errors are occurs | Encoder unit | | | | | | Wiring | | | | | |
|---|--------------|--------|--------|--------|--------|--------|--------|-----|-----|-----|-----|-----|
| | Axis 1 | Axis 2 | Axis 3 | Axis 4 | Axis 5 | Axis 6 | (a) | (b) | (c) | (d) | (e) | (f) |
| Axis 1 | ○ | | | | | | ○ | | | | | |
| Axis 2 | | ○ | | | | | | ○ | | | | |
| Axis 3 | | | ○ | | | | | | ○ | | | |
| Axis 4 | | | | ○ | | | | | | ○ | | |
| Axis 5 | | | | | ○ | | | | | | ○ | |
| Axis 6 | | | | | | ○ | | | | | | ○ |

- Diagnostics **If an abnormality occurs on two or more axes simultaneously**
 Check the items listed as below. (👉 See figures on next page)
 •The power supply boards of the encoder (UM336).
 •The encoder branch boards (UM333).
 •Wirings connecting between the encoder branch boards (UM333) (From (A) to (C)).

| Axis names in which the errors are occurs | Printed circuit board | | | Wiring | | |
|---|-----------------------|----------|----------|--------|-----|-----|
| | UM336-10 | UM333-10 | UM333-20 | (A) | (B) | (C) |
| Axis 1, 2, 3 | ○ | ○ | | ○ | ○ | |
| Axis 3 | | | ○ | | | ○ |

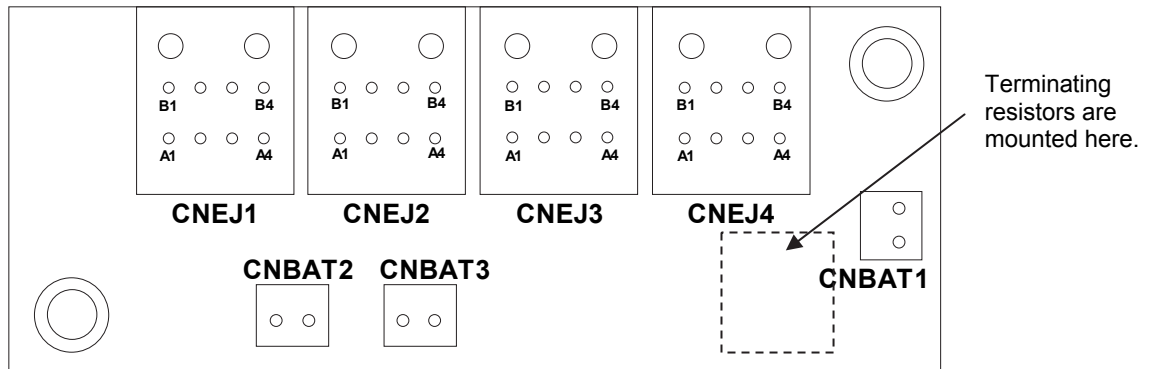
- Diagnostics **Other items to be checked**
 •Align the zeroing pin with the reference position, and then check the position data for any errors.
 •Move each axis of the robot to check whether or not there are any points in which data (bits) show irregular changes.
 •Check the controller for the model of drive unit. Drive unit type varies due to the number of robot type. If any drive unit of the corresponding model is available, replace the drive unit to check whether or not the symptom is transferred to this drive unit. Refer to the controller maintenance manual.
- Resolutions •If the encoder branch board or the power supply board of the encoder is damaged, replace the damaged board
 •Check for brake wirings. If no wirings are broken, replace the motor (👉 "5.2 Motor replacement"). If any wirings are broken, replace the wiring.
 •If the symptom is transferred to this drive unit, replace this drive unit.



| | |
|--------------------|--|
| CAUTION | <p>If the encoder is left with the battery completely exhausted, or power of $5VDC \pm 5\%$ not supplied to the encoder from the controller, data saved in the encoder may be lost, thus disabling the encoder to properly operate. In the cases like this, reset the encoder. (👉 "5.2.5 Encoder reset".)</p> |
| CAUTION | <p>This robot uses the bus line method for communication between its encoders. Therefore, in an abnormal situation, errors may be displayed on two or more or all of the axes simultaneously.</p> |

Encoder branch board UM333-10/20

- Features:
- Connectors for the encoder data backup batteries.
 - Relay / branch function for the encoder cable (Communication lines and power supply lines).
 - Terminating resistors (Only on UM333-20).



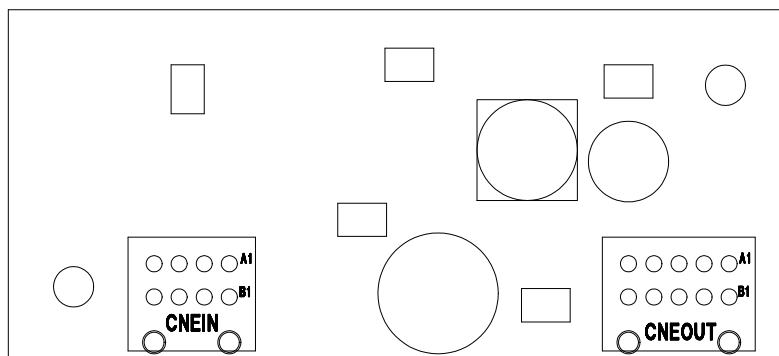
| Connector name | Function | Destination |
|----------------|--------------------------|---|
| CNEJ1 | Encoder connection (IN) | This is an input port from the previous stage. (NOTE) In case of the 1st stage, the output from the UM336-10 (CNEOUT) is connected here. |
| CNEJ2 | Encoder connection (OUT) | This is an output port to the next stage. |
| CNEJ3 | Encoder connection (OUT) | This is an output port to the next stage. |
| CNEJ4 | Encoder connection (OUT) | This is an output port to the next stage. |
| CNBAT1 | Battery connection | Not used |
| CNBAT2 | Battery connection | |
| CNBAT3 | Battery connection | |



If the connectors on this PCB are disconnected, the power is not supplied for the following encoders and encoder errors may occur. Therefore, it is strongly recommended to set every axis to the reference position (where the zeroing pin can be inserted) in advance of disconnecting the connectors. If the robot is set to this reference posture, the encoder correction procedure will become easier.

Encoder power supply board UM336-10

- Features:
- Relay / branch function for the encoder cable (Communication lines and power supply lines).
 - Converting the encoder power supply voltage.



| Connector name | Function | Destination |
|----------------|--------------------------|--|
| CNEIN / ID | Encoder connection (IN) | CNEIN from the CNR04 is connected here. |
| CNEOUT | Encoder connection (OUT) | Connected to the CNEJ1 on the next stage UM333-10. |



If the connectors on this PCB are disconnected, the power is not supplied for the following encoders. At this time, if any batteries are not connected to the PCB "UM333-10(#1)", the data of the encoders will become abnormal. Be careful.

■ Belt (Axis 5, 6)


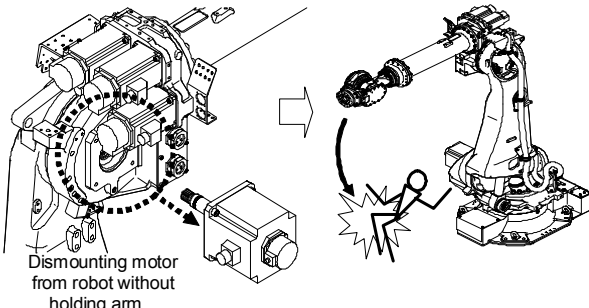



If a belt is damaged, vibration or abnormal sounds will be produced, thus resulting in overload. Furthermore, the robot may completely stop or cause displacement. If a belt breaks, the axes may drop.

- | | |
|-------------|--|
| Diagnostics | •While in operation, check for any vibration or abnormal sounds. •Check the belts for excessive wear. |
| Resolutions | •Replace the belt. (👉 "4.4 Belt replacement") |

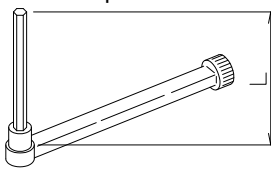
■ Tool

- | | |
|-------------|--|
| Diagnostics | •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. |
| Resolutions | •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 | <p>Never forget to hold robot arm or wrist/tool in advance. If motor is dismounted without supporting them, forearm will fall down or will jump up (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.</p> <p>To hold robot arm, use a crane or chain block etc. In case of axis 2 and 3, wooden blocks or fixing jig set (option) can be used.</p> <p>Note that zeroing pin and block are not for supporting arm.</p> <p>Furthermore, Never attempt to hold robot arm with hands.</p>  <p>Dismounting motor from robot without holding arm...</p> | | | | | | | | | | |
|---|---|------------|-----------|--------|-----------|--------|----------|--------|--------|--------|--------|
|  CAUTION | <p>When touching the motor immediately after robot stops, check that motor is not hot and then touch it with care.</p> | | | | | | | | | | |
|  CAUTION | <p>The motor mass is listed below. Consequently, handle the motor with care.</p> <table><tr><th>Robot type</th><th>Axis 1, 2</th><th>Axis 3</th><th>Axis 4, 5</th><th>Axis 6</th></tr><tr><td>MC10S-01</td><td>7.8 kg</td><td>3.1 kg</td><td>1.7 kg</td><td>1.3 kg</td></tr></table> | Robot type | Axis 1, 2 | Axis 3 | Axis 4, 5 | Axis 6 | MC10S-01 | 7.8 kg | 3.1 kg | 1.7 kg | 1.3 kg |
| Robot type | Axis 1, 2 | Axis 3 | Axis 4, 5 | Axis 6 | | | | | | | |
| MC10S-01 | 7.8 kg | 3.1 kg | 1.7 kg | 1.3 kg | | | | | | | |
|  CAUTION | <p>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 stay on guard to press an Emergency Stop button at any time, while the other person must promptly finish the work with thorough attention paid to the robot operating area.</p> <p>Furthermore, prior to starting the work, check for safe corridors.</p> | | | | | | | | | | |

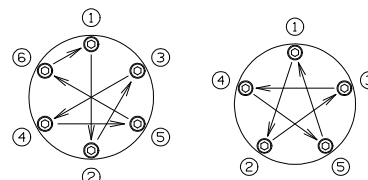
Tools required (Prepared by customer)

| Tool name | Axis name | Part No. (Model) | Remark |
|---|--------------|--|--------|
|  | Axis 1 | M8 torque wrench (Long type: Not less than 200 mm in length) | |
| | Axis 2 | M8 torque wrench (Long type: Not less than 200 mm in length) | |
| | Axis 3 | M5 torque wrench (Long type: Not less than 180 mm in length) | |
| | Axis 4 | M4 torque wrench (Long type: Not less than 200 mm in length) | |
| | | M6 torque wrench | |
| | Axis 5 | M3 torque wrench | |
| | | M4 torque wrench (Long type: Not less than 200 mm in length) | |
| | Axis 6 | M3 torque wrench | |
| | | M4 torque wrench (Long type: Not less than 200 mm in length) | |
| Screw lock | Axis 1,4,5,6 | Three bond 1374 | |
| Grease | Axis 1 to 4 | ALVANIA RA-J | |
| Lubricator | Axis 1 to 3 | Three bond 1801B | |

The “coupling gear set” described in the chapter 6 includes motor fixing bolts, O-rings, sheet packing also. When replacing a motor unit, it is recommended to replace the old bolts, O-rings and sheet packings to the new ones that are included in the set in spite of their damage level.

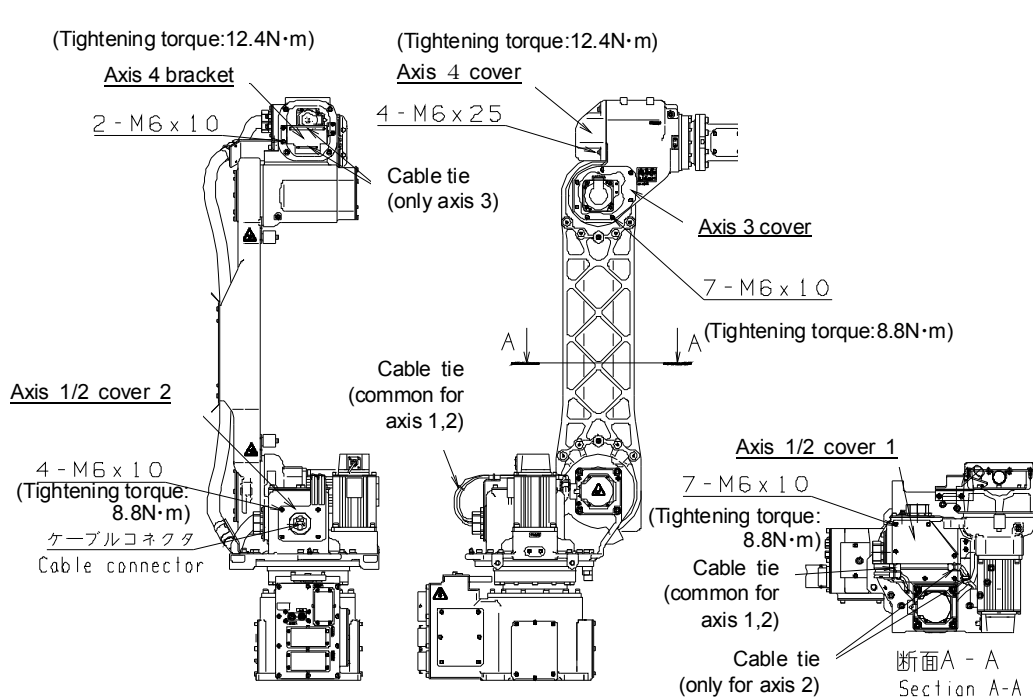
Be absolutely sure to use the torque wrench to tighten the bolts.

