FANUC Robot LR-10*i*A

MECHANICAL UNIT

OPERATOR'S MANUAL

B-84384EN/01

- **Original Instructions**

Thank you very much for purchasing FANUC Robot.
Before using the Robot, be sure to read the "FANUC Robot series SAFETY HANDBOOK (B-80687EN)" and understand the content.

The products in this manual are controlled based on Japan's "Foreign Exchange and Foreign Trade Law". The export from Japan may be subject to an export license by the government of Japan.
Further, re-export to another country may be subject to the license of the government of the country from where the product is re-exported. Furthermore, the product may also be controlled by re-export regulations of the United States government.
Should you wish to export or re-export these products, please contact FANUC for advice.

In this manual, we endeavor to include all pertinent matters. There are, however, a very large number of operations that must not or cannot be performed, and if the manual contained them all, it would be enormous in volume. It is, therefore, requested to assume that any operations that are not explicitly described as being possible are "not possible".

SAFETY PRECAUTIONS

This chapter describes the precautions which must be followed to enable the safe use of the robot. Before using the robot, be sure to read this chapter thoroughly.

For detailed functions of the robot operation, read the relevant operator's manual to understand fully its specification.

For the safety of the operator and the system, follow all safety precautions when operating a robot and its peripheral equipment installed in a work cell.
For safe use of FANUC robots, you must read and follow the instructions in “FANUC Robot series SAFETY HANDBOOK (**B-80687EN)**”.

1 PERSONNEL

Personnel can be classified as follows.

Operator:
- Turns the robot controller power ON/OFF
- Starts the robot program from operator panel

Programmer or Teaching operator:
- Operates the robot
- Teaches the robot inside the safeguarded space

Maintenance technician:
- Operates the robot
- Teaches the robot inside the safeguarded space
- Performs maintenance (repair, adjustment, replacement)

- The operator is not allowed to work in the safeguarded space.
- The programmer or teaching operator and maintenance technician are allowed to work in the safeguarded space. Works carried out in the safeguarded space include transportation, installation, teaching, adjustment, and maintenance.
- To work inside the safeguarded space, the person must be trained on proper robot operation.

Table 1 (a) lists the work outside the safeguarded space. In this table, the symbol "O" means the work allowed to be carried out by the specified personnel.

Table 1 (a) List of work outside the Safeguarded Space

	Operator	Programmer or Teaching operator	Maintenance technician
Turn power ON/OFF to Robot controller	O	O	O
Select operating mode (AUTO/T1/T2)		O	O
Select remote/local mode		O	O
Select robot program with teach pendant		O	O
Select robot program with external device		O	O
Start robot program with operator's panel	O	O	O
Start robot program with teach pendant		O	O
Reset alarm with operator's panel		O	O
Reset alarm with teach pendant		O	O
Set data on teach pendant		O	O
Teaching with teach pendant		O	O
Emergency stop with operator's panel	O	O	O
Emergency stop with teach pendant	O	O	O
Operator's panel maintenance			O
Teach pendant maintenance			O

During robot operation, programming and maintenance, the operator, programmer, teaching operator and maintenance technician take care of their safety using at least the following safety protectors.

- Use clothes, uniform, overall adequate for the work
- Safety shoes
- Helmet

2 DEFINITION OF SAFETY NOTATIONS

To ensure the safety of users and prevent damage to the machine, this manual indicates each precaution on safety with "**WARNING**" or "**CAUTION**" according to its severity. Supplementary information is indicated by "**NOTE**". Read the contents of each **"WARNING"**, "**CAUTION**" and "**NOTE**" before using the robot.

Symbol	Definitions
⚠**WARNING**	Used if hazard resulting in the death or serious injury of the user will be expected to occur if he or she fails to follow the approved procedure.
⚠**CAUTION**	Used if a hazard resulting in the minor or moderate injury of the user, or equipment damage may be expected to occur if he or she fails to follow the approved procedure.
NOTE	Used if a supplementary explanation not related to any of WARNING and CAUTION is to be indicated.

3 PROCEDURE TO MOVE ARM WITHOUT DRIVE POWER IN EMERGENCY OR ABNORMAL SITUATIONS

Please drop the power supply of the robot control system at once when the worker is placed by the robot by any chance or it is confined, push the robot arm directly, change posture, and liberate the worker.

4 WARNING & CAUTION LABEL

(1) Transportation label

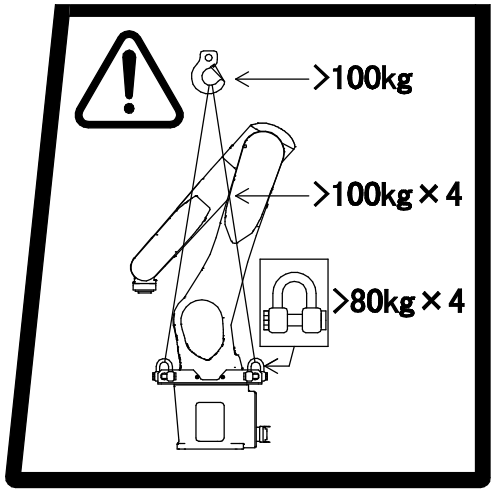


Fig. 4 (a) Transportation label

Description

When transporting the robot, observe the instructions indicated on this label.

1) Use a crane having a load capacity of 100 kg or greater.
2) Use at least four slings each having a load capacity of 100 kg or greater.
3) Use at least four shackles and eyebolts each having an allowable load of 784 N (80 kgf) or greater.

(2) Greasing label (if greasing kit A05B-1142-K021 is specified)

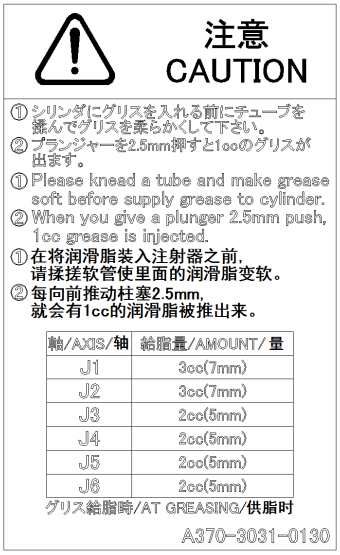


Fig. 4 (b) Greasing label

Description

When using a grease kit, observe the instructions indicated on this label.

1) Before filling the cylinder with grease from tube, squeeze the tube to make the grease in it soft.
2) Pushing in the plunger by 2.5 mm causes a grease of 1 ml to be pushed out.

(3) Reach and payload label

The following label is added if the CE specification is requested.

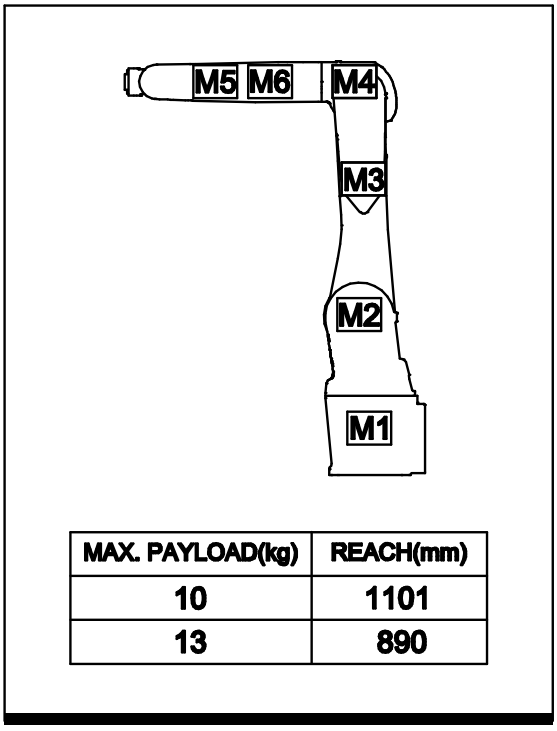


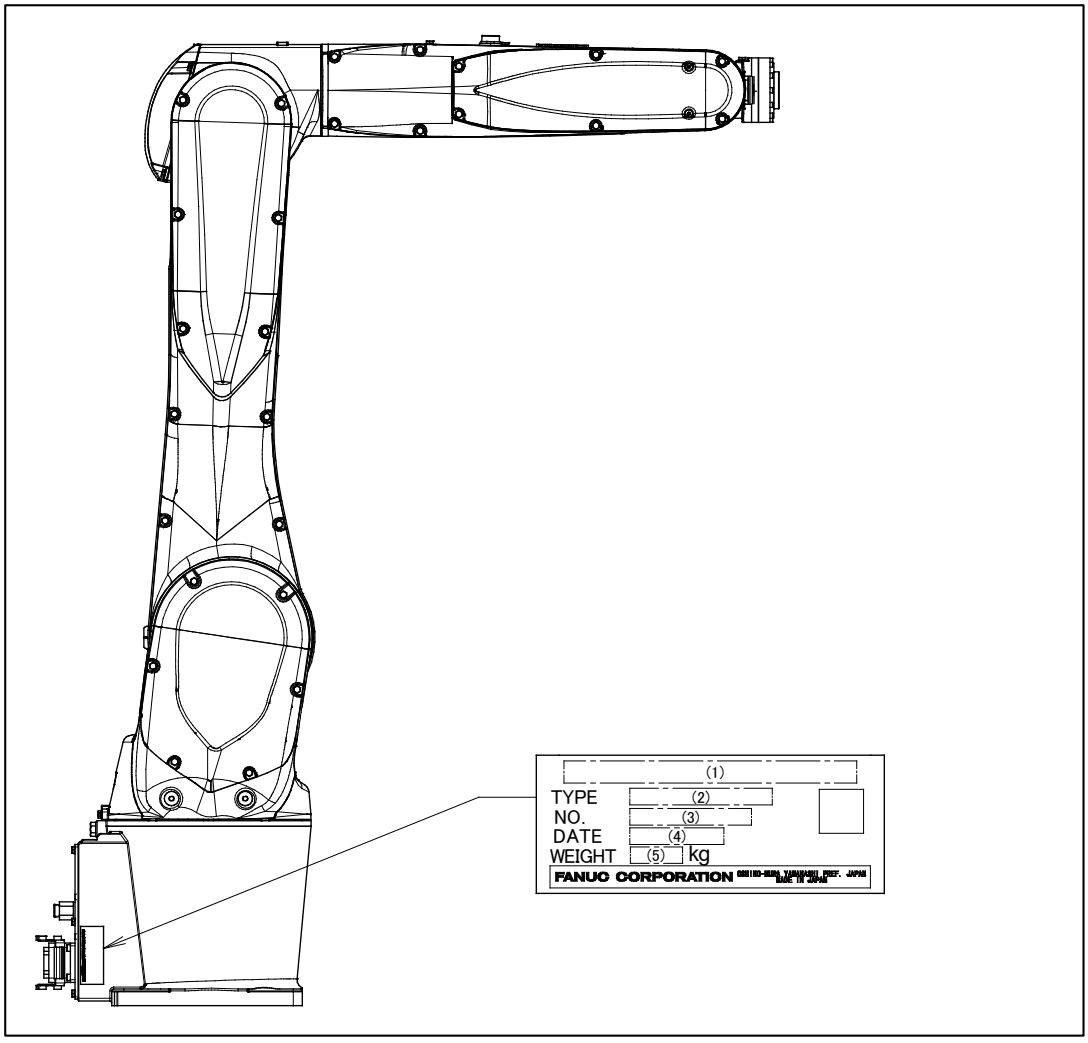
Fig. 4 (c) Reach and payload label

PREFACE

This manual explains maintenance procedures for the following mechanical units:

Model name	Mechanical unit specification No.	Load capacity	Remarks
FANUC Robot LR-10*i*A/10	A05B-1144-B201	10kg (Max. 13kg)	

The label stating the mechanical unit specification number is affixed in the position shown below. Before reading this manual, verify the specification number of the mechanical unit.



Position of label indicating mechanical unit specification number

TABLE 1)

	(1)	(2)	(3)	(4)	(5)
CONTENTS	**Model name**	**TYPE**	**No.**	**DATE**	**WEIGHT kg (Without controller)**
LETTERS	FANUC Robot LR-10*i*A/10	A05B-1144-B201	SERIAL NO. IS PRINTED	PRODUCTION YEAR AND MONTH ARE PRINTED	46

RELATED MANUALS

For the FANUC Robot series, the following manuals are available:

SAFETY HANDBOOK **B-80687EN** All persons who use the FANUC Robot and system designer must read and understand thoroughly this handbook		Intended readers : Operator, system designer Topics : Safety items for robot system design, operation, maintenance
R-30*i*B Mate Plus controller	OPERATOR'S MANUAL Basic Operation **B-83284EN** Alarm Code List **B-83284EN-1** Optional Function **B-83284EN-2**	Intended readers : Operator, programmer, maintenance technician, system designer Topics : Robot functions, operations, programming, setup, interfaces, alarms Use : Robot operation, teaching, system design
	MAINTENANCE MANUAL **Standard : B-83525EN** **Open Air : B-83555EN**	Intended readers : Maintenance technician, system designer Topics : Installation, start-up, connection, maintenance Use : Installation, start-up, connection, maintenance

This manual uses following terms.