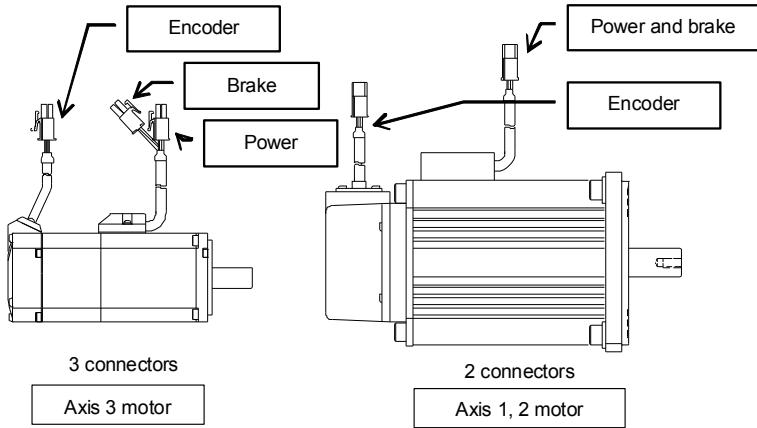
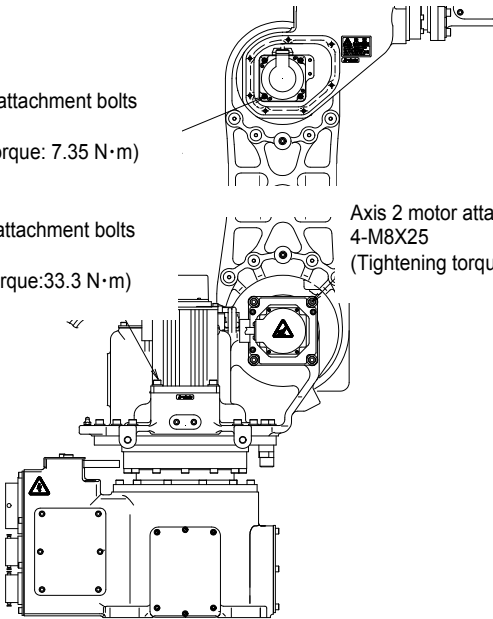
In case of the bolts on circumference, tighten them equally and gradually.

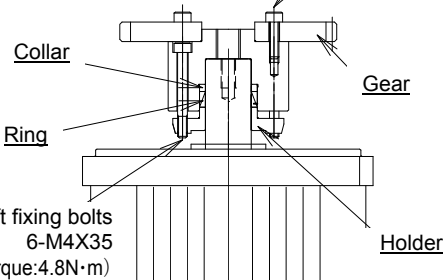
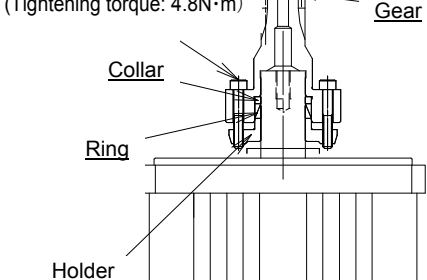
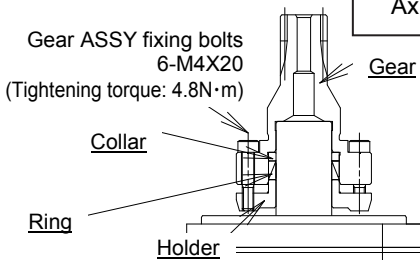
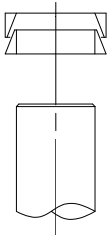
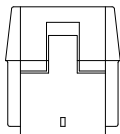
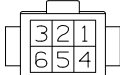


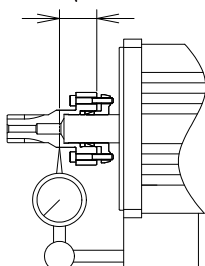


Order to tighten bolts

5.2.1 Motor replacement procedure (Axis 1, 2 and 3)

| No. | Contents of operation | Points |
|-----|---|--|
| 1 | Register the encoder ID of the axis concerned (the motor of which is to be replaced). (☞ "5.2.4 Writing encoder ID (Axis 1, 2 and 3)") | This robot uses the bus line system for encoder communication. When replaced, its encoder ID must be registered. |
| 2 | Turn ON the motor power to get ready for manual operation. | If an abnormality has occurred, and the axis cannot be operated manually, then proceed with the step 4. |
| 3 | If possible, operate the axis concerned to the reference position, then insert the zeroing pin. (☞ "5.2.6 Encoder correction") | If zeroing pin is inserted in advance, there is some case that the work after replacement is easier. |
| 4 | Hold the arm using a crane or chain block, etc. | |
| 5 | Press the emergency stop button, and then turn OFF the power of the controller. | |
| 6 | <p>Remove the cover and bracket of the axis concerned, and then remove the cable tie that bundle the cable.</p> <p> <u>Axis 1</u> Axis 1/2 cover 1, Axis 1/2 cover 2, Cable connector <u>Axis 2</u> Axis 1/2 cover 1, Axis 1/2 cover 2, Cable connector <u>Axis 3</u> Axis 3 cover, Axis 4 cover, Axis 4 bracket </p>  <p> (Tightening torque:12.4N·m) Axis 4 bracket 2 - M6 x 10 (Tightening torque:12.4N·m) Axis 4 cover 4 - M6 x 25 Cable tie (only axis 3) Axis 3 cover 7 - M6 x 10 (Tightening torque:8.8N·m) Axis 1/2 cover 2 4 - M6 x 10 (Tightening torque: 8.8N·m) ケーブルコネクタ Cable connector Cable tie (common for axis 1,2) Axis 1/2 cover 1 7 - M6 x 10 (Tightening torque: 8.8N·m) Cable tie (common for axis 1,2) Cable tie (only for axis 2) 断面A - A Section A-A </p> | |
| 7 | Disconnect the connector from the motor. (In order to remove the connector of axis 3, separate cable tie that fix axis 4 bracket and the wiring bunch. There is axis 3 connector in the wiring bunch.) | The encoder data is erased when the encoder connector is disconnected. Do not apply large pressure onto the encoder connector. If large pressure is applied, the connector may be broken. |


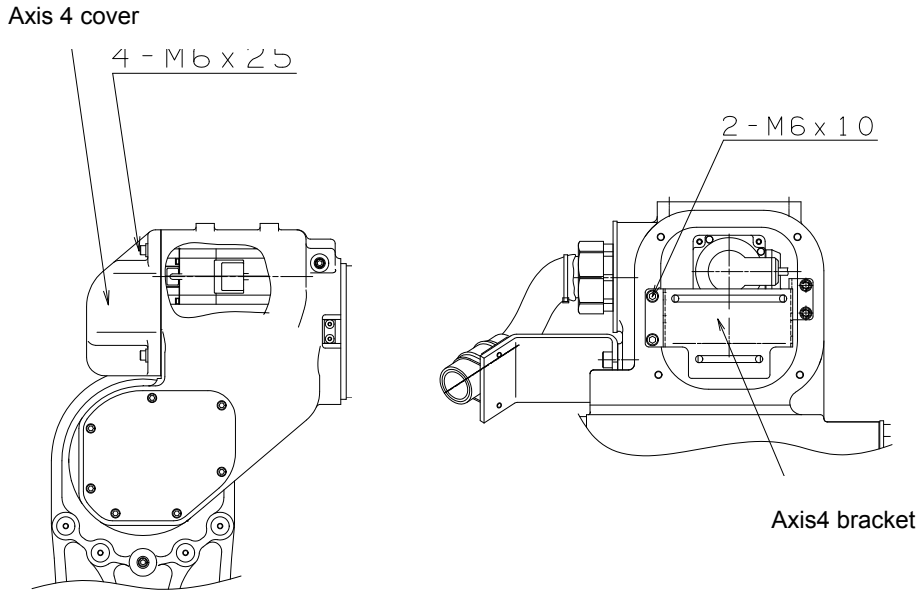
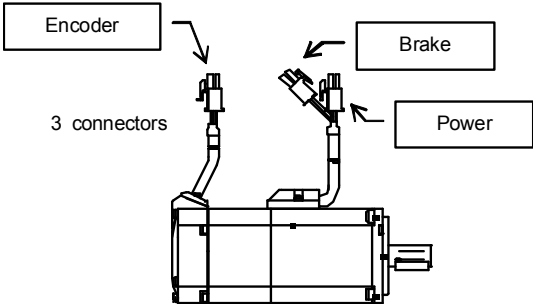
| No. | Contents of operation | Points |
|-----|--|--|
| |  <p>3 connectors Axis 3 motor</p> <p>2 connectors Axis 1, 2 motor</p> | |
| 8 | In case of axis 2 and 3, prepare a plastic bag to the bottom of the motor to catch the grease that drips from it. | Affix the plastic bag to the motor firmly, using adhesive tape or the like. |
| 9 | <p>Remove the following motor attachment bolts, and then remove the motor from the robot.</p>  <p>Axis 3 motor attachment bolts 4-M5X20 (Tightening torque: 7.35 N·m)</p> <p>Axis 1 motor attachment bolts 4-M8X25 (Tightening torque: 33.3 N·m)</p> <p>Axis 2 motor attachment bolts 4-M8X25 (Tightening torque: 33.3 N·m)</p> | <ul style="list-style-type: none"> • Do not give a high impact to the motor shaft. • Be careful not to cause damage to the lip of oil seal by the gear mounted to the motor shaft. |
| 10 | <p>Remove the gear assembly from the motor.</p> <p>Axis 1</p> <ol style="list-style-type: none"> 1. Remove “Gear Assy fixing bolts”, and then remove the gear. 2. Remove “Shaft fixing bolts”, and then remove collar, two rings, and holder. <p>Axis 2</p> <ol style="list-style-type: none"> 1. Remove “Gear Assy fixing bolts”, and then remove the gear. 2. Remove collar, two rings, and holder. <p>Axis 3</p> <ol style="list-style-type: none"> 1. Remove “Gear Assy fixing bolts”, and then remove the gear. 2. Remove collar, two rings, and holder. | Do not give a high impact to the motor shaft. |

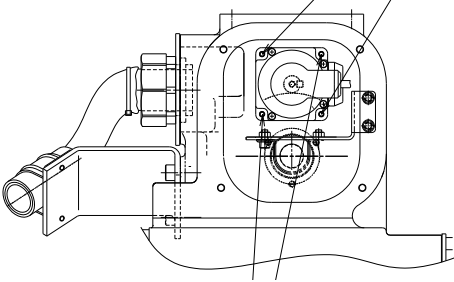
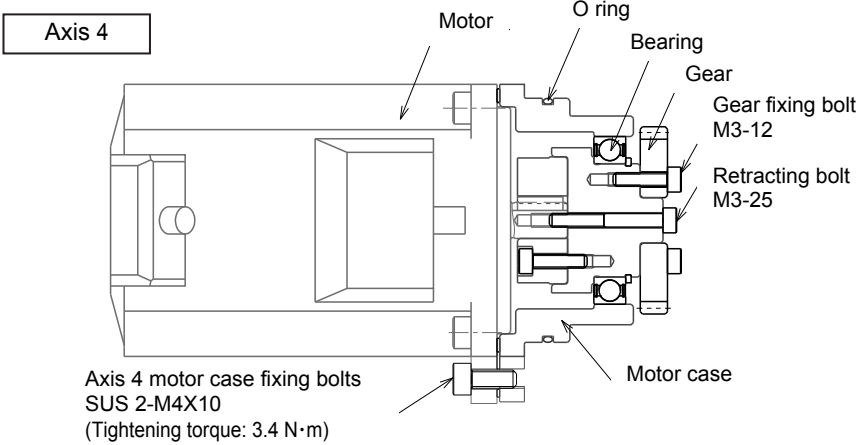
| No. | Contents of operation | Points | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
|---------|---|--|-------|--------|---|-----|---|---|-------|---|---|-------|---|---|--------------|---|---|--------|-------|---|--------|-------|---------|-------|--------|---|--------|-------|---|--------|-------|
| | <div><div><div><div>Axis 1</div><div></div></div><div><div>Gear ASSY fixing bolts 6-M4X15 (Tightening torque: 4.8N·m)</div><div></div></div><div><div>Gear ASSY fixing bolts 6-M4X20 (Tightening torque: 4.8N·m)</div><div></div></div></div></div> | <div><div>Axis 2</div><div>Gear ASSY fixing bolts 6-M4X25 (Tightening torque: 4.8N·m)</div><div>Gear</div><div>Collar</div><div>Ring</div><div>Holder</div></div> <div><div>Axis 3</div><div>Gear ASSY fixing bolts 6-M4X20 (Tightening torque: 4.8N·m)</div><div>Gear</div><div>Collar</div><div>Ring</div><div>Holder</div></div> | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 11 | <p>Mount the removed gear assembly to a new motor.</p> <p>Axis 1</p> <ol style="list-style-type: none">1. Mount collar, two rings, and holder to the motor shaft with “Shaft fixing bolts”.2. Apply one or two drops a screw lock (THREEBOND 1374) to a thread, and mount the gear with “Gear Assy fixing bolts”. <p>Axis 2, 3</p> <ol style="list-style-type: none">1. Mount collar, two rings, and holder to the motor shaft.2. Apply a thin coating of grease (Alvania RA-J) to the boss (mating surface of the oil seal) of the gear, and mount the gear with “Gear Assy fixing bolts”3. Check the <i>run-out tolerance</i> of the gear. If the run-out tolerance exceeds 0.03 mm, loosen “Gear Assy fixing bolts” and try again from step 2. | <ul style="list-style-type: none">• Apply a thin coating of THREEBOND 1801B to the shaft of the new motor and the two rings.• When mounting the rings, be careful to place them correctly. <div></div> <ul style="list-style-type: none">• Do not give a high impact to the motor shaft. | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | <p><How to measure the “run-out tolerance”></p> <p>It is necessary to release the brake inside the motor and rotate the gear by hand. To release the brake, add DC24V voltage in the CNMB* connector.</p> <p>Axis 2: 5→+24V, 6→0V Axis 3: 1→+24V, 2→0V</p> <p>Run-out tolerance should be measured on the boss of gear using a dial gauge.</p> <div><div><div>Axis 2 Power and brake connector</div><div></div><div></div></div><div><div>Axis 3 Power and brake connector</div><div></div><div></div></div></div> <div><div>Axis 2: 24~27mm Axis 3: 23~26mm</div><div></div></div> <table><tr><th>Pin No.</th><th>color</th><th>signal</th></tr><tr><td>1</td><td>Red</td><td>U</td></tr><tr><td>2</td><td>Black</td><td>V</td></tr><tr><td>3</td><td>White</td><td>W</td></tr><tr><td>4</td><td>Green/Yellow</td><td>E</td></tr><tr><td>5</td><td>Yellow</td><td>Brake</td></tr><tr><td>6</td><td>Yellow</td><td>Brake</td></tr></table> <table><tr><th>Pin No.</th><th>color</th><th>signal</th></tr><tr><td>1</td><td>Yellow</td><td>Brake</td></tr><tr><td>2</td><td>Yellow</td><td>Brake</td></tr></table> | Pin No. | color | signal | 1 | Red | U | 2 | Black | V | 3 | White | W | 4 | Green/Yellow | E | 5 | Yellow | Brake | 6 | Yellow | Brake | Pin No. | color | signal | 1 | Yellow | Brake | 2 | Yellow | Brake |
| Pin No. | color | signal | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 1 | Red | U | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 2 | Black | V | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 3 | White | W | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 4 | Green/Yellow | E | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 5 | Yellow | Brake | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 6 | Yellow | Brake | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Pin No. | color | signal | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 1 | Yellow | Brake | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 2 | Yellow | Brake | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |

| No. | Contents of operation | Points |
|-----|--|---|
| 12 | Apply an appropriate coating of grease (Alvania RA-J) to the gear tooth surface, and mount the motor to the robot. | <ul style="list-style-type: none"> • Use a torque wrench for tightening bolts. Carefully and evenly tighten the bolts. • When mounting the motor, be careful not to damage any gear tooth. • If the O ring of the motor flange is damaged, replace the O-ring. (👉 "6 Recommended spare parts and special tools for maintenance") |
| 13 | Connect the connector to the motor. | |
| 14 | Mount the cover and the bracket to the robot. | |
| 15 | Attach the cable tie that bundle the cable. | |
| 16 | When axis 2 or 3 motor is replaced, refill the same amount of grease as that discharged. | |
| 17 | Reset the encoder on the axis concerned. (👉 "5.2.5 Encoder reset ") | |
| 18 | Correct the encoder on the axis concerned. (👉 "5.2.6 Encoder correction") | |
| 19 | Remove the zeroing pin. | If the zeroing pin is not removed before the robot is operated, the pin or the pin hole may deform. As a result, it may not be possible to remove the pin or the subsequent encoder corrections may not be performed correctly. |
| 20 | Check to be sure that the robot has no problem with the movement. | |

This now completes the replacement procedure of axis 1, 2 and 3 motors.

5.2.2 Motor replacement procedure (Axis 4)

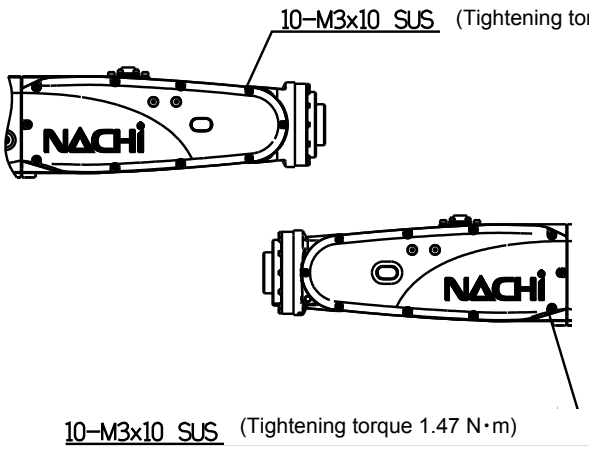
| No. | Contents of operation | Points |
|-----|---|--|
| 1 | Turn ON the motor power to get ready for manual operation. | If an abnormality has occurred, and the axis cannot be operated manually, then proceed with the step 3. |
| 2 | Operate the axis concerned to the position where the zeroing pin can be inserted, then insert the pin. ( "5.2.6 Encoder correction") | If zeroing pin is inserted in advance, there is some case that the work after replacement is easier. |
| 3 | Hold the arm using a crane or chain block, etc. | |
| 4 | Press the emergency stop button, and then turn OFF the power of the controller. | |
| 5 | Remove the cover and bracket of axis 4.  <p>Axis 4 cover</p> <p>4 - M6 x 25</p> <p>2 - M6 x 10</p> <p>Axis4 bracket</p> | |
| 6 | Disconnect the connector from the motor.  <p>Encoder</p> <p>Brake</p> <p>Power</p> <p>3 connectors</p> | The encoder data is erased when the encoder connector is disconnected. Do not apply large pressure onto the encoder connector. If large pressure is applied, the connector may be broken. |
| 7 | Prepare a vinyl bag to the bottom of the motor to catch the grease that drips from it. | Affix a vinyl bag to the motor firmly, using adhesive tape or the like. |
| 8 | Remove "motor attachment bolts", and then dismount the motor assembly from the robot. There is no need to remove "motor case fixing bolts". | |

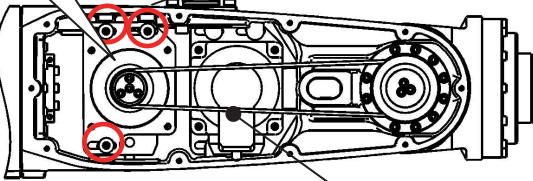
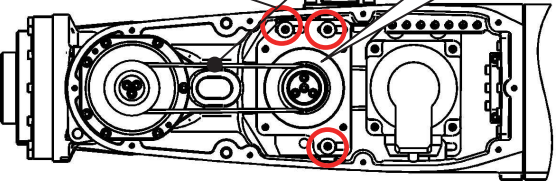
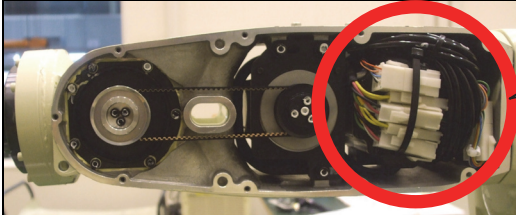
| No. | Contents of operation | Points |
|-----|--|---|
| | <p>Axis 4 motor attachment bolts 2-M4X25 (Tightening torque: 3.63 N·m)</p>  <p>Axis 4 motor case fixing bolts 2-M4X15 (Tightening torque: 3.4 N·m)</p> | |
| 9 | <p>Dismount the gear and pulley from the motor.</p> <ol style="list-style-type: none"> 1. Unfasten “retaining set screws”. 2. Remove the gear using a pulley puller. 3. Remove “motor case fixing bolts”, and then dismount the motor case from the motor.  | <ul style="list-style-type: none"> • Do not give a high impact to the motor shaft. • Use a commercially available pulley puller to remove the gear and the pulley. Special jigs for removing the gear and the pulley are also available. Refer to “6 Recommended spare parts and special tools for maintenance” and contact our Service Department if you need the jigs. |
| 11 | <p>Mount the removed gear and pulley to a new motor.</p> <ol style="list-style-type: none"> 1. Loosely mount the motor case to the motor with “motor case fixing bolts”. If the O-ring is damaged, replace it. (☞ “6 Recommended spare parts and special tools for maintenance”) 2. Mount the gear to the motor shaft. 3. Make sure that the end surface of the motor shaft is in the groove inside the gear, and then tighten “retaining set screws”. At this time, apply one or two drops a screw lock (THREEBOND 1374) to a thread, and then tighten screws. | <ul style="list-style-type: none"> • Apply a thin coating of THREEBOND 1801B to the shaft of the new motor and the two rings. • When mounting, do not give a high impact to the motor shaft. Special jigs for mounting the gear and the pulley are also available. Refer to “6 Recommended spare parts and special tools for maintenance” and contact our Service Department if you need the jigs. • Use a torque wrench for tightening bolts. Carefully and evenly tighten the bolts. |

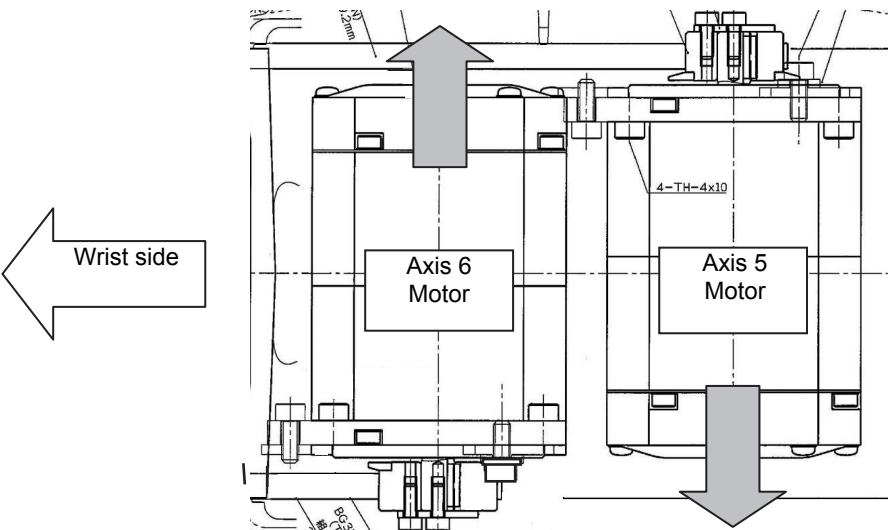
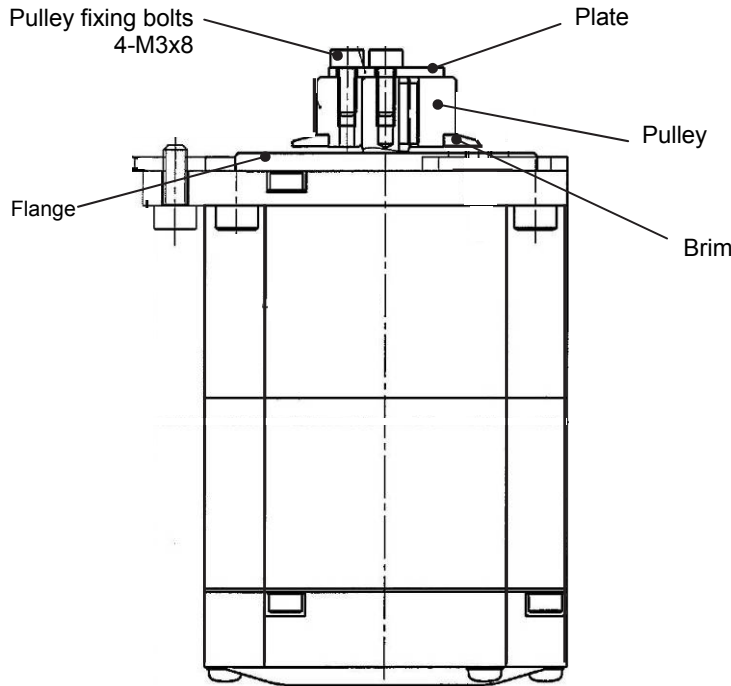
| No. | Contents of operation | Points |
|-----|--|---|
| 12 | <p>Mount the motor to the robot.</p> <ol style="list-style-type: none"> 1. Mount the motor to the motor to the robot with "motor attachment bolts". 2. Apply an appropriate coating of grease (Alvania RA-J) to the gear teeth (enough to cover the gear teeth). | <ul style="list-style-type: none"> • Use a torque wrench for tightening bolts. Carefully and evenly tighten the bolts. • When mounting the motor, be careful not to damage any gear tooth. |
| 13 | Connect the connector to the motor. | |
| 14 | Mount the cover and the bracket to the robot. | |
| 15 | Connect the connector (encoder , power) to the motor. | |
| 16 | Reset the encoder on the axis concerned. (👉 "5.2.5 Encoder reset ".) | |
| 17 | Correct the encoder on the axis concerned. (👉 "5.2.6 Encoder correction".) | |
| 18 | <p>Remove the zeroing pin.</p> <p>Remove the zeroing block, and then mount the cover.</p> | If the zeroing pin is not removed before the robot is operated, the pin or the pin hole may deform. As a result, it may not be possible to remove the pin or the subsequent encoder corrections may not be performed correctly. |
| 19 | Check to be sure that the robot has no problem with the movement. | |


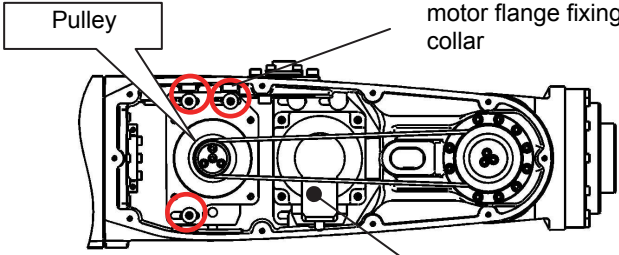
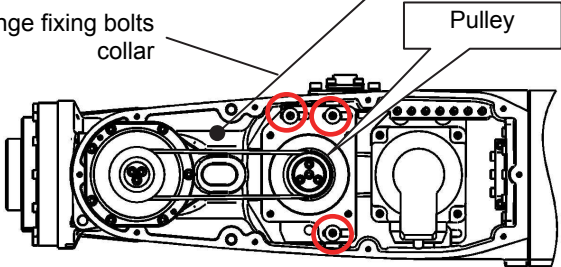
This now completes the replacement procedure of axis 4 motor.