Name	Terms in this manual
Connection cable between robot and controller	Robot connection cable
Robot mechanical unit	Mechanical unit

TABLE OF CONTENTS

1 TRANSPORTATION AND INSTALLATION

1.1 TRANSPORTATION

Use a crane to transport the robot. Before transporting the robot, be sure to change the posture of the robot to that shown below and lift by using the eyebolts and the transport equipment at designated points.

⚠ WARNING
1 The robot becomes unstable when it is transported with the end effector applied to wrist. Please be sure to remove the end effector when the robot is transported.
2 Before moving the robot with a crane, check and tighten any loose bolts on the transport equipment on the robot.
3 Do not pull eyebolts sideways.

Transportation using a crane (Fig. 1.1 (a))
Fasten the transport equipment to the robot base and lift the robot with the four slings.

⚠ CAUTION
Note that slings with insufficient length may break the J2 base or J2 arm cover.

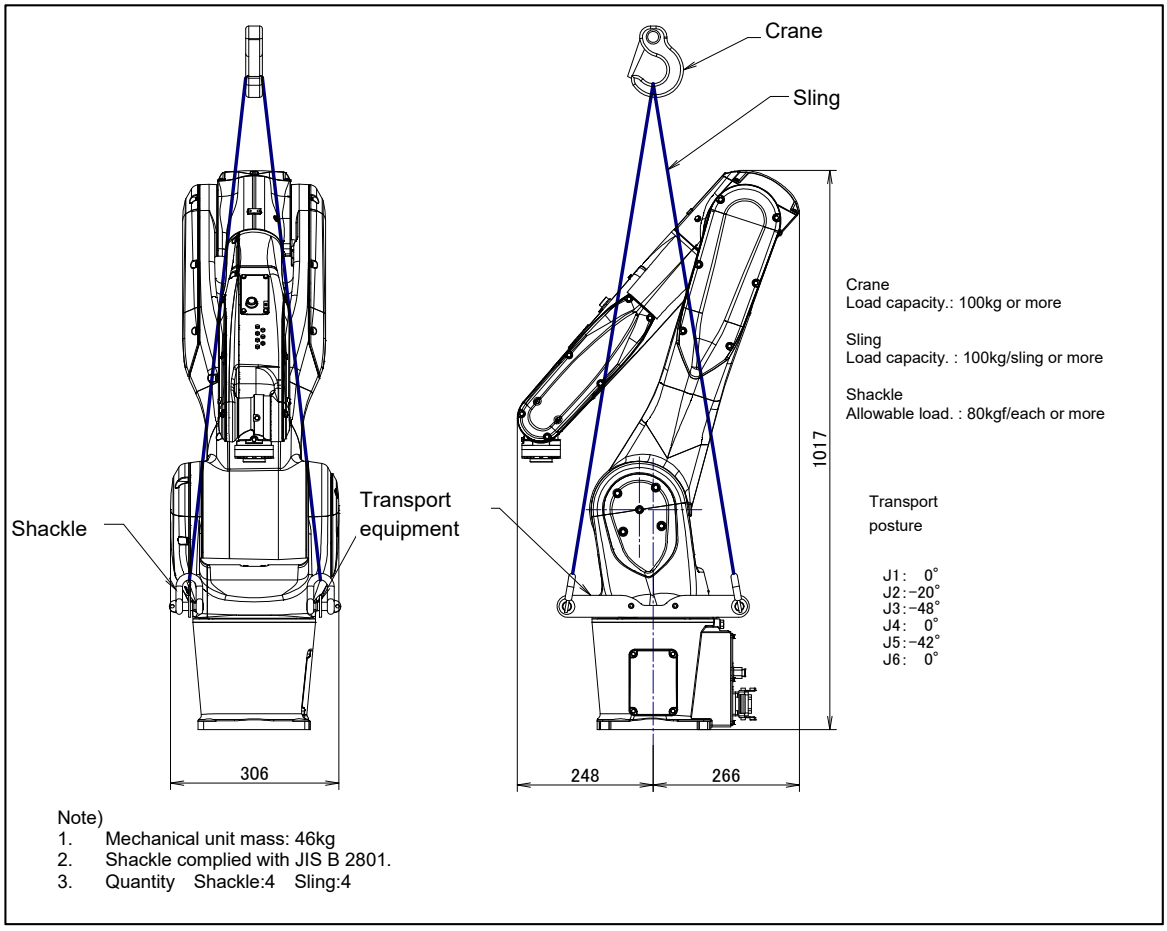


Fig. 1.1 (a) Transportation using a crane (In case of back side connector plate)

1.2 INSTALLATION

Fig. 1.2 (a) shows the robot base dimensions.

⚠ CAUTION
Flatness of robot installation surface must be less than or equal to 0.5mm.
Inclination of robot installation surface must be less than or equal to 0.5°.
If robot base is placed on uneven ground, it may result in the base breakage or low performance of the robot.

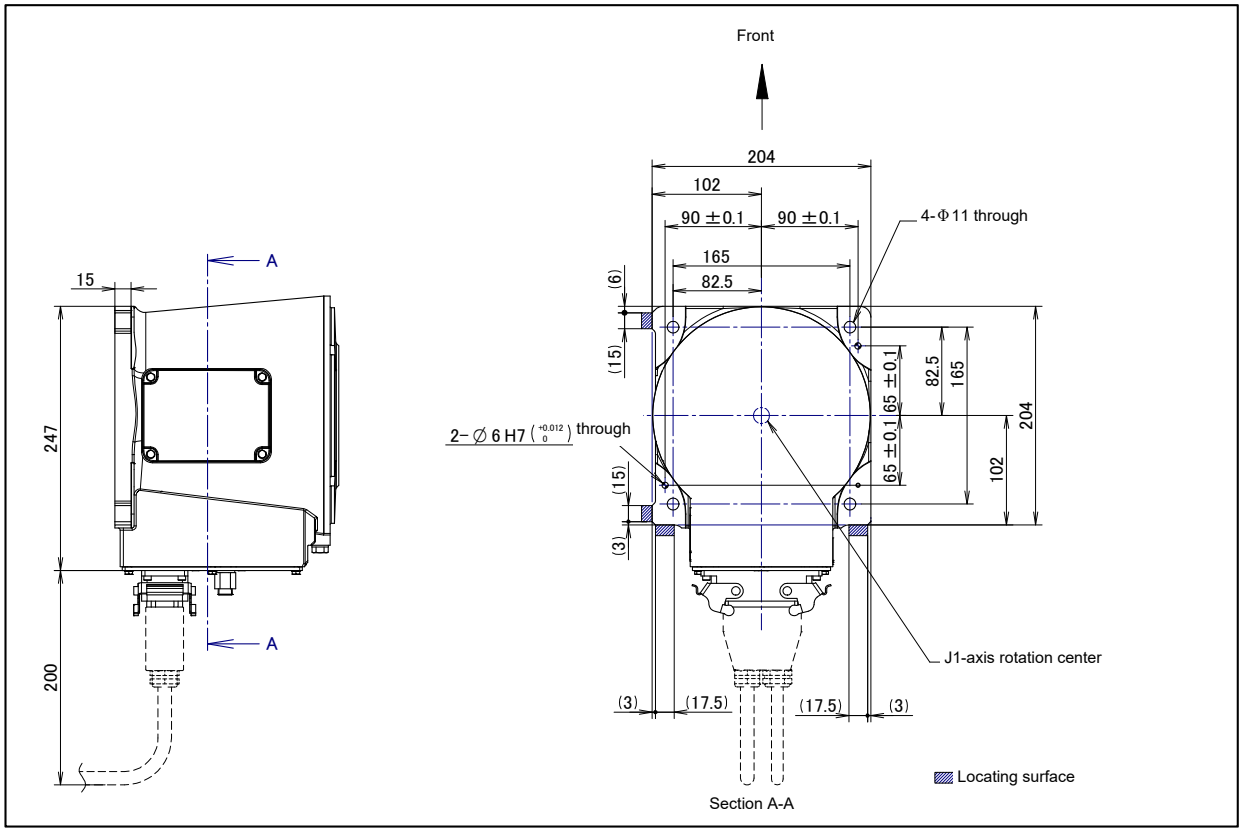


Fig. 1.2 (a) Dimensions of the robot base (back side connector plate)

Fig. 1.2 (b) and Table 1.2 (a) indicate the force and moment applied to the base plate. Table 1.2 (b) to (c) indicate the stopping distance and time of the J1 to J3 axis until the robot stops by Power-Off stop or by Smooth stop after input of the stop signal. Refer to the data when considering the strength of the installation face.

NOTE
Table 1.2 (b) to (c) are measured reference value complied with ISO10218-1.
Values differs depending on each robot individual difference, payload and the program. So confirm the real value by measurement. Values in Table 1.2 (b) is affected by the robot operating status and number of times of the servo-off stop.
Periodically measure the real values and confirm those.

Table 1.2 (a) Force and moment that acts on J1 base

	Vertical moment M_V(Nm)	Force in Vertical direction F_V(N)	Horizontal moment M_H(Nm)	Force in Horizontal direction F_H(N)
During stillness	250	590	0	0
During acceleration or deceleration	560	1030	310	550
During Power-Off stop	1660	1630	1290	1660

Table 1.2 (b) Stopping time and distance until the robot stopping by Power-Off stop after input of stop signal

		J1	J2	J3
LR-10*i*A/10	Stopping time [ms]	372	292	220
	Stopping angle [deg] (rad)	59.5 (1.04)	37.8 (0.66)	36.3 (0.63)

Table 1.2 (c) Stopping time and distance until the robot stopping by Smooth stop after input of stop signal

		J1	J2	J3
LR-10*i*A/10	Stopping time [ms]	576	452	280
	Stopping angle [deg] (rad)	80.4 (1.40)	48.7 (0.85)	37.9 (0.66)

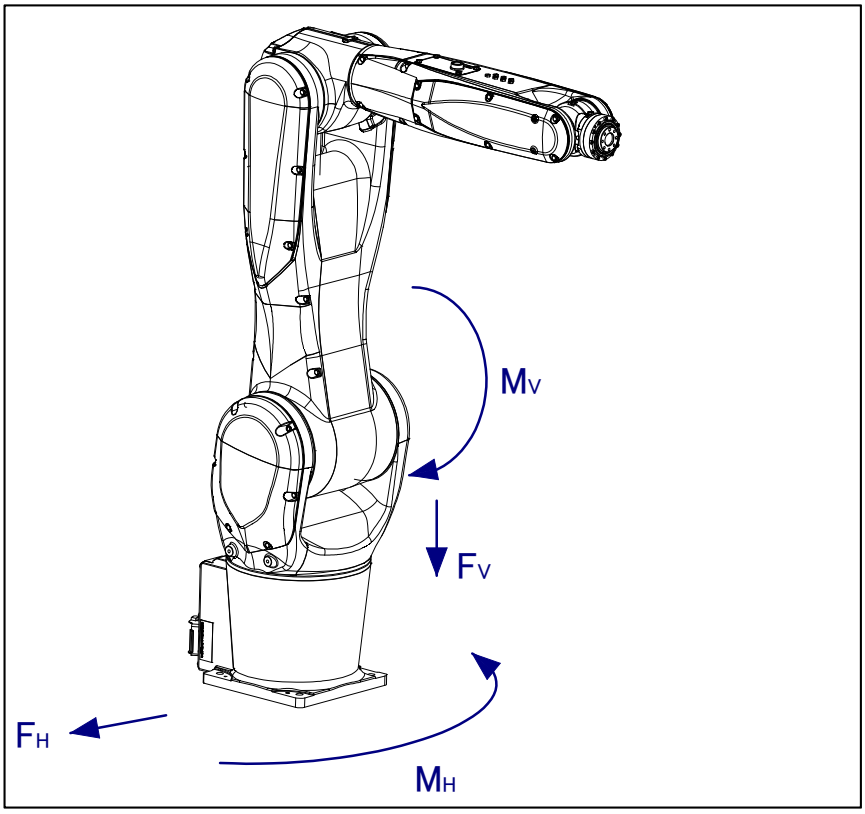
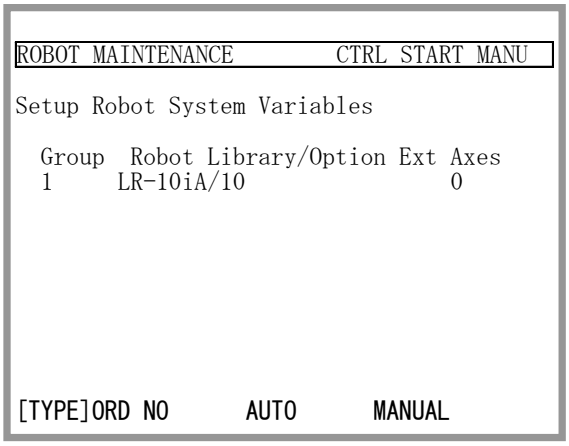