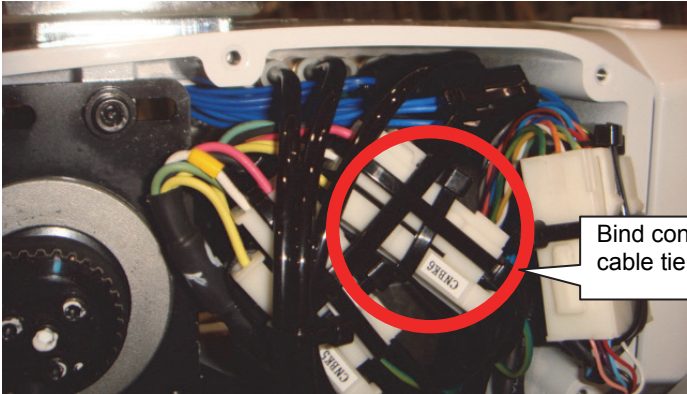
5.2.3 Motor replacement procedure (Axis 5 and 6)

| No. | Contents of operation | Points |
|-----|--|---|
| 1 | Turn ON the motor power to get ready for manual operation. | If an abnormality has occurred, and the axis cannot be operated manually, then proceed with the step 3. |
| 2 | Operate the axis concerned to the position where the zeroing pin can be inserted, then insert the pin. (👉 "5.2.6 Encoder correction") | If zeroing pin is inserted in advance, there is some case that the work after replacement is easier. |
| 3 | Hold the arm using a crane or chain block, etc. | |
| 4 | Press the emergency stop button, and then turn OFF the power of the controller. | |
| 5 | <p>Remove the cover of both sides.</p>  <p>10-M3x10 SUS (Tightening torque 1.47 N·m)</p> <p>10-M3x10 SUS (Tightening torque 1.47 N·m)</p> | Pay attention not to hurt packing. |

| No. | Contents of operation | Points |
|-----|--|---|
| 6 | Loosen the motor flange fixing bolts of pulley side. Move motor and remove the belt. <u>Axis 5, 6</u> 3-M4x10 (Tightening torque : 3.63 N · m) | Just loosen the bolts. Do not remove them. |
| | <div data-bbox="292 495 432 539" data-label="Text">Axis 5</div> <div data-bbox="501 439 660 483" data-label="Text">Pulley</div> <div data-bbox="927 439 1182 461" data-label="Text">motor flange fixing bolts</div>  <div data-bbox="927 730 1326 752" data-label="Text">Loosen the bolts and remove the belt</div> <div data-bbox="292 842 432 887" data-label="Text">Axis 6</div> <div data-bbox="461 797 716 819" data-label="Text">motor flange fixing bolts</div> <div data-bbox="1003 797 1099 819" data-label="Text">Pulley</div>  | |
| 7 | Cut the cable tie which binds connector and cables. Then remove connectors. <u>Axis 5</u> CN5, CNBK5, CNE5 <u>Axis 6</u> CN6, CNBK6, CNE6 | <ul style="list-style-type: none"> • The encoder data is erased when the encoder connector is disconnected. • Do not apply large pressure onto connectors, wires and hoses. |
| |  <div data-bbox="1150 1323 1366 1379" data-label="Text">Cut cable tie and remove connectors.</div> | |

| No. | Contents of operation | Points |
|-----|---|--|
| 8 | <p>Remove 3 motor flange fixing bolts (loosened at step 6) and 3 collars. Then remove motor and its flange together from robot body.</p>  | <p>Do not hurt connectors, wires and hoses.</p> |
| 9 | <p>Remove plate, pulley and flange.</p> <p>Axis 5, 6</p> <ol style="list-style-type: none"> 1. Remove pulley fixing bolts. 2. Remove plate. 3. Remove pulley by using minus driver or like that. 4. Remove bolts (4-M4x10) and remove flange.  | <ul style="list-style-type: none"> • Do not give a high impact to the motor shaft. It may cause of damage on encoder. • Use a minus driver to remove pulley. |

| No. | Contents of operation | Points |
|-----|---|---|
| 10 | <p>Mount the removed pulley and others to a new motor.</p> <p>Axis 5, 6</p> <ol style="list-style-type: none"> 1. Wipe off unnecessary grease on a new motor shaft. 2. Mount the flange to the motor with fixing bolts 4-M4x10. (tightening torque : 4.0 N · m) 3. Clean the surface where pulley and shaft contacts by using parts cleaner. Then wipe off it. 4. Insert pulley to the shaft. At this time, brim must be under. 5. Fix plate with 4 bolts. At this time, apply one or two drops a screw lock (THREEBOND 1374) to a thread, and then tighten the screws. (tightening torque : 1.77 N · m) | <ul style="list-style-type: none"> • When mounting, do not give a high impact to the motor shaft. • Use a torque wrench for tightening bolts. Carefully and evenly tighten the bolts. • After tightening is finished, paint marking. |
| 11 | <p>Mount the motor assembly to robot body.</p> <p>Axis 5, 6</p> <ol style="list-style-type: none"> 1. Insert motor assembly in robot body. 2. Apply an appropriate coating of Threebond 1801B to the gear teeth. Attach collar and tighten motor flange fixing bolts (3-M4x10) temporary. 3. Move motor and hook the belt 4. Adjust the belt tension and tighten motor flange fixing bolts with specified torque (3.63 N · m). <p> "3.5 Inspection and adjustment of belt")</p> <div data-bbox="288 920 1299 1570"> <div data-bbox="288 1010 432 1061"> <p>Axis 5</p> </div>  <div data-bbox="288 1357 432 1408"> <p>Axis 6</p> </div>  <p>Loosen the bolts and hook the belt</p> </div> | <ul style="list-style-type: none"> • When mounting the motor, be careful not to damage any gear tooth. • Do not tighten bolts tightly at first. After belt tension adjustment is finished, tighten them in specified torque. <p>Initial tension : 29 to 40 N SPAN: 179.2 mm MASS: 0.006kg</p> |


| No. | Contents of operation | Points |
|-----|---|---|
| 12 | Plug the connectors to motor. Axis 5 CN5, CNBK5, CNE5 Axis 6 CN6, CNBK6, CNE6 | <ul style="list-style-type: none"> • Do not apply large pressure onto connectors, wires and hoses. • After connecting, bind them by cable tie. |
| |  | |
| 13 | Mount the cover of both sides 20-M3x10 SUS (tightening torque : 1.47 Nm) | <ul style="list-style-type: none"> • Do not hurt packing. • Pay attention for cables. |
| 14 | Perform encoder reset on the axis concerned. (👉 "5.2.5 Encoder reset".) | |
| 15 | Perform encoder correction on the axis concerned. (👉 "5.2.6 Encoder correction".) | |
| 16 | Remove the zeroing pin. Remove the zeroing block, and then mount the cover. | If the zeroing pin is not removed before the robot is operated, the pin or the pin hole may deform. As a result, it may not be possible to remove the pin or the subsequent encoder corrections may not be performed correctly. |
| 17 | Check to be sure that the robot has no problem with the movement. | |

This now completes the replacement procedure of axis 5 and 6 motors.

5.2.4 Writing encoder ID (Axis 1, 2 and 3)

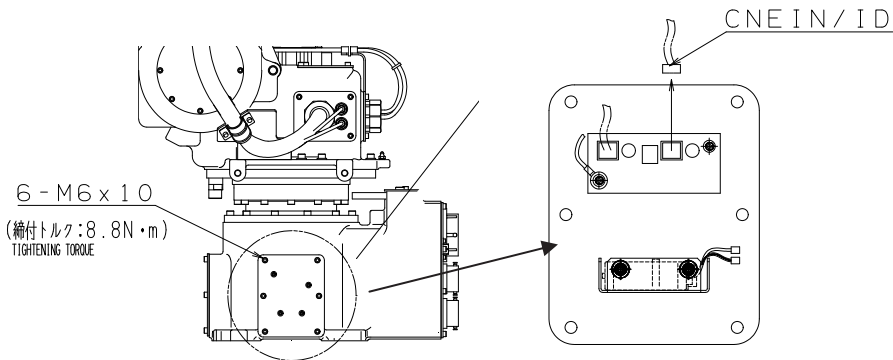

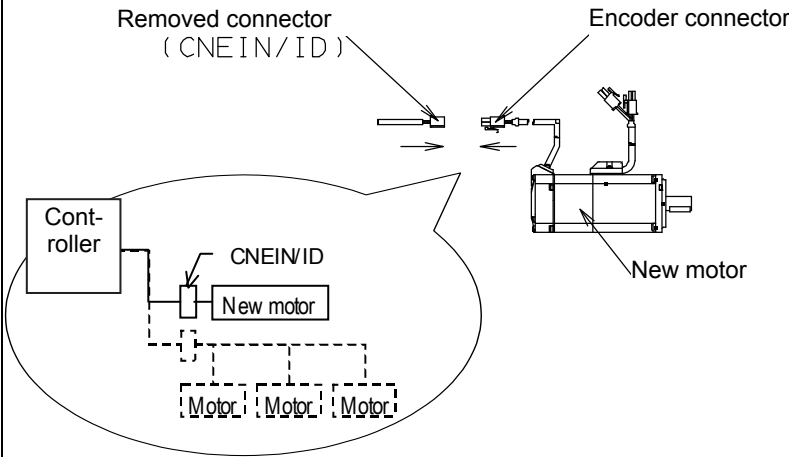
Axis 1, 2 and 3 of this robot uses the bus line system for encoder communication. Therefore, when replacing the motor, be sure to register each encoder ID before mounting a new motor to the robot.


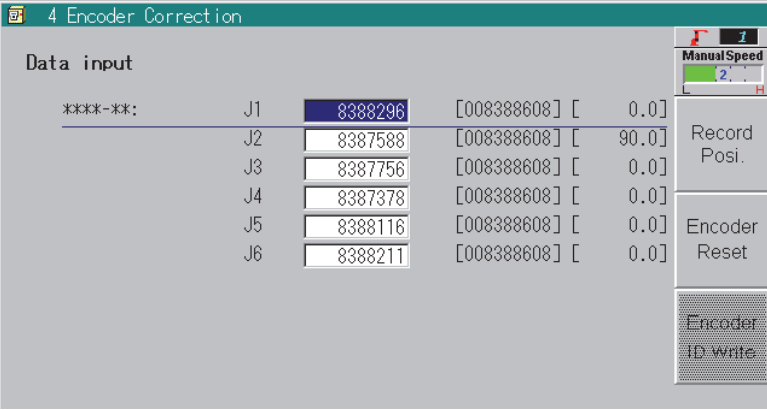

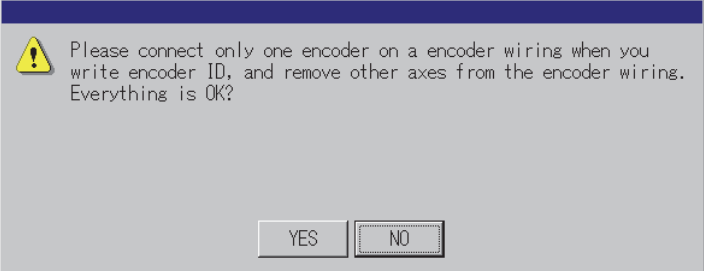
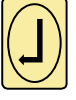
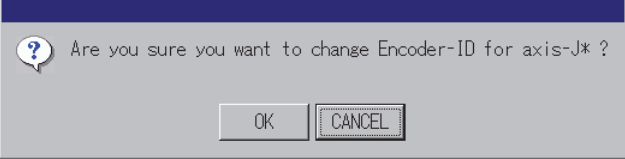

Axis 4, 5 and 6 does not have bus line system encoder. So This procedure is unnecessary for those axis. When performing this procedure for axis 1 to 3, axis 4 to 6 encoders do not have to be unplugged.

| | |
|--|--|
|  <p>CAUTION</p> | <p>Only the axis for writing is connected with the encoder line when encoder ID is written, and other axes are removed from the encoder line. If encoder ID is written while 2 or more encoder cables are connected, robot does not operate properly. Beware to follow the procedure written below.</p> |
|--|--|

Encoder ID writing procedure, without “Encoder ID Writing cable”

Needed tools M6 torque wrench



| | | |
|---|---------------------------|---|
| | <div>1</div> <div>2</div> | <div>Press the emergency stop button, and then turn OFF the power of the controller.</div> <div>After removing cover, make sure that the all battery connector is connected, then disconnect the CNEIN/ID connector.</div> <div></div> |
| <div></div> <div>CAUTION</div> | | <div>Pay special attention not to disconnect the battery connectors in mistake. If those battery connectors are disconnected with the controller primary power is OFF, the encoder position data may be lost and encoder errors occur. When the position data is lost, the encoder reset procedure and the encoder correction procedure for the axis must be performed again.</div> |
| | <div>3</div> | <div>Connect the connector which is removed from the board to the encoder connector of the motor to be replaced.</div> <div></div> |
| | <div>4</div> | <div>Turn ON the power supply of the controller.</div> <div>>> Even though encoder related errors occur, proceed with the next step.</div> |
| | <div>5</div> | <div>Select the [TEACH] mode.</div> |
| | <div>6</div> | <div>Switch the operator class to EXPERT or higher.</div> |

| | | |
|---|--------|--|
|  | 7 | <p>Open [Constant Setting] [3 Machine Constants] [4 Encoder Correction]. >> The setting screen shown below will be displayed on the screen.</p>  <p><i>This is sample screen. Adequate machine name is displayed at ****.</i></p> |
|  | 8 9 | <p>Place the cursor at the axis concerned (the motor of which is to be replaced). Press the [Enable] key + f key <Encoder ID write>. >> The following confirmation message is displayed.</p>  |
|  | 10 | <p>Select "YES", and press the [Enter] key if there is no problem in the connection of the encoder line. >> The following confirmation message is displayed.</p>  <p><i>This is sample screen. Adequate axis number is displayed at ****.</i></p> |
|  | 11 | <p>Select "OK" and press the [Enter] key. >> The writing result for the encoder is displayed in the dialog. If the writing of the encoder ID fails, make sure that the encoder cable is connected properly, and repeat the procedure for writing the encoder ID.</p> <p><u>Message when succeeding</u> Encoder ID writing was completed normally. But it may occur the error of Encoder. Please carry out "Encoder reset" or "Encoder correction" succeeding. Push any keys.</p> <p><u>Message when failing</u> Encoder ID writing went wrong. Please perform encoder ID writing again. Even if it does how many times, when failing, the encoder may be out of order. Push any keys.</p> |
| | 12 | Press the emergency stop button, and then turn OFF the power of the controller. |
| | 13 | Disconnect the encoder connector of the motor and the CNEIN/ID connector. Then, connect the CNEIN/ID connector to its original connector. |
| | 14 | Mount the removed cover. |

This now completes the procedure for writing an encoder ID.

5.2.5 Encoder reset


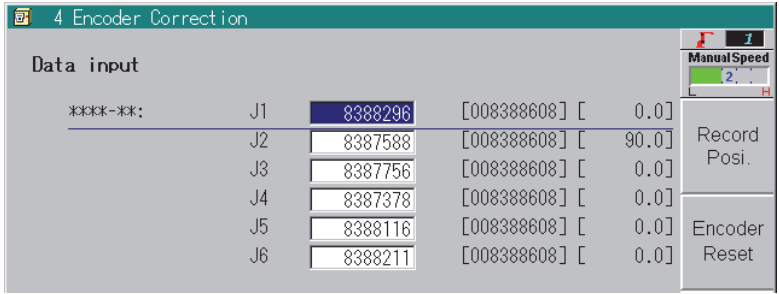

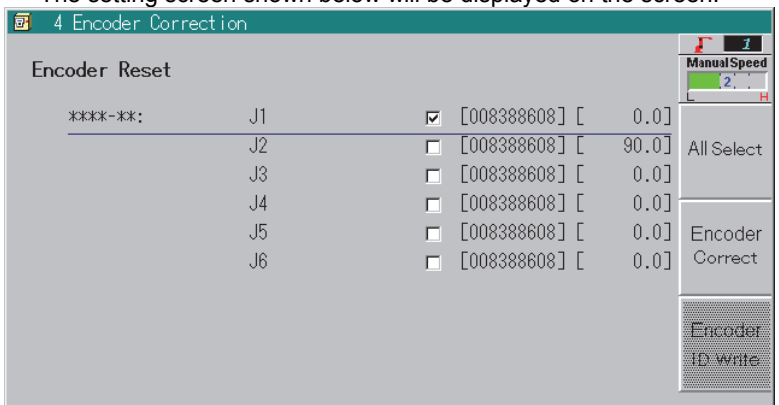
If the encoder data shows any abnormal value due to a certain trouble or the motor is replaced, encoder correction procedure must be performed. Prior to encoder correction, encoder needs to be reset by following procedure.

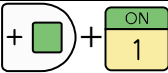


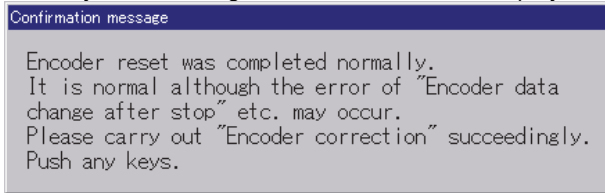
| | |
|---|---|
|  WARNING | <p>The encoder data will be initialized when encoder reset is performed so the robot will no longer move properly. Upon completion of encoder reset, therefore, be absolutely sure to use the zeroing pin to perform encoder correction. If the work program is played back without 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.</p> |
|  CAUTION | <p>The following error may occur after a motor is connected to an encoder. (These errors may occur when a new motor which super capacitor is not charged is connected, or in other cases.) E0050: Occurrence of an encoder counter overflow or underflow E0052: Encoder batteries abnormal condition and possibility of abnormal encoder data In such a case, turn ON the power of the controller, wait for at least 10 minutes, and then reset the encoder by the following procedure. After completing this procedure, turn OFF the power of the controller. Then, when the power supply is turned ON again, it will return to normal condition.</p> |

Encoder resetting procedure

Needed tools

No special tools are necessary for encoder rest procedure.


| | | |
|---|----------|--|
| | 1 | Turn ON the power of the controller, wait for at least 10 minutes, and then proceed with the following procedure. |
| | 2 | Select the [TEACH] mode. |
| | 3 | Switch the operator class to EXPERT or higher. |
|  | 4 | <p>Open [Constant Setting] [3 Machine Constants] [4 Encoder Correction]. >> The setting screen shown below will be displayed on the screen.</p>  <p><i>This is sample screen. Adequate machine name is displayed at ****.</i></p> |
|  | 5 | <p>Press f key <Encoder Reset>. >> The setting screen shown below will be displayed on the screen.</p>  <p><i>This is sample screen. Adequate machine name is displayed at ****.</i></p> |

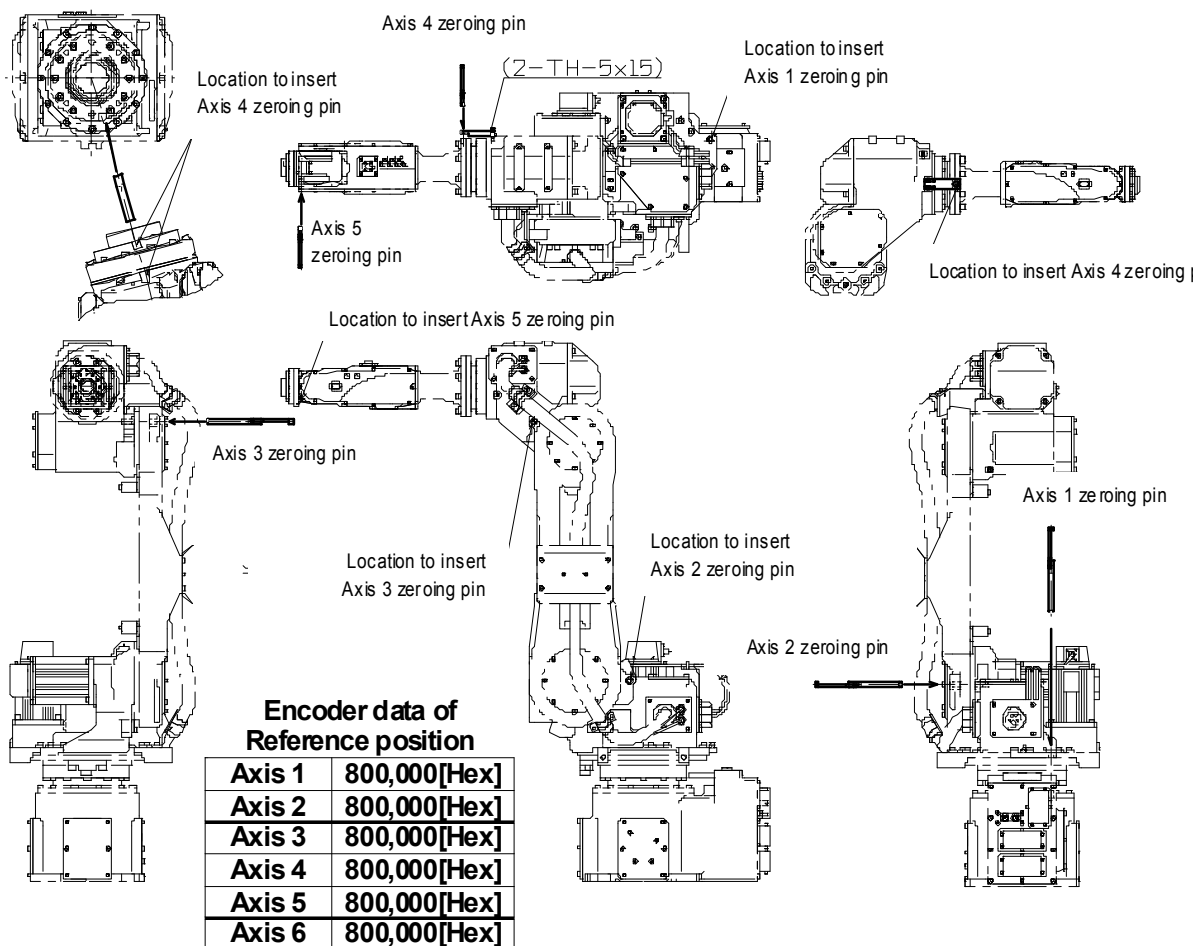
| | | |
|---|----------|--|
|  | 6 | <p>Place the cursor at the axis concerned on which the encoder resetting should be performed, and then press the [Enable] key + [ON/1] key. >> A checkmark will be placed in the checkbox.</p>  <p><i>This is sample screen. Adequate machine name is displayed at *****.</i></p> <p>Supplement</p> <ul style="list-style-type: none"> • To erase the check mark, press the [Enable] key + [OFF/2] key. • To place checkmarks in all the axes at one time, press f key <All Select>. |
|  | 7 | <p>After the completion of choice of the axis, press the f key <Execute>. >> Encoder reset is executed by this operation. If encoder reset was completed normally, the following confirmation screen is displayed.</p>  |

This now completes encoder resetting. Next, perform the encoder correction.




5.2.6 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 can be inserted here).

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



Reference position (Locations to insert zeroing pin)


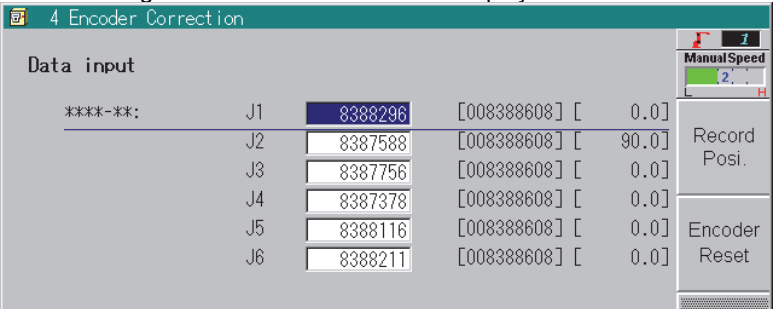

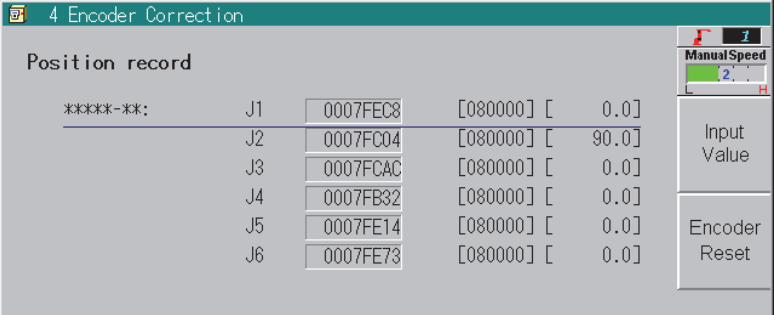
| | |
|--|---|
|  CAUTION | <p>When the motor is damaged during robot operation, there may be some cases where the motor replacement and encoder reset work must be done in a position where it is impossible to insert a zeroing pin.</p> <p>If an error occurs when an axis is being operated, and the robot cannot be operated, perform a temporary encoder correction in that position; move the axis concerned to a position at which the zeroing pin can be inserted; and then repeat the resetting and the correcting of the encoder.</p> |
|  WARNING | <p>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.</p> |
|  CAUTION | <p>Before performing axis operations, be absolutely sure to remove the zeroing pins. Performing axis operation with the zeroing pins still in place may bend the pins, damage the pin holes 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.</p> |

Encoder correction procedure

Needed tools

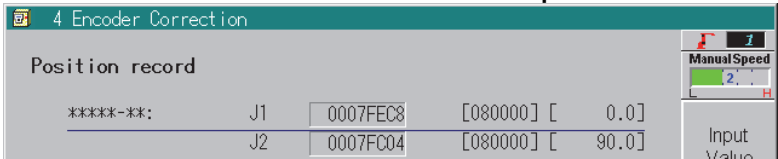
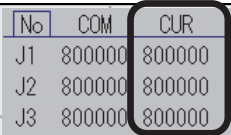
For this procedure, zeroing pin and block (OP-T2-*** ; option) is necessary.

Please prepare these tools by referring to "6 Recommended spare parts and special tools for maintenance".

| | | |
|---|---|---|
| | 1 | Select the [TEACH] mode. |
| | 2 | Switch the operator class to EXPERT or higher. |
|  | 3 | <p>Open [Constant Setting] [3 Machine Constants] [4 Encoder Correction].</p> <p>>> The setting screen shown below will be displayed on the screen.</p>  <p><i>This is sample screen. Adequate machine name is displayed at ****.</i></p> |
|  | 4 | <p>Press f key < Record Posi.>.</p> <p>>> The setting screen shown below will be displayed on the screen.</p>  <p><i>This is sample screen. Adequate machine name is displayed at *****.</i></p> |
| | 5 | <p>In case of axis 4 and 6</p> <p>The zeroing block is required, so mount it in the following procedure.</p> <ol style="list-style-type: none"> 1. Remove the cover for block mounting. 2. Mount the zeroing block with the two hexagon socket head bolts. For the size and the length of the bolts, refer to "6 Recommended spare parts and special tools for maintenance". |

| | |
|--|---|
| | 6 Move the axis in manual operation speed 2 or 3 to the reference position by referring to the figure and then insert a zeroing pin into the pin hole. Pay special attention to the motion of the robot because the encoder correction value is still incorrect here. |
|--|---|

| | |
|-------------|---|
| CAUTION | Axis interference in wrist (axis 5, 6) Axis interference exists due to the structure of the wrist on this robot. When executing encoder correction for axis 6, axis 5 must be in the reference position. It is therefore essential that the encoder correction operation of the wrist axes to be done in the sequence of axis 5 and 6. If the encoder correction is not done in this sequence, the reference position of the wrist axes are not set correctly and the robot cannot move correctly. |
|-------------|---|

| | |
|--|--|
| | 7 Place the cursor at the axis concerned into which the zeroing pin is inserted and press the keys in the order of the [Enter] key and then [O.WRITE/REC] key. >> "Encoder correction value" is adjusted so that the reference position of the axis concerned becomes "Encoder data of reference position" .  <p><i>This is sample screen. Adequate machine name is displayed at ****.</i></p> If the other axes also require encoder correction, perform the step 5 to 7 in the same way. |
| | 8 Remove the zeroing pin. In case of axis 4 and 6, remove the positioning block and mount the cover of the mounting part for the positioning block in the original position. |
| | 9 Press the emergency stop button. |
| | 10 Press f key <Complete>. >> The encoder correction values are saved in the internal memory. |
| | 11 Press the f key <Monitor 2> to display [2 Axis Monitor]. >> Confirm that the [CUR] value of the axis concerned is "Encoder data of reference position" .  |

This now completes encoder correction.
After confirming that zeroing pins and zeroing blocks are removed, perform manual operations and check that the robot moves without a problem.

Chapter 6 Recommended spare parts and special tools for maintenance

Recommended spare parts are listed in Table shown as below. Please check your robot serial no. and manufacturing date if you purchase spare parts. Consult NACHI service center for help if necessary.