Fig. 1.2 (b) Force and moment that acts on J1 base

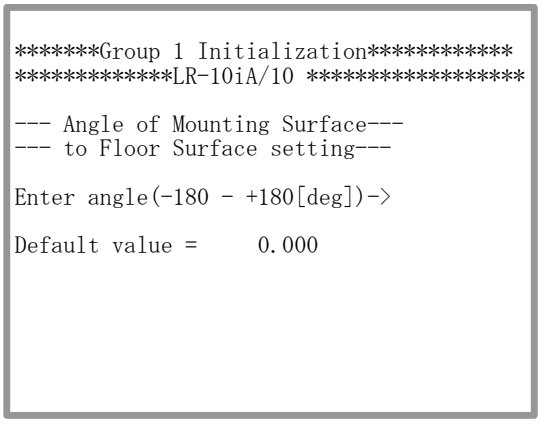
1.2.1 Angle of Mounting Surface Setting

If robot is not installed on a horizontal surface, be sure to set the mounting angle referring to the procedure below. Refer to specifications in Section 3.1 for installation type.

1 Turn on the controller with the [PREV] and the [NEXT] key pressed.
2 Then select [3 Controlled start].
3 Press the [MENU] key and select “9 MAINTENANCE”.
4 Select the robot for which you want to set the mount angle and press the [ENTER] key.



5 Press the [F4] key.
6 Press the [ENTER] key until screen below is displayed.



7 Input the mount angle 1 referring to Fig.1.2.1 (a).

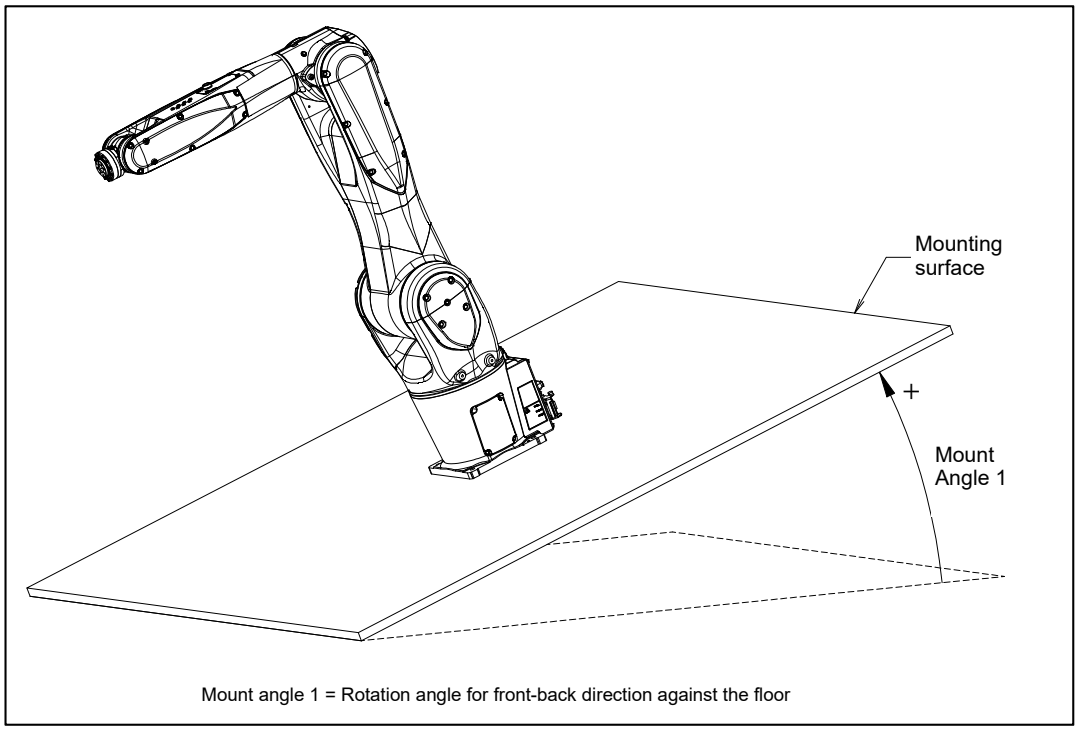


Fig. 1.2.1 (a) Robot mounting angle

8 Press the [ENTER] key. Then the following screen will be displayed.

```
*******Group 1 Initialization************
*************LR-10iA/10******************

--- Angle of Robot to ---
--- Mounting Surface setting --

  0 [deg] : Front-Back (Default)
 90 [deg] : Side
Enter angle (0 or 90[deg])->

Default value =     0.000
```

9 Input the mount angle 2 referring to Fig.1.2.1 (b).

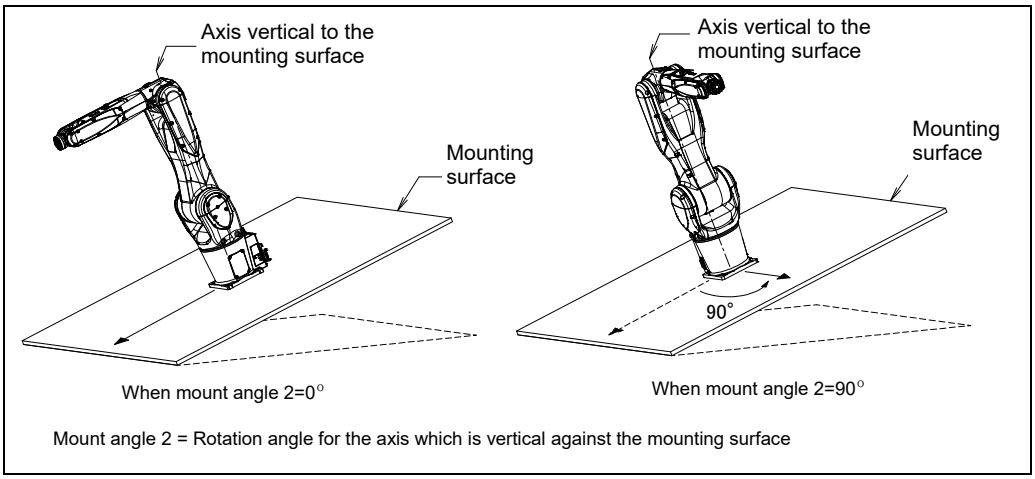
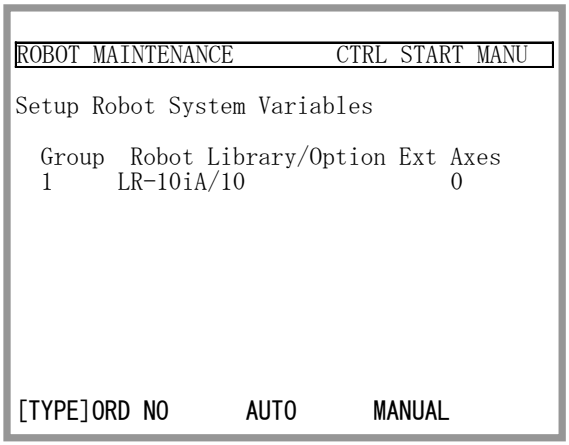


Fig. 1.2.1 (b) Robot mounting angle

10 Press the [ENTER] key until screen below is displayed.



11 Press the [FCTN] key and select ”1 START (COLD)”.

1.3 MAINTENANCE AREA

Fig.1.3 (a) shows the maintenance area of the mechanical unit. Be sure to leave enough room for the robot mastering process. See Chapter 8 for the mastering process.

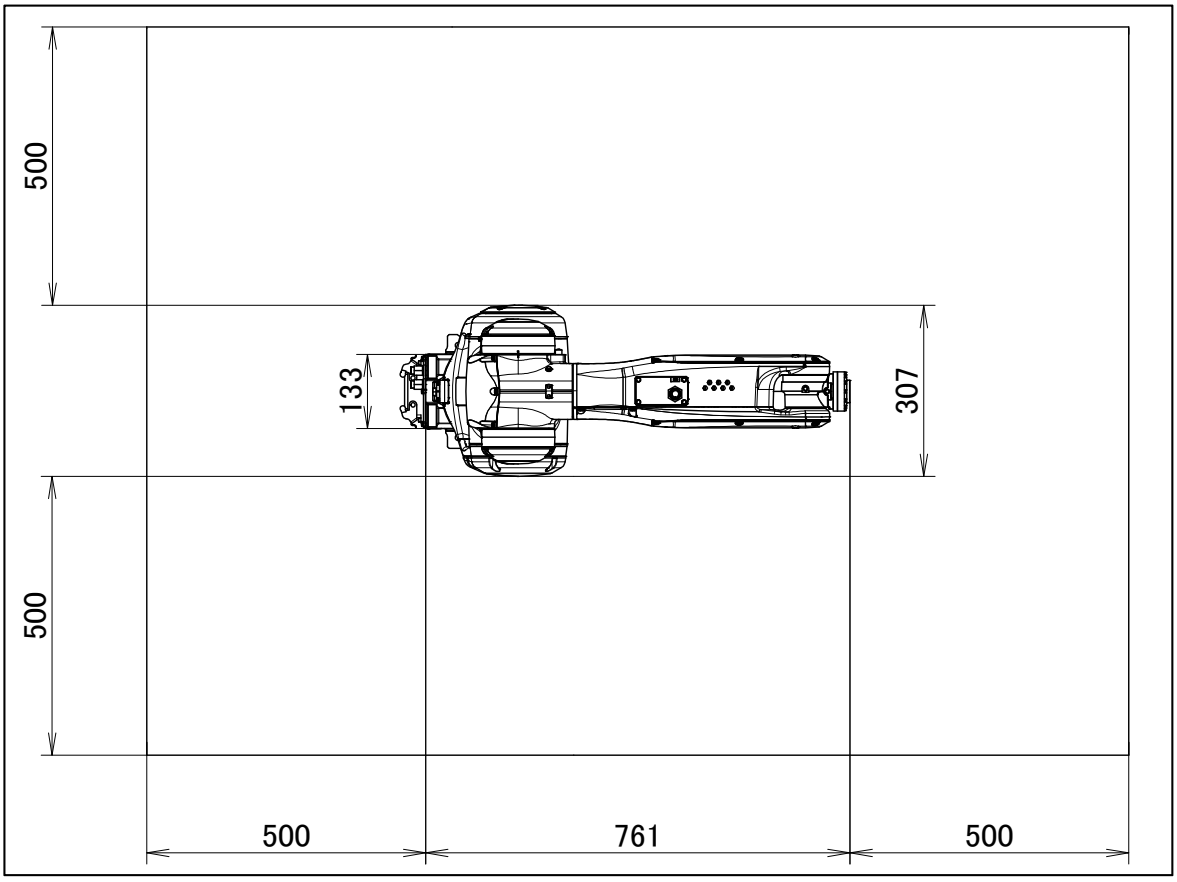


Fig. 1.3 (a) Maintenance area

1.4 INSTALLATION CONDITIONS

Refer to the caution below concerning installation conditions.
Refer to also to the specifications found in Section 3.1 and Section 3.2.

> ⚠ **CAUTION**
> Damage of coating of robot connection cable can cause water intrusion. Take care when installing the cable and replace it if it is damaged.

2 CONNECTION WITH THE CONTROLLER

The robot is connected with the controller via the power cable and signal cable. Connect these cables to the connectors on the back of the robot base. Please be sure to connect the earth cable.
For details of the air supply and option cables, see Chapter 5.

> ⚠ **WARNING**
> Before turning on controller power, be sure to connect the robot and controller with the earth line (ground). Otherwise, there is the risk of electrical shock.

> ⚠ **CAUTION**
> 1 Before connecting the cables, be sure to turn off the controller power.
> 2 Don't use 10m or longer coiled cable without first untying it. The long coiled cable will heat up and become damaged.