Classification A: Periodical maintenance parts, B: Spare parts

| Recommended spare parts | | | | | | |
|-------------------------|-------------------|---------------------|-------------|------------------|-------------|---------------------------------------|
| Classification | Name | Part No. (Model) | In use/unit | Recommended/unit | Robot model | Remarks |
| | | | | | MC10S-01 | |
| A | GREASE | PM/W-16KG | — | 1 | ○ | MOLYWHITE RE No.00 (*2) |
| A | GREASE | ALVANIA-RA-J-16KG | — | 1 | ○ | ALVANIA RA-J (*1) (*2) |
| A | BATTERY | ER17/50H | 2 | 2 | ○ | (*3) |
| A | BATTERY UNIT | KP-ZA-006 | 1 | 1 | ○ | 3pcs of battery (*4) |
| B | AC SERVO MOTOR | MQMA202T4V3 | 2 | 1 | ○ | Axis 1, 2 |
| B | AC SERVO MOTOR | MSMD082T2D3 | 1 | 1 | ○ | Axis 3 |
| B | AC SERVO MOTOR | MQMD012S6V | 2 | 1 | ○ | Axis 4, 5, 6 |
| B | COUPLING GEAR SET | KP-ZH-093 | 1 | 1 | ○ | Axis 1 |
| B | COUPLING GEAR SET | KP-ZH-074 | 1 | 1 | ○ | Axis 2 |
| B | COUPLING GEAR SET | KP-ZH-075 | 1 | 1 | ○ | Axis 3 |
| B | COUPLING GEAR SET | KP-ZH-171 | 1 | 1 | ○ | Axis 4 |
| B | ULTRA PX BELT | BG459UP3M6-HC | 1 | 1 | ○ | Axis 5 |
| B | ULTRA PX BELT | BG303UP3M6-HC | 1 | 1 | ○ | Axis 6 |
| B | PCB ASSY | UM333-10 | 1 | 1 | ○ | Axis 1, 2, 3, 4 UM333-10 (*5) |
| B | PCB ASSY | UM333-20 | 1 | 1 | ○ | Axis 5, 6 UM333-20 terminator (*5) |
| B | PCB ASSY | UM336-10 | 1 | 1 | ○ | |
| B | BJ1 UNIT ASSY | SP-BJ1-187 | 1 | 1 | ○ | Machine wiring: BJ1~BJ2 |
| B | BJ2 UNIT ASSY | SP-BJ2-134 | 1 | 1 | ○ | Machine wiring: BJ2~Wrist |
| B | OIL SEAL | AC1314F0 | 2 | 1 | ○ | |

(*1) Conventional grease (ALVANIA-RA-16KG) still can be used. And current grease (ALVANIA-RA-J-16KG) can be mixed with conventional grease.

(*2) If MSDS (Material Safety Data Sheet) for chemical material such as grease is necessary, customer needs to require it to the chemical material supplier.

(*3) In case of purchasing this in China, please order ER18505-2. This is compatible with ER17/50H.

(*4) In case of purchasing this in China, please order KP-ZA-006CN. This is compatible with KP-ZA-006. When replacing all batteries in robot, please order battery unit which consists of all needed batteries.

(*5) Choose adequate PCB by referring wiring diagram in Chapter 7.

<Reference> Seals listed below are already included in COUPLING GEAR SET and or so. Please refer them to order individually.

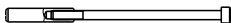



| | |
|--------------------------------|------------------------|
| COUPLING GEAR SET of axis 1,2→ | RO-G105 (motor flange) |
| COUPLING GEAR SET of axis 3 → | RO-P55 (motor flange) |
| COUPLING GEAR SET of axis 4 → | ROA-033 (motor case) |

The fixtures listed below are required fixture for maintenance work or for efficient work. Please check your robot serial no. and manufacturing date if you purchase these tools. Consult NACHI service center for help if necessary.

Special tools for maintenance (option)

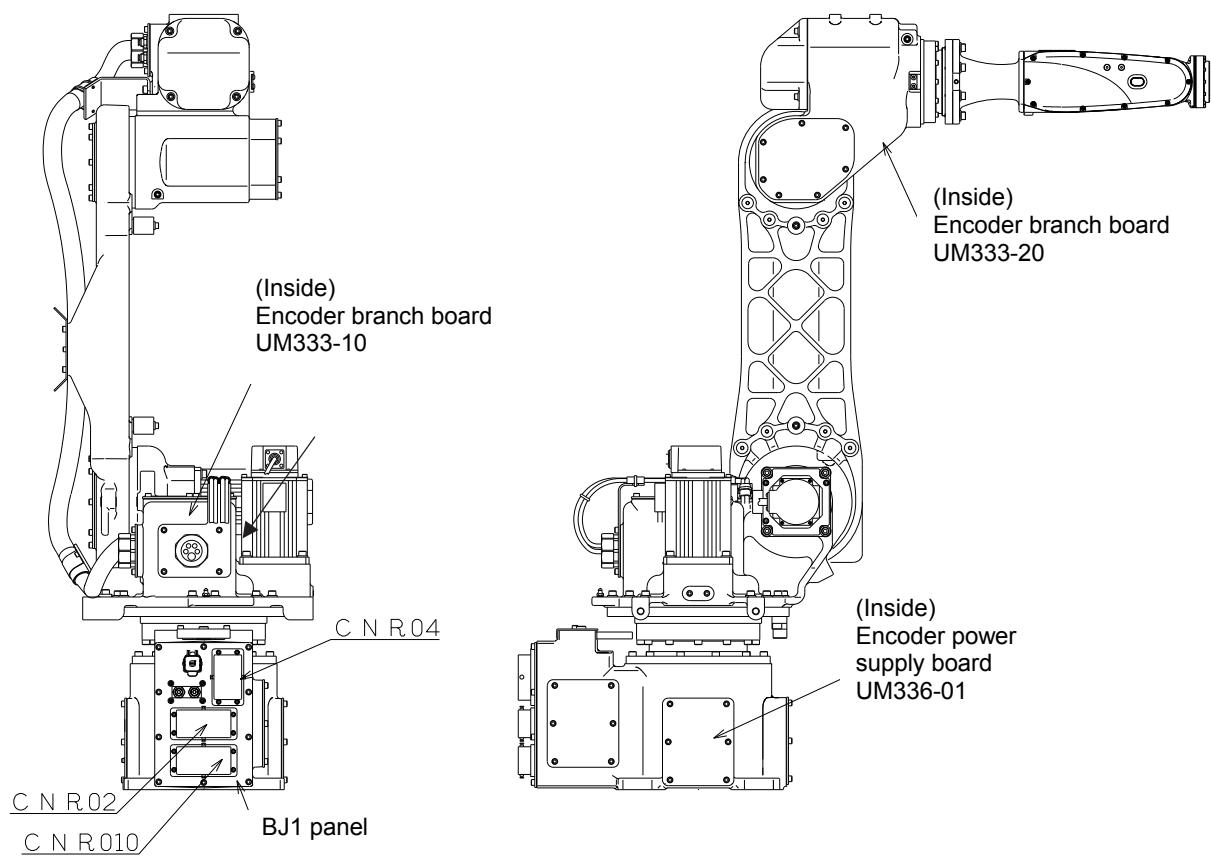
| Name | Part No. (Model) | Robot model | Remarks |
|-----------|---------------------|-------------|--------------------------------|
| | | MC10S-01 | |
| ACCESSORY | OP-T2-085 | ○ | Zeroing pin & zeroing block |
| ACCESSORY | OP-T3-014 | ○ | Axis 2・3 Oil seal inserter |

Contents of OP-T2-085 (Zeroing pin & zeroing block) (option)

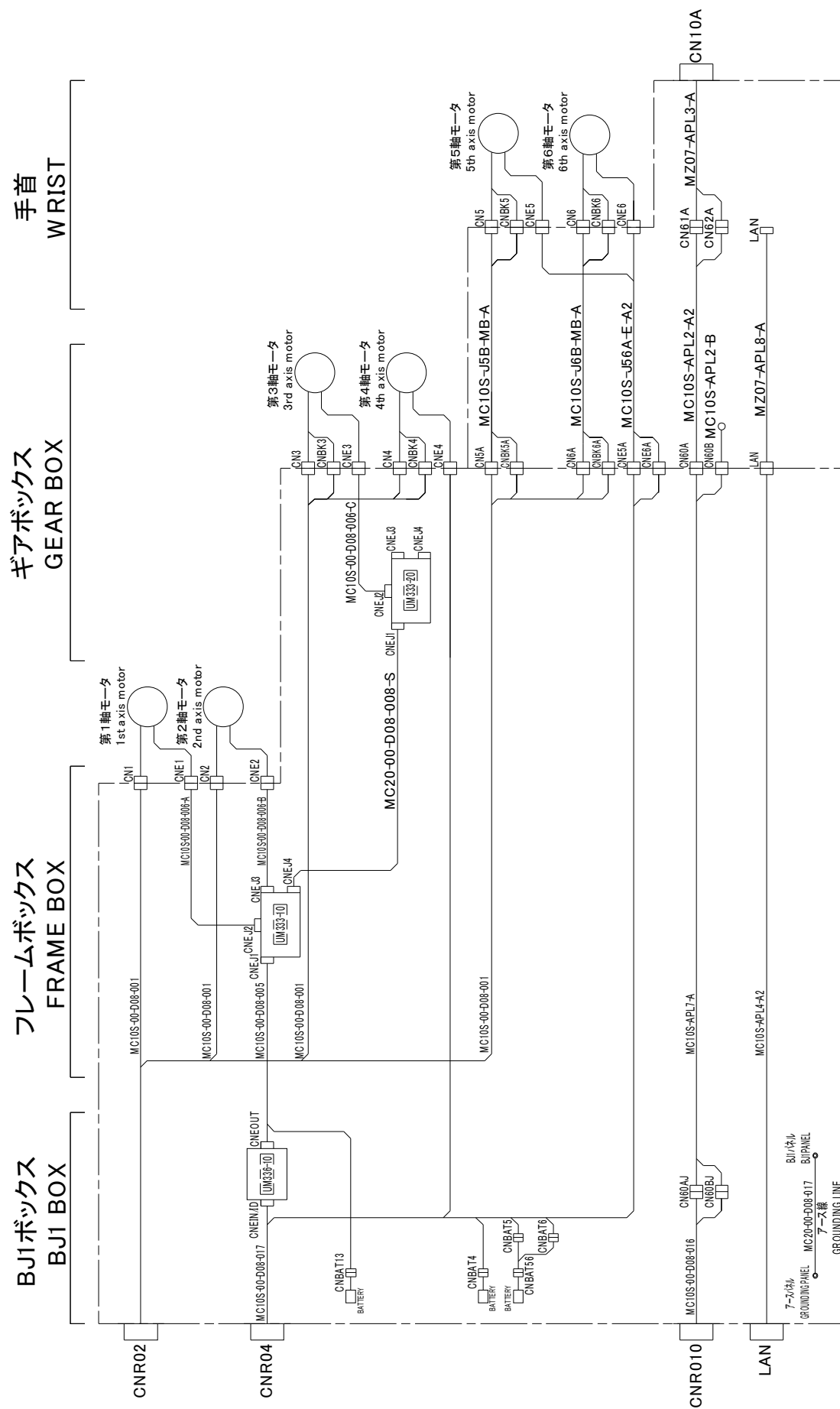
| Applied Robot model | Name | Marking | Appearance, etc |
|------------------------|---|-------------|---|
| MC10S-01 | Axis 4,5 Zeroing pin | |  |
| | Axis 6 Zeroing block | |  |
| | Axis 1,2,3 Zeroing pin | |  |
| | Axis 4 fixed side Zeroing block | MC10S J4 |  |
| | Axis 4 fixed side Zeroing block fixing bolt | | Hex. socket head cap screw 2-M5X15 |

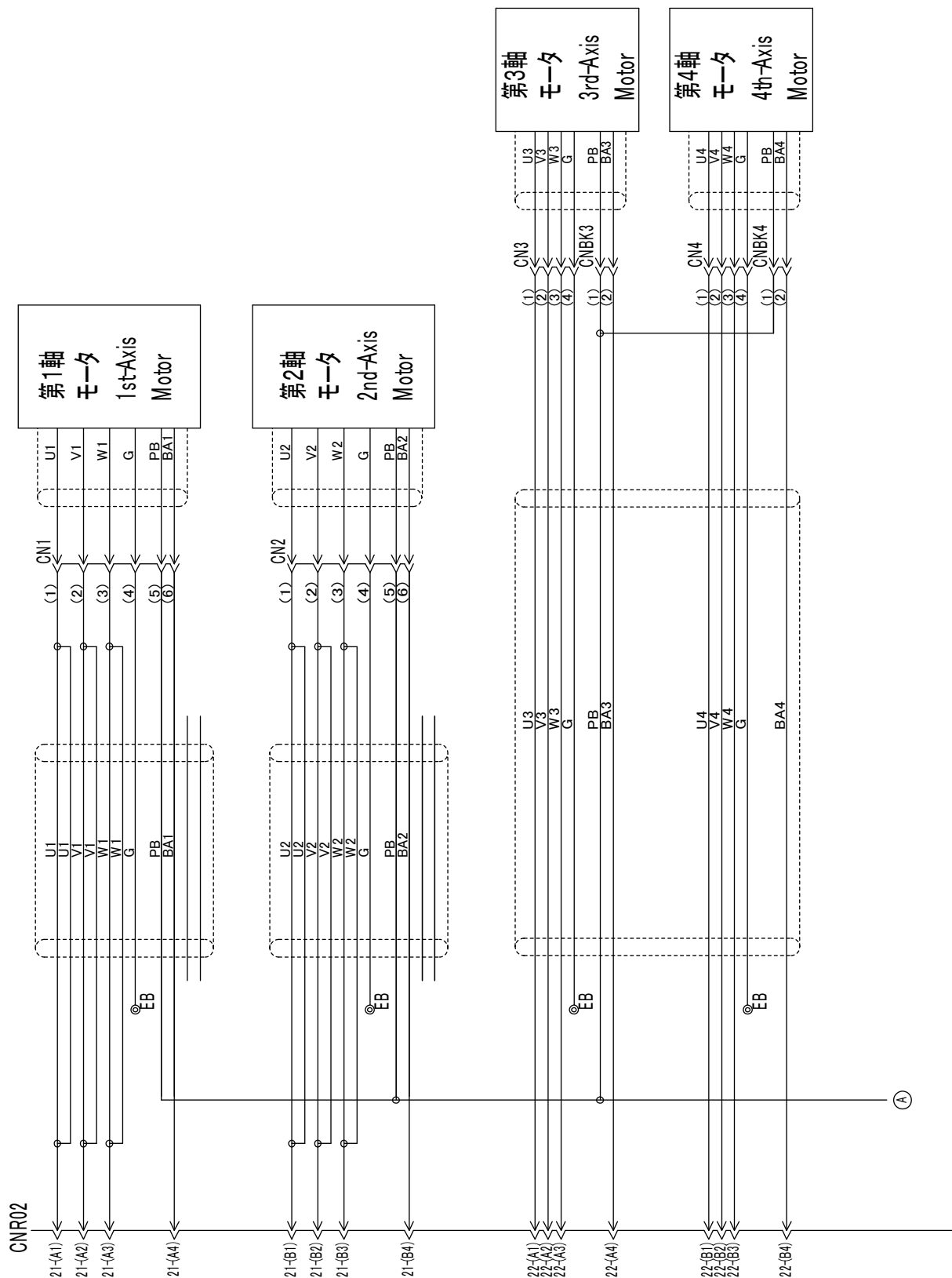
Recommended tightening torque of M5 bolt is 7.35 N・m