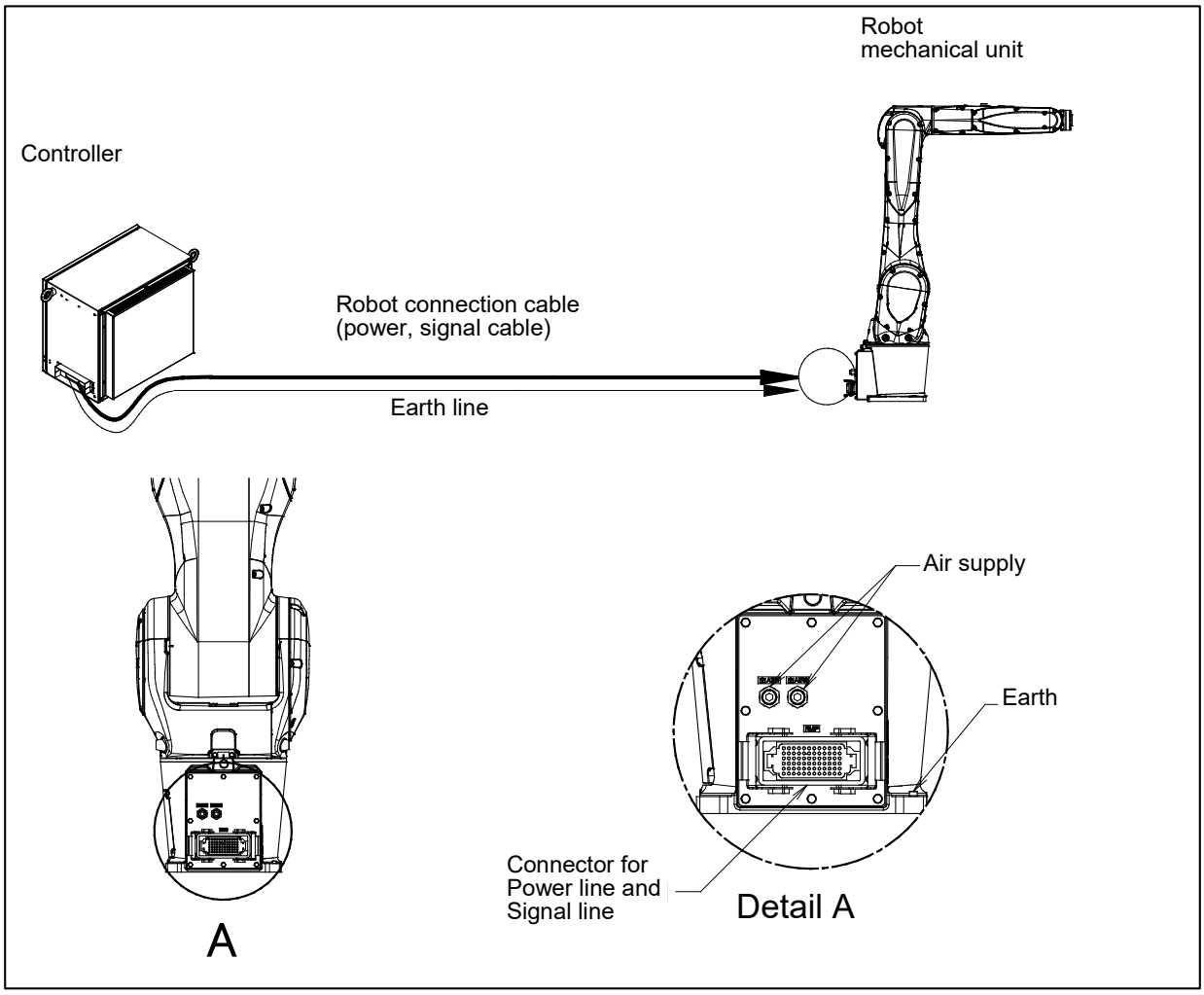


Fig. 2 (a) Cable connection (back side connector plate)

3 BASIC SPECIFICATIONS

3.1 ROBOT CONFIGURATION

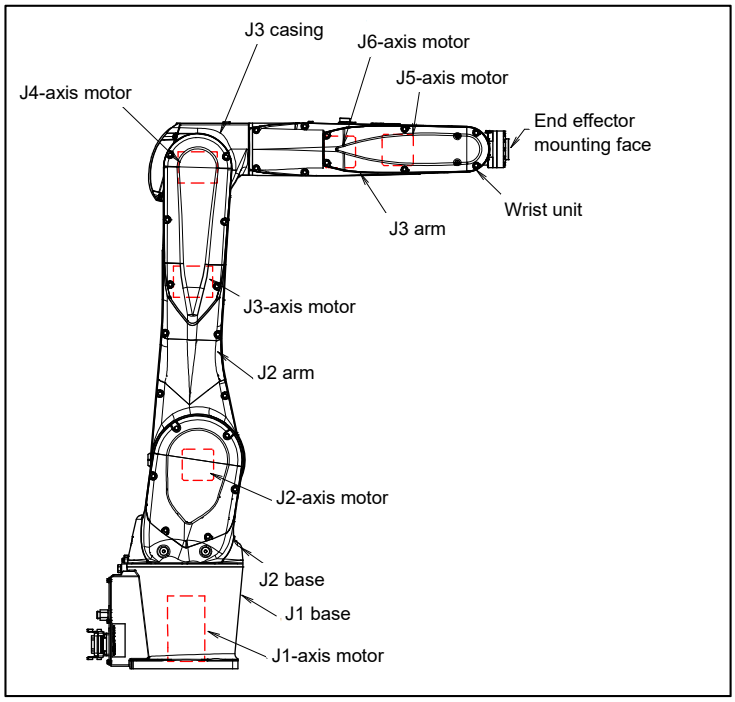


Fig. 3.1 (a) Mechanical unit configuration

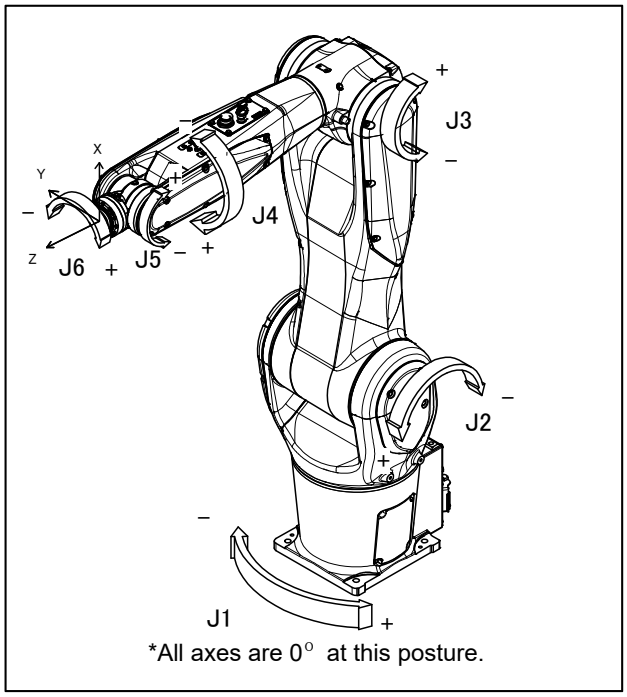


Fig. 3.1 (b) Each axis coordinates and mechanical interface coordinates

NOTE
The end effector mounting face center is 0, 0, 0 of the mechanical interface coordinates.

Table 3.1 (a) Specifications (NOTE 1)

Item		Specifications
Model		LR-10*i*A/10
Type		Articulated Type
Controlled axis		6-axis (J1, J2, J3, J4, J5, J6)
Reach		1101mm
Installation (NOTE 2)		Floor, Upside-down (Angle mount)
Motion range (Max. speed) (NOTE 3)	J1-axis	370° (300°/s) 6.46rad (5.24rad/s)
	J2-axis	235° (230°/s) 4.10rad (4.01rad/s)
	J3-axis	421° (340°/s) 7.35rad (5.93rad/s)
	J4-axis	380° (500°/s) 6.63rad (8.73ad/s)
	J5-axis	250° (400°/s) 4.36rad (6.98rad/s)
	J6-axis	720° (800°/s) 12.57rad (13.96rad/s)
Load capacity (NOTE 4)	Wrist	10 kg (Max. 13kg NOTE 5)
Allowable load moment at wrist	J4-axis	21.0Nm
	J5-axis	21.0Nm
	J6-axis	10.0Nm
Allowable load inertia at wrist	J4-axis	0.77 kg·m^2
	J5-axis	0.77 kg·m^2
	J6-axis	0.28 kg·m^2
Drive method		Electric servo drive by AC servo motor
Repeatability (NOTE 6)		±0.02 mm
Mass (NOTE 7)		46kg
Dust proof and drip proof mechanism (NOTE 8)		Conform to IP67
Acoustic noise level		Less than 70dB (NOTE 9)
Installation environment		Ambient temperature: 0 - 45°C (NOTE 10) Ambient humidity: Normally 75%RH or less. (No condensation allowed.) Short time (within one month) Max 95%RH (No condensation allowed.) Permitted altitude: Up to 1000 m above sea level. Vibration acceleration : 4.9m/s^2 (0.5G) or less Free of corrosive gases (NOTE 11)

NOTE 1) Even if the robot is used according to the defined specifications, motion programs might shorten reducer life or cause the robot to overheat. Use ROBOGUIDE (system design support tool by FANUC) for further evaluation before running production.
NOTE 2) Under the installation condition within ( ), the J1 and J2 axis motion range will be limited. See Section 3.6.
NOTE 3) During short distance motions, the axis speed may not reach the maximum value stated.
NOTE 4) The all up weight including the equipment and connection cables and its swing must not exceed this value when you install the equipment. Section 3.5.
NOTE 5) If the load on the wrist is more than 10kg, the operating space is restricted . Refer to Section 3.2.
NOTE 6) Compliant with ISO 9283.
NOTE 7) It doesn't contain the mass of the controller part.
NOTE 8) The liquid that is the deterioration of the seal material such as Organic solvent, acid, alkali and chlorine system, cutting liquid cannot be use. (See Subsection 3.1.1.)
NOTE 9) This value is equivalent continuous A-weighted sound pressure level that applied with ISO11201 (EN31201). This value is measured with the following conditions.
- Maximum load and speed
- Operating mode is AUTO

NOTE 10) When robot is used in low temperature environment that is near to 0ºC, or robot is not operated for a long time in the environment that is less than 0ºC in a holiday or the night, because viscous resistance of the drive train is so big that may cause occurrence of collision detect alarm (SRVO –050) etc. In this case, we recommend performing the warm up operation for several minutes.
NOTE 11) Contact the service representative, if the robot is to be used in an environment or a place subjected to hot/cold temperatures, severe vibrations, heavy dust, water, water vapor, cutting oil, cleaning fluid splash and or other contaminations.

3.1.1 Note of Severe Dust /Liquid Specification

1 The liquids below cannot be applied because they may cause deterioration or corrosion of the rubber parts (such as gaskets, oil seals, and O-rings) used in the robot.
   (a) Organic solvents
   (b) Cutting fluid or cleaning fluid including chlorine / gasoline
   (c) Amine type cutting fluid or cleaning fluid
   (d) Acid, alkali and liquid causing rust
   (e) Other liquids or solutions, that will harm NBR or CR rubber
2 When the robot is used in an environment where a liquid such as water is dashed over the robot, great attention should be given to drainage under the J1 base. A failure may be caused if the J1 base is kept immersed in water due to poor drainage.
3 Don’t use unconfirmed liquid.

3.2 MECHANICAL UNIT OPERATION AREA AND INTERFERENCE AREA

Fig. 3.2 (a) shows the robot operating space. When installing peripheral equipment, be careful not to interfere with the robot and its operating space.