Chapter 7 Wiring diagrams

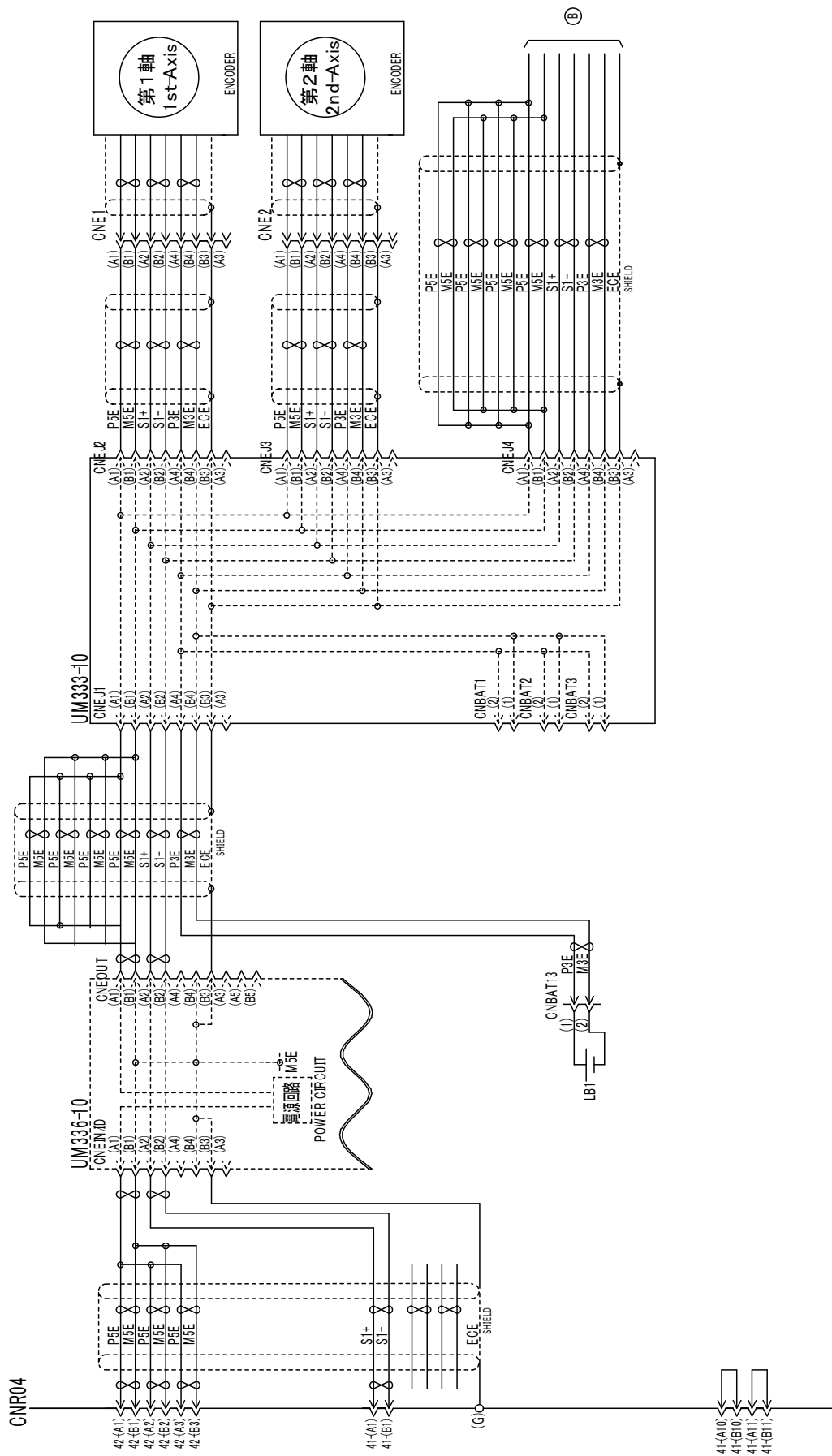


Robot Parts Layout 【MC10S-01】

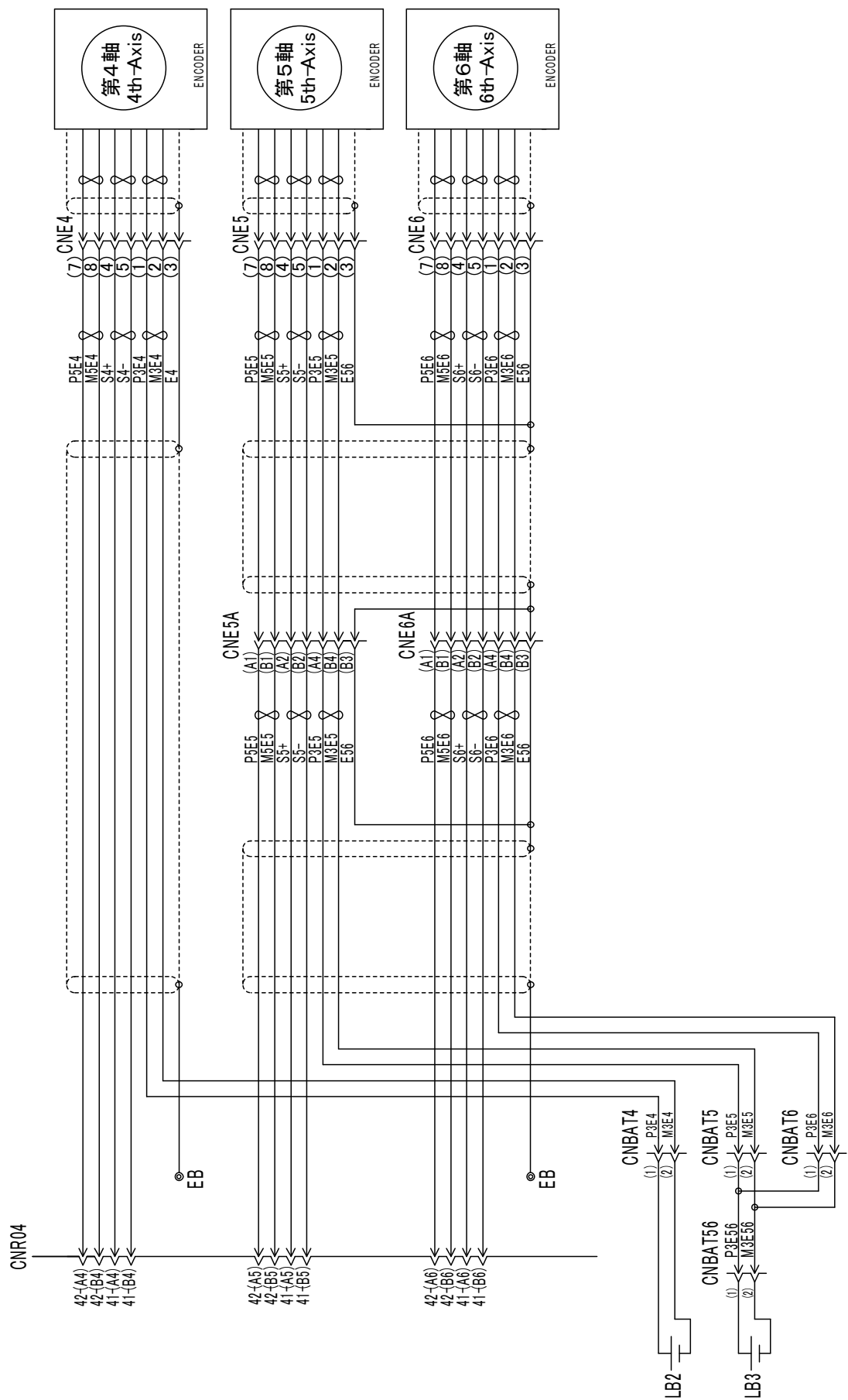




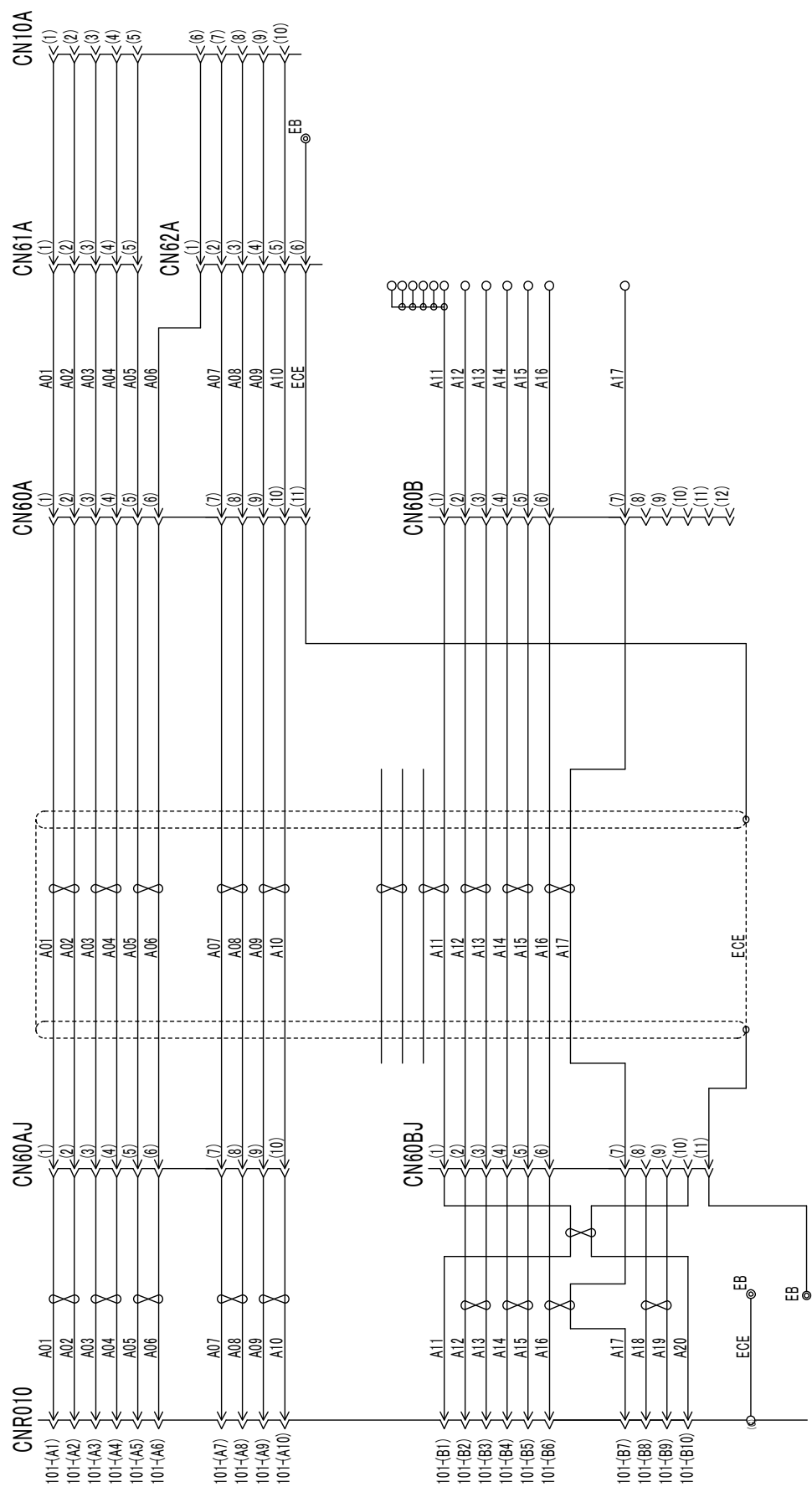
Internal wiring connection diagram : motor (1)

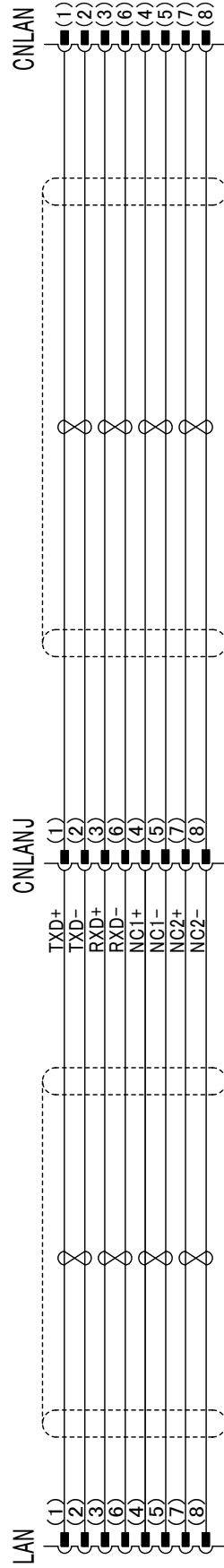


Internal wiring connection diagram : encoder (1)

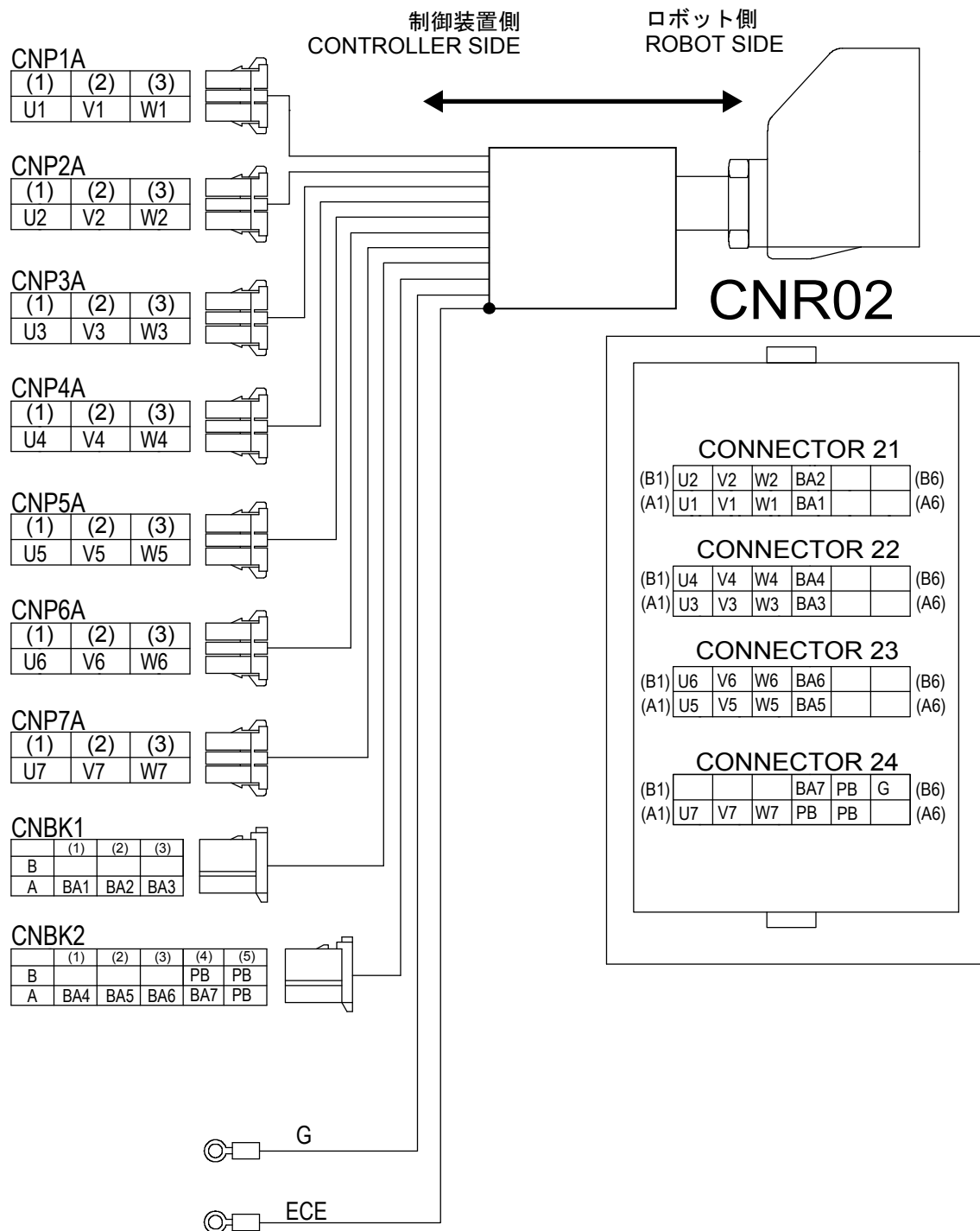


Internal wiring connection diagram : encoder (3)

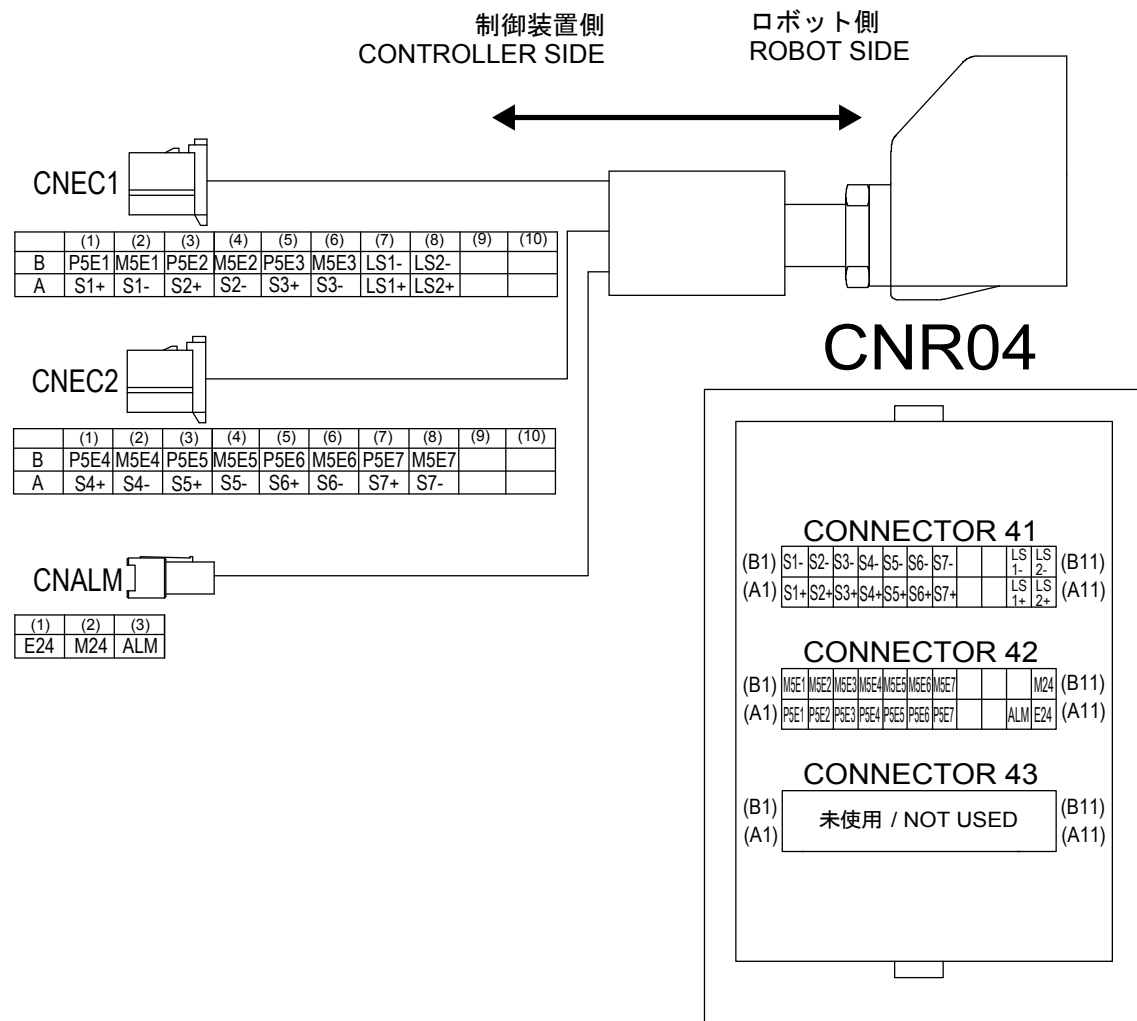




Internal wiring diagram : LAN



FD controller wire-harness CNR02 (motor power and brake control)

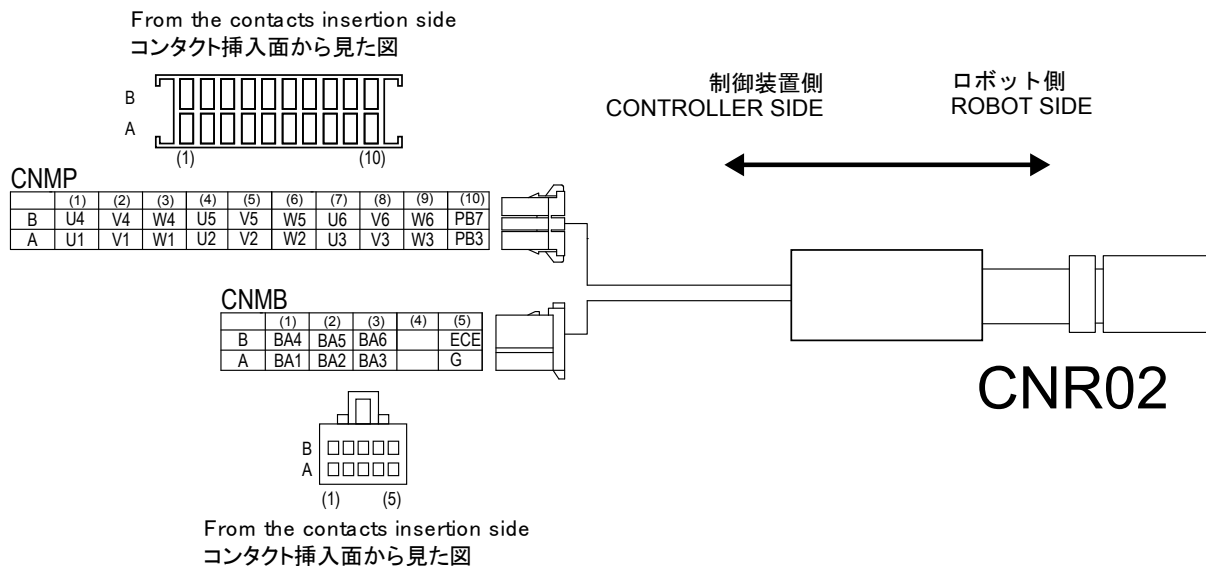


FD controller wire-harness CNR04 (encoder)

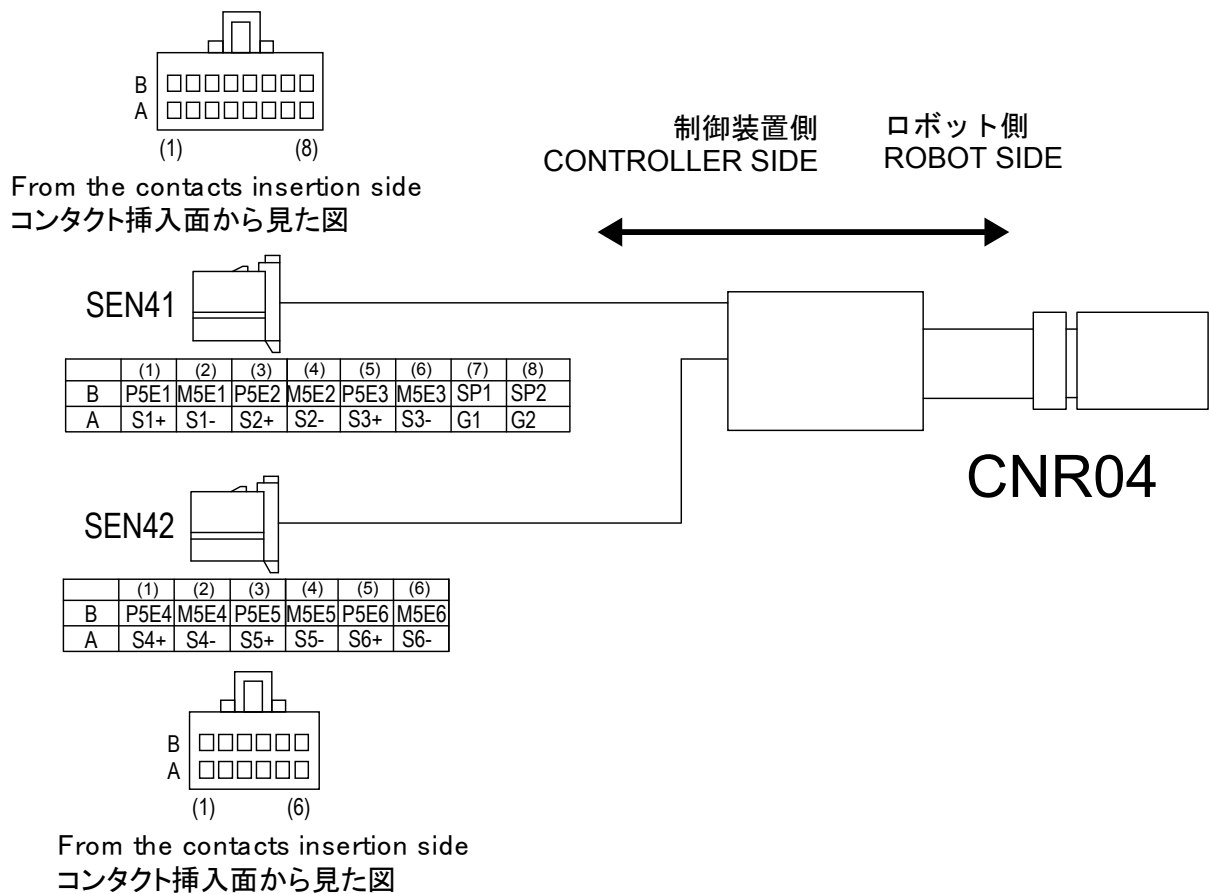
(NOTE) In this robot, the connector “CNALM” is not used.

(NOTE) The encoder communication lines used in this robot is shown in the following table.


| Axis name | Signal name | Remarks |
|-----------|-------------|-----------------------------|
| J1 | S1+/- | Bus connection type encoder |
| J2 | | |
| J3 | | |
| J4 | S4+/- | |
| J5 | S5+/- | |
| J6 | S6+/- | |



CFD3000 controller wire-harness CNR02 (motor and brake control)
(Concerning the robot side connector, see the previous pages)



CFD3000 controller wire-harness CNR04 (encoder communication lines)
(Concerning the robot side connector, see the previous pages)

| | | | |
|--|-------------------------------|---|--|
|  NACHI-FUJIKOSHI CORP. | | http://www.nachi-fujikoshi.co.jp/ | |
| Japan Main Office | Phone: +81-3-5568-5245 | Fax: +81-3-5568-5236 | Shiodome Sumitomo Bldg. 17F, 1-9-2 Higashi-Shinbashi Minato-ku, TOKYO, 105-0021 JAPAN |
| Nachi Robotic Systems Inc. (NRS) | | http://www.nachirobotics.com/ | |
| North America Headquarters | Phone: 248-305-6545 | Fax: 248-305-6542 | 42775 W. 9 Mile Rd. Novi, Michigan 48375, U.S.A |
| Indiana Service Center | Phone: 502-517-1553 | Fax: 317-535-3659 | 715 Pushville Road, Greenwood, Indiana, 46143, U.S.A. |
| South Caroline Service Center | Phone: 864-458-8000 | Fax: 864-458-8256 | 1310 Garlington Road, Suite L, Greenville, SC 29615, U.S.A. |
| Canada Branch Office | Phone: 905-760-9542 | Fax: 905-760-9477 | 89 Courtland Ave., Unit No.2, Concord, Ontario, L4K 3T4, CANADA |
| Mexico Branch Office | Phone :+52-555312-6556 | Fax:+52-55-5312-7248 | Urbina No.54, Parque Industrial Naucalpan, Naucalpan de Juarez, Estado de Mexico C.P. 53489, MEXICO |
| NACHI EUROPE GmbH | | http://www.nachi.de/ | |
| Central Office Germany | Phone: +49-2151-65046-0 | Fax: +49-2151-65046-90 | Bischofstrasse 99, 47809, Krefeld, GERMANY |
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