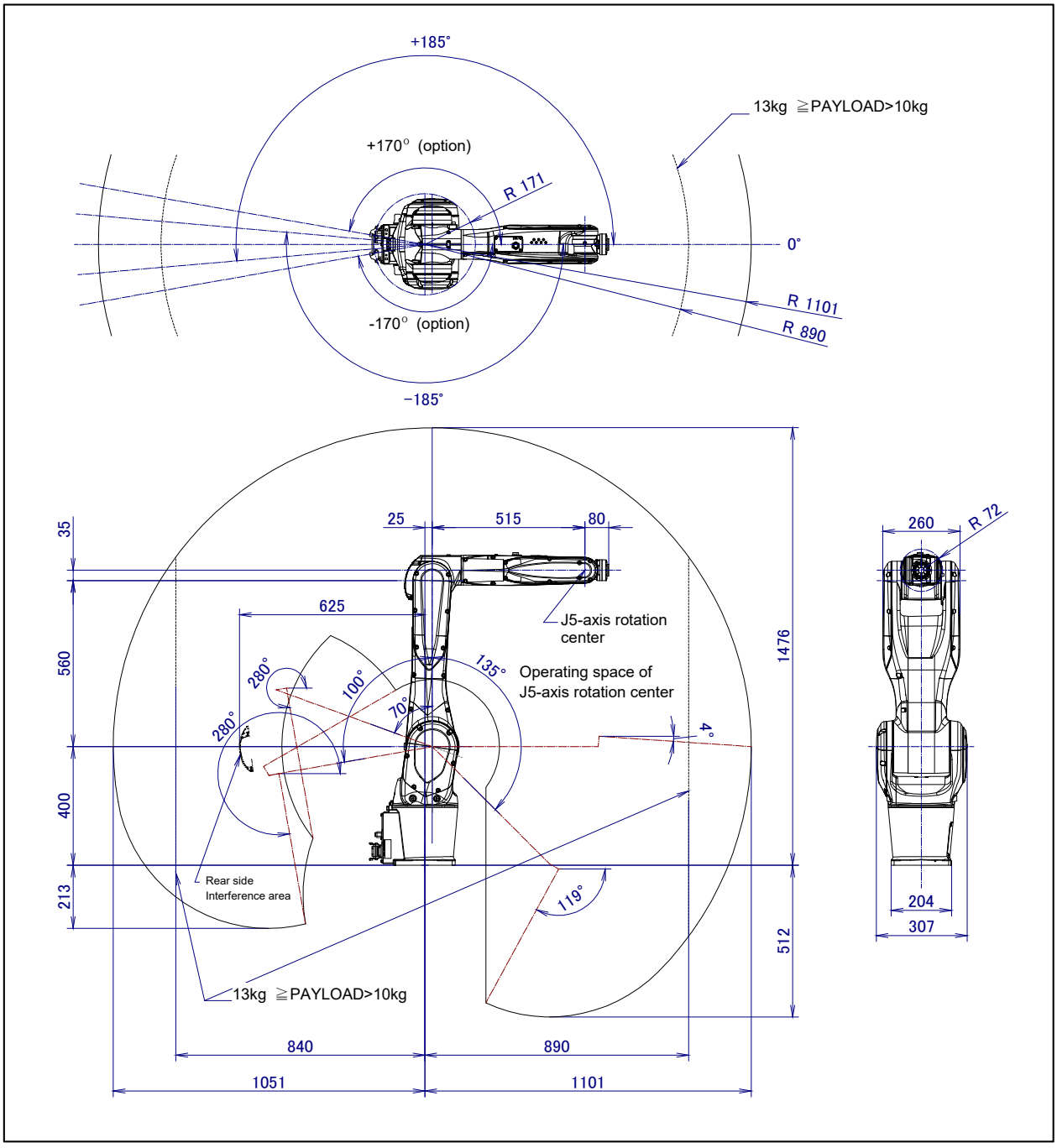


Fig. 3.2 (a) Operating space

3.3 ZERO POINT POSITION AND MOTION LIMIT

A zero point and motion range are provided for each controlled axis. Exceeding the software motion limit of a controlled axis is called overtravel (OT). Overtravel is detected at both ends of the motion limit for each axis. The robot cannot exceed the motion range unless there is a loss of the zero point position due to abnormalities in servo system or a system error. In addition, a mechanical stopper is also available to limit maximum motion and to improve safety.

Fig. 3.3 (a) shows the position of the mechanical stopper. Don't reconstruct the mechanical stopper. If you do, there is a possibility that the robot will not stop normally.

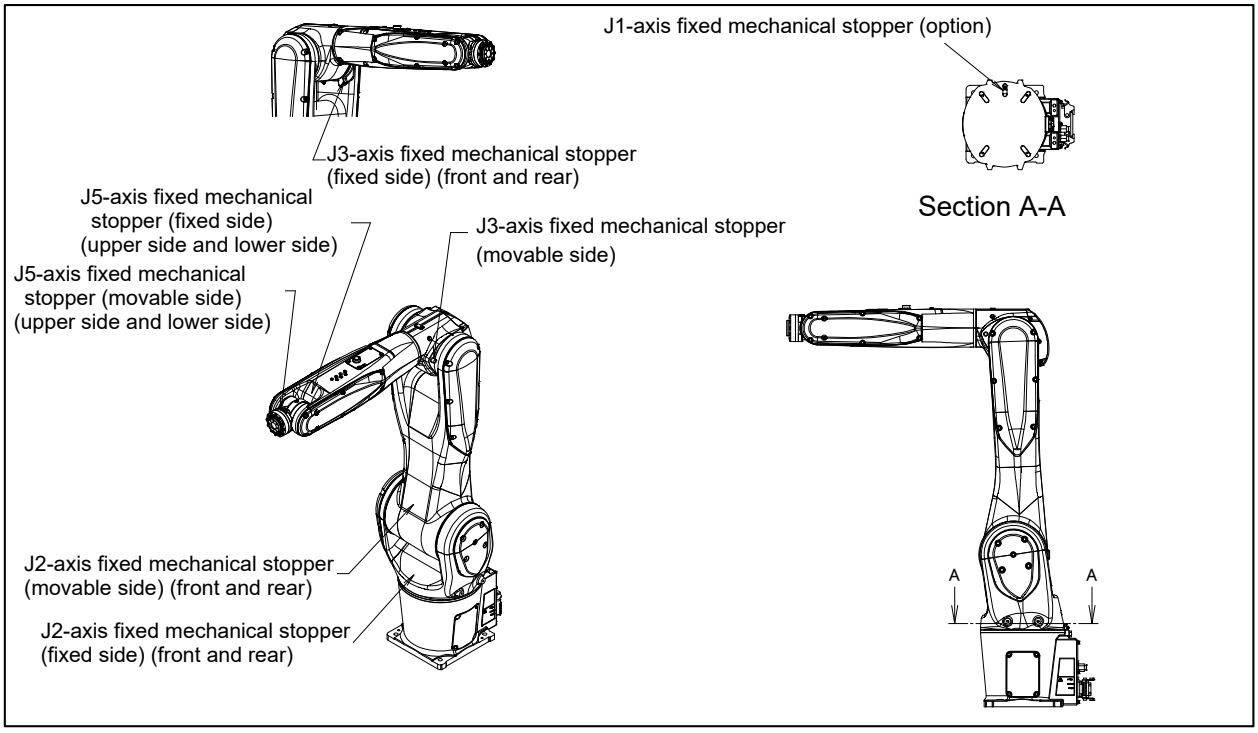


Fig. 3.3 (a) Position of mechanical stopper

Fig.3.3 (b) to (h) show the zero point, motion limit and maximum stopping distance (stopping distance in condition of max speed and max load) of each axis.

Only in case of the J1, J3-axis, when the robot comes in contact with the mechanical stopper, it may deform. When the mechanical stopper is deformed, replacement is needed. See Fig.3.3 (a) about replacing J1-axis or J3-axis mechanical stopper.

* The motion range can be changed. For information on how to change the motion range, see Chapter 6, "AXIS LIMIT SETUP".

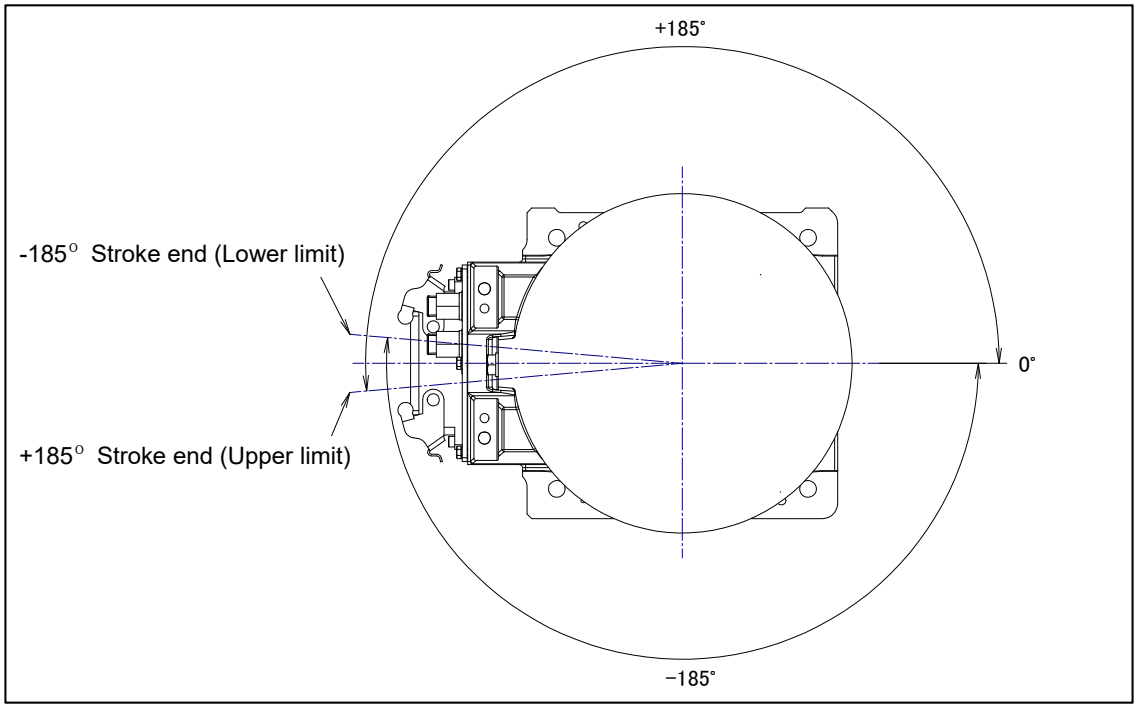


Fig. 3.3 (b) J1-axis motion limit (When fixed mechanical stopper is not specified)

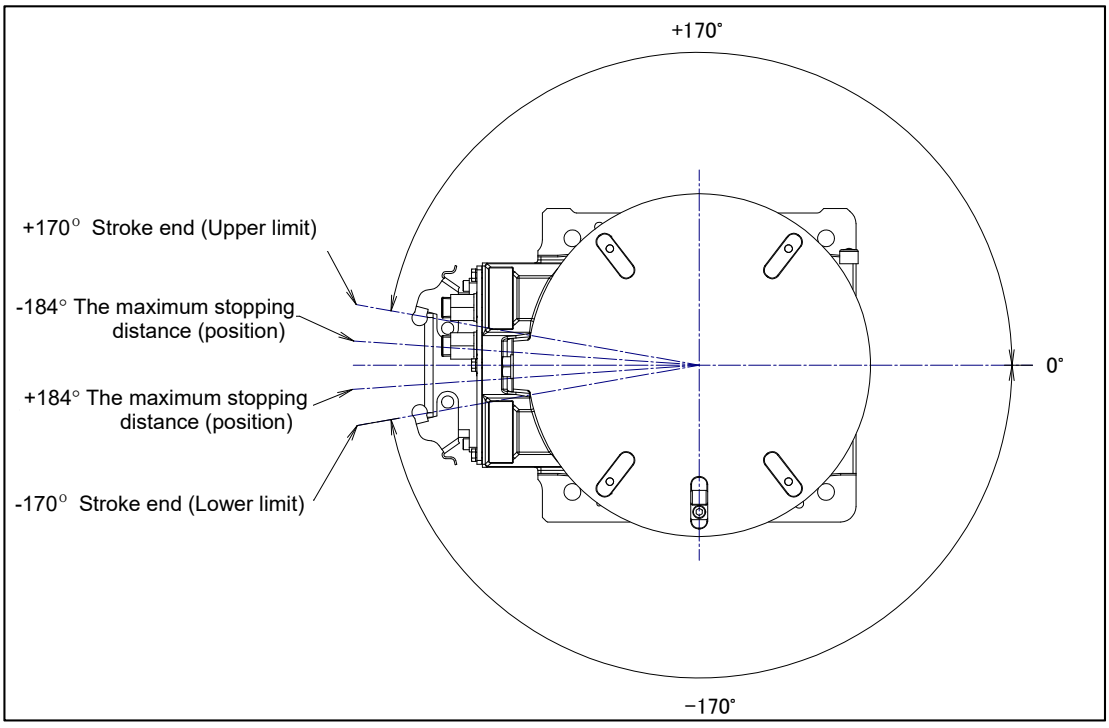


Fig. 3.3 (c) J1-axis motion limit (When fixed mechanical stopper is specified)

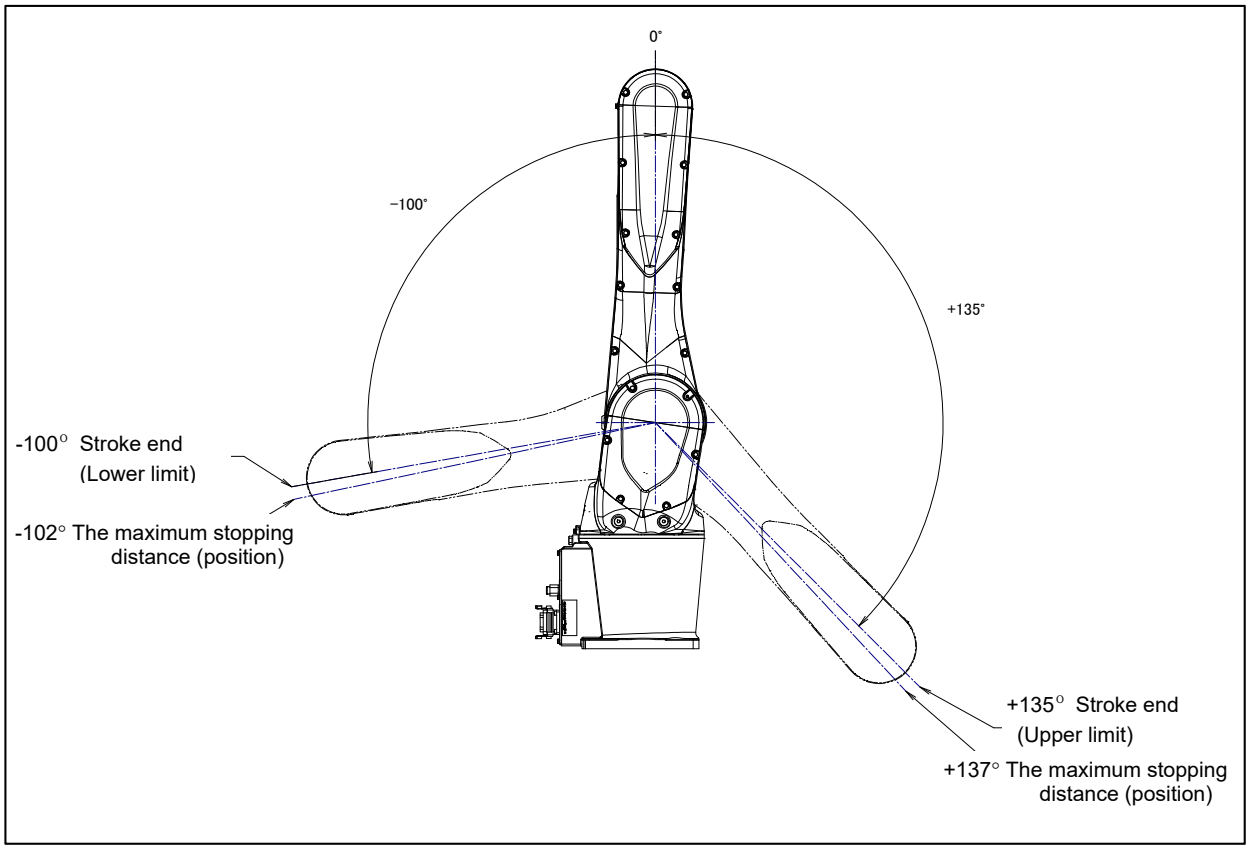


Fig. 3.3 (d) J2-axis motion limit

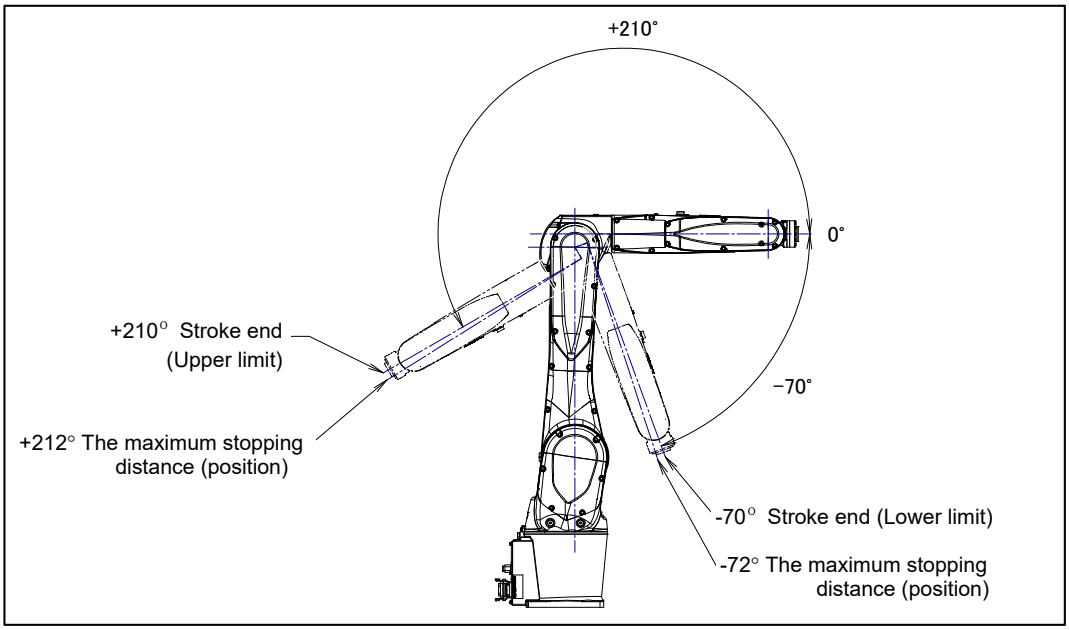


Fig.3.3 (e) J3-axis motion limit

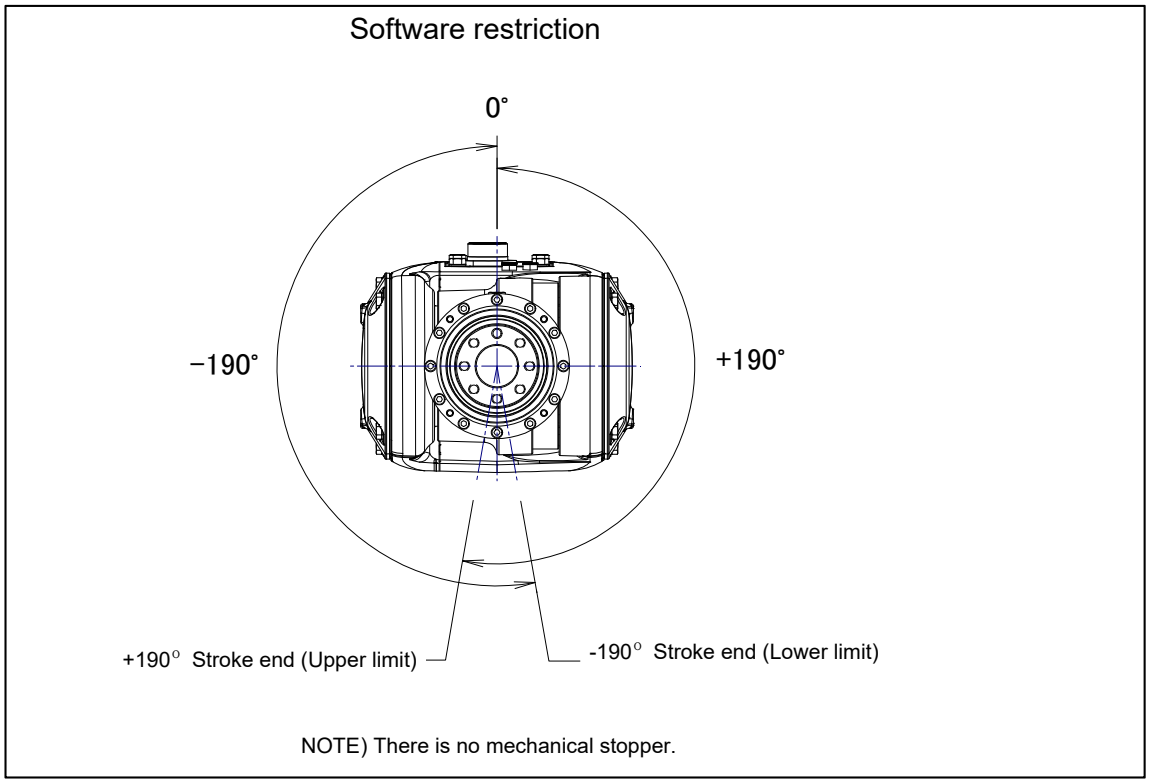


Fig. 3.3 (f) J4-axis motion limit

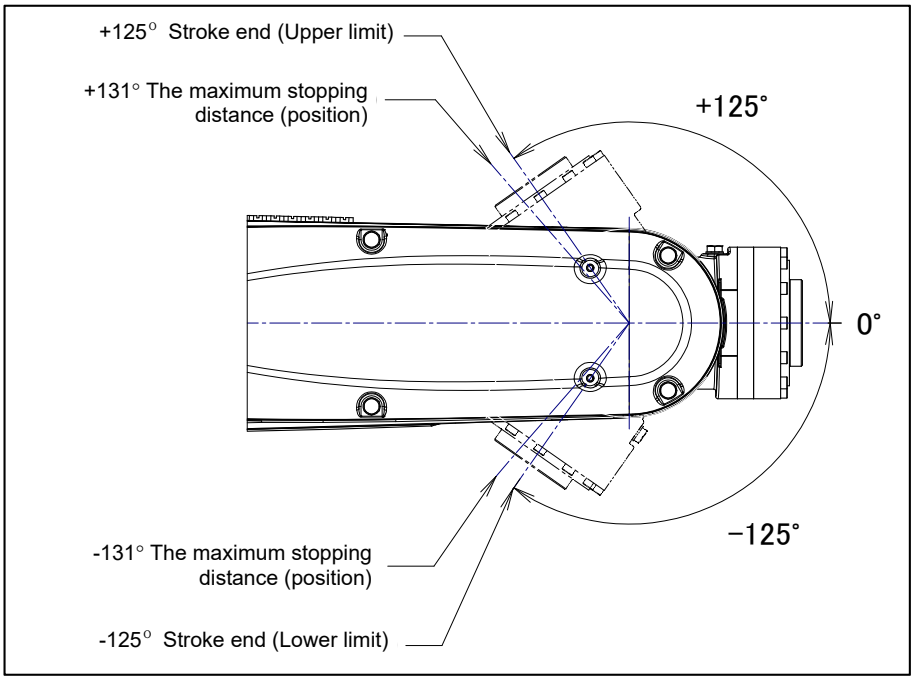


Fig. 3.3 (g) J5-axis motion limit

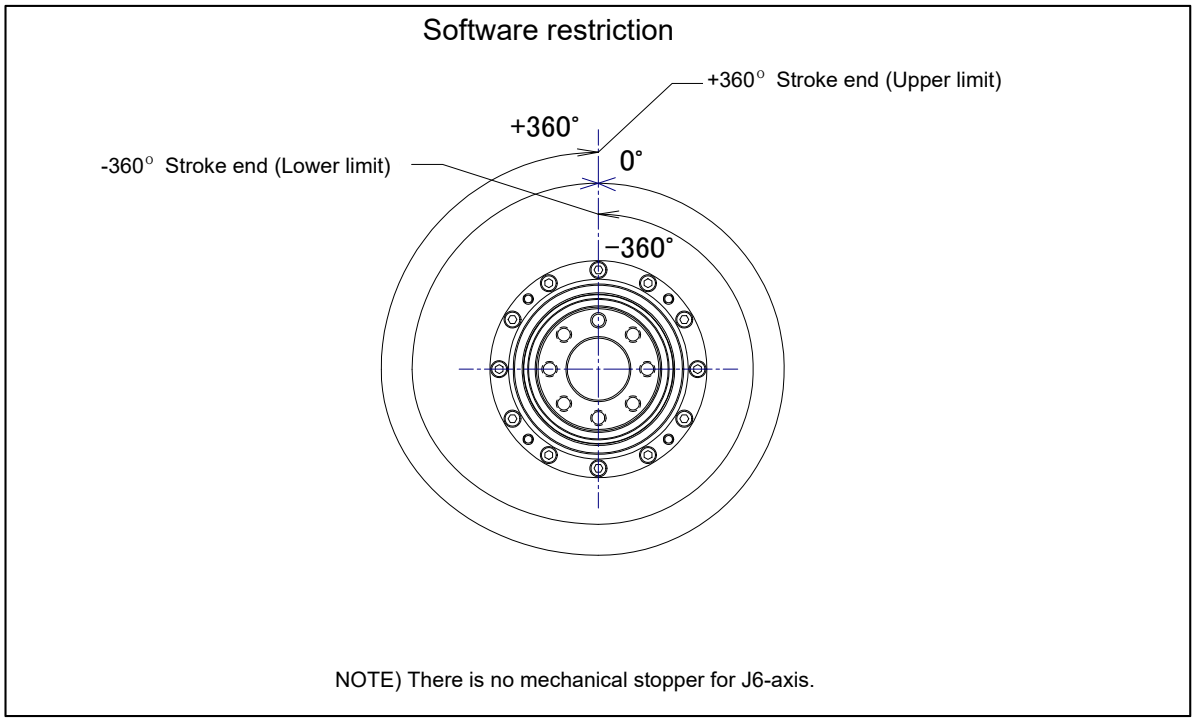


Fig. 3.3 (h) J6-axis motion limit

3.4 WRIST LOAD CONDITIONS

Fig. 3.4 (a) is a diagram to limit loads applied to the wrist.

- Apply a load within the region indicated in the graph.
- Apply the conditions of the allowable load moment and the allowable load inertia. See Section 3.1 about the allowable load moment and the allowable load inertia.
- See Section 4.1 about the mounting of an end effector.

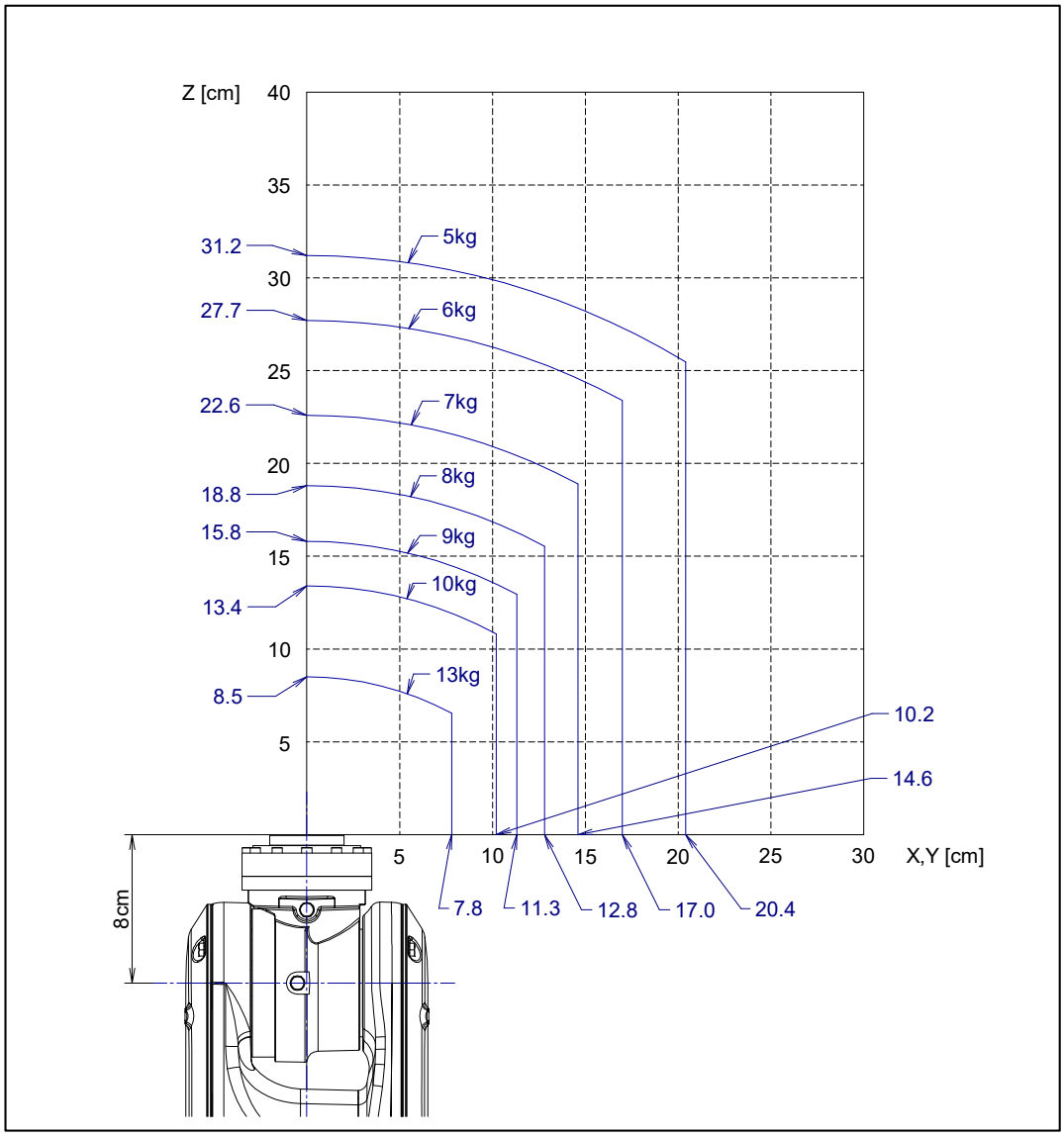


Fig. 3.4 (a) Wrist load diagram

3.5 LOAD CONDITION ON EQUIPMENT MOUNTING FACE

The equipment can be installed as shown in Fig. 3.5 (a). When the equipment is installed, the total mass of the installed equipment, end effector and work piece must not exceed 10kg (13kg in case of max. 13kg payload). Please refer to Chapter 4 for the size on the equipment installation side.

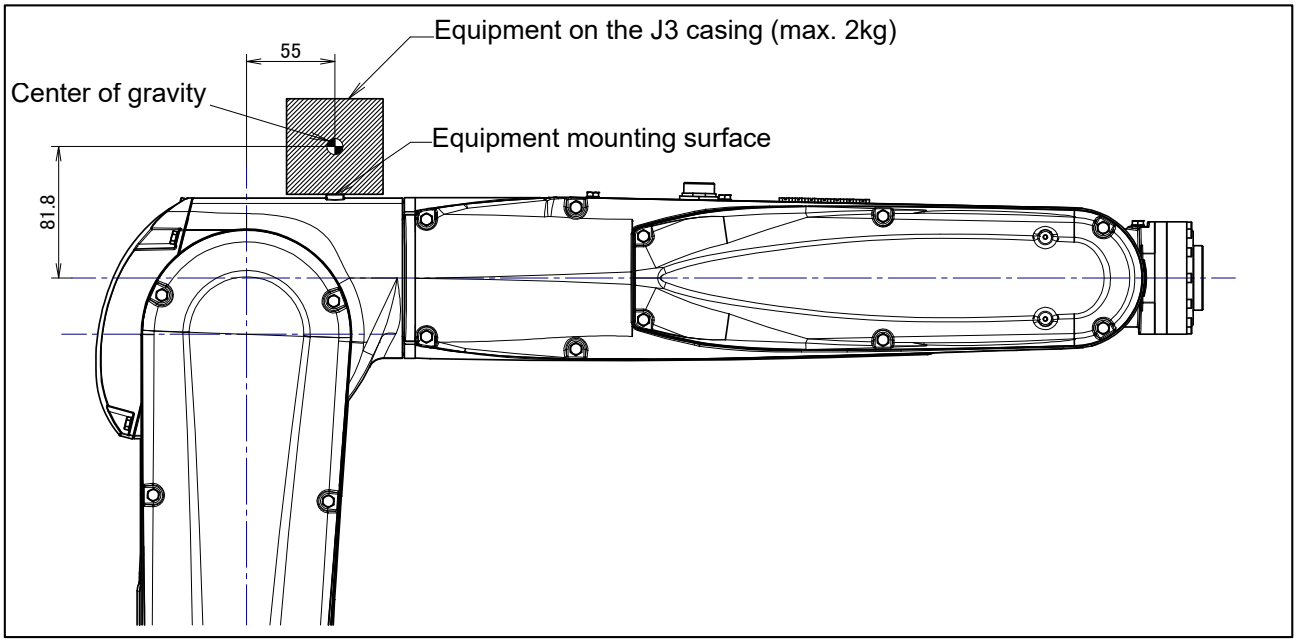


Fig. 3.5 (a) Load condition of equipment mounting face

3.6 OPERATING AREA FOR INCLINATION INSTALLATION

When the robot is installed on an inclined surface, the operating area is limited by the mount angle 1. The robot can't stop except for the ranges that are shown in the fig. 3.6 (a) to (d).
If payload is less than 8.5 kg or between more than 10kg and less than 11.5kg (in case of max. 13kg payload), there is no restriction of the operating space even in the inclination installation.

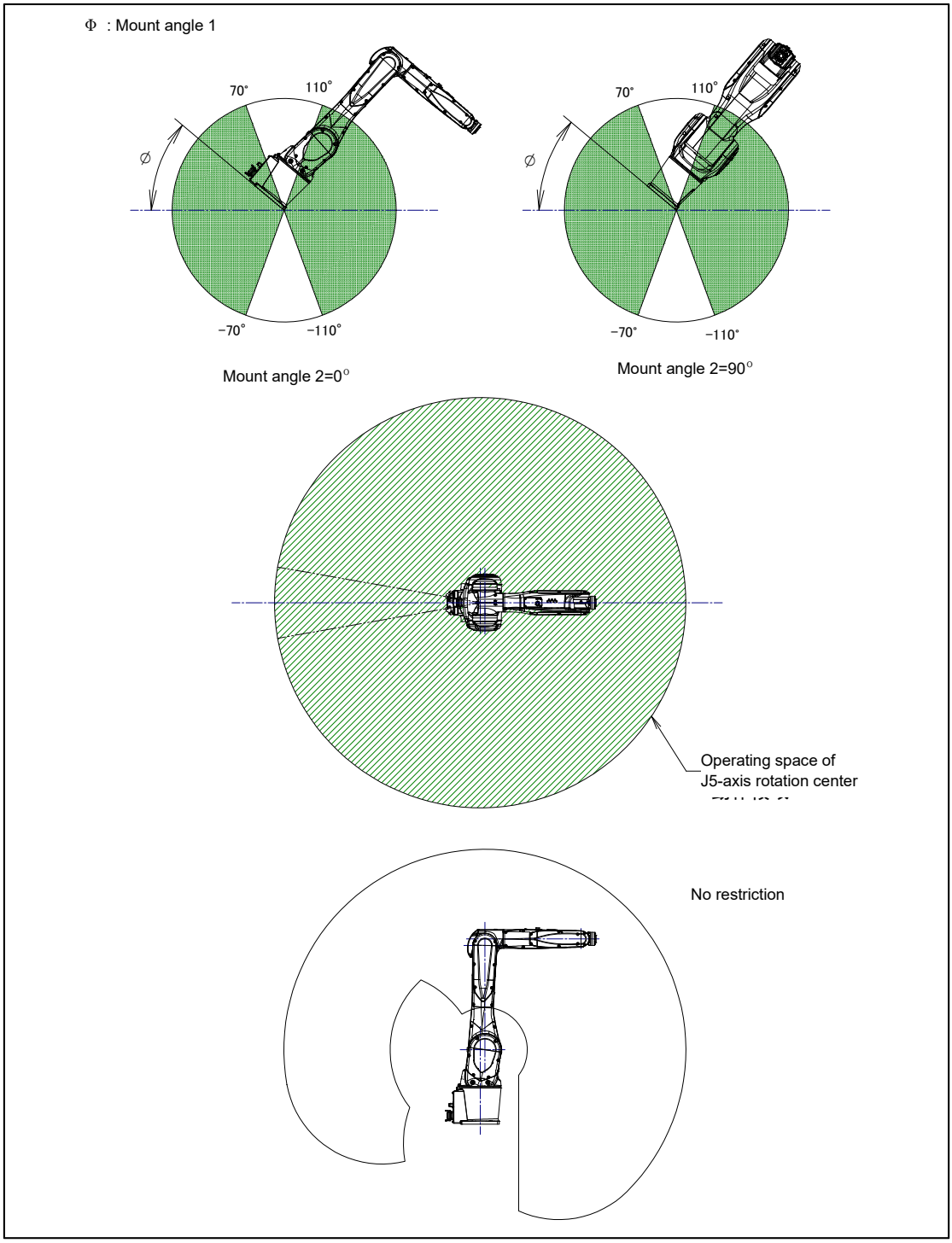


Fig. 3.6 (a) Installation area (1) Operation area (max. 10kg payload)
(-180°≦ϕ≦-110°, -70°≦ϕ≦70°, 110°≦ϕ≦180°)

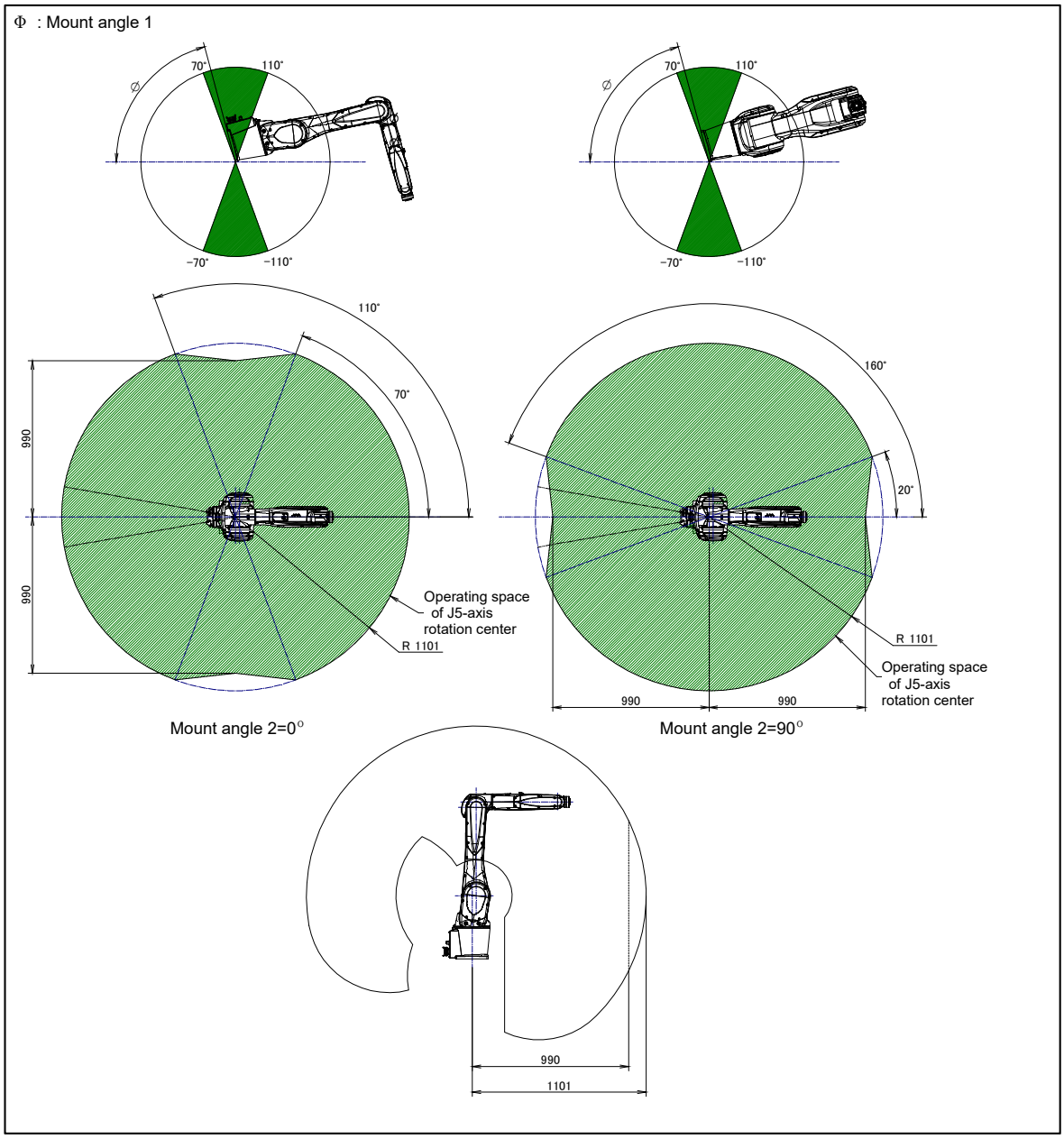


Fig. 3.6 (b) Installation area (2) Operation area (max. 10kg payload)
(-110°<ϕ<-70°, 70°<ϕ<110°)

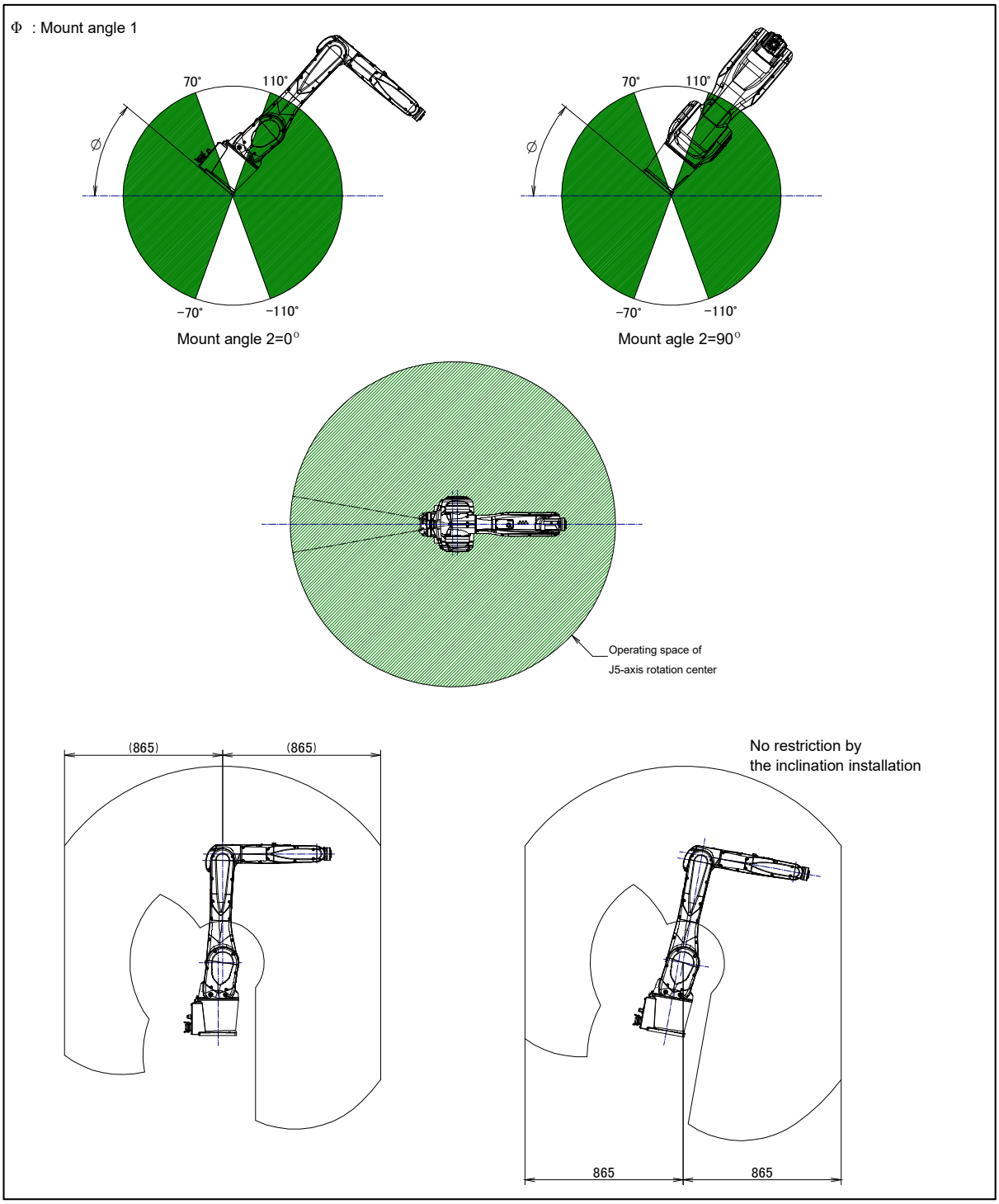


Fig. 3.6 (c) Installation area (1) Operation area (max. 13kg payload)
(-180°≦ϕ≦-110°, -70°≦ϕ≦70°, 110°≦ϕ≦180°)

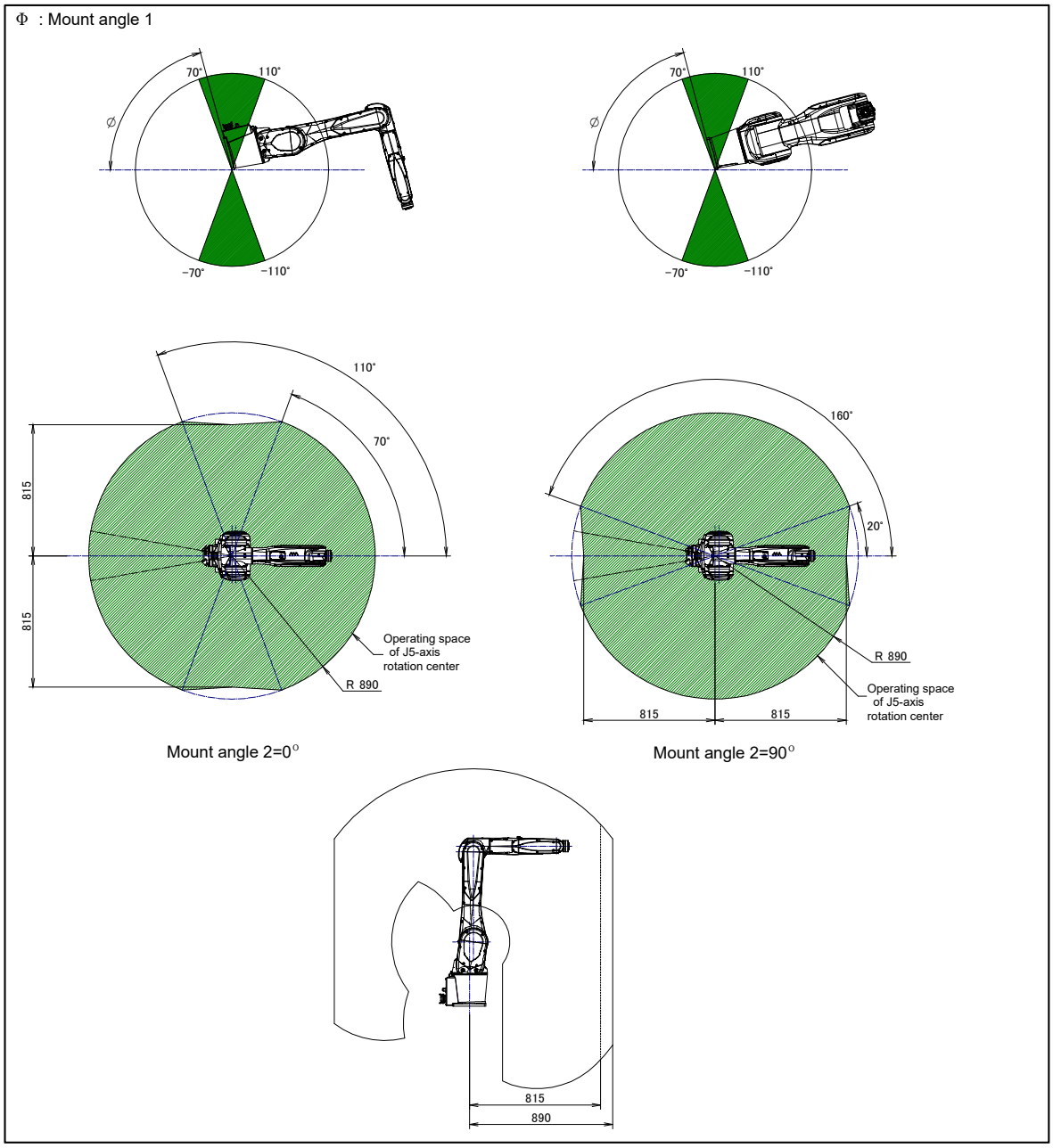


Fig. 3.6 (d) Installation area (2) Operation area (max. 13kg payload)
(-110°<ϕ<-70°, 70°<ϕ<110°)

4 EQUIPMENT INSTALLATION TO THE ROBOT

4.1 END EFFECTOR INSTALLATION TO WRIST

Fig. 4.1 (a) is the diagrams for installing end effectors on the wrist. Select screws and positioning pins of a length that match the depth of the tapped and pin holes. Fasten the bolt for attaching the end effector referring to Appendix B for the tightening torque.

⚠ CAUTION
1 Notice that the depth of the end effector coupling should be shorter than the length of the wrist flange coupling.
2 In mating the end effector to the wrist flange, don't use a positioning pin that doesn't have a removal tap.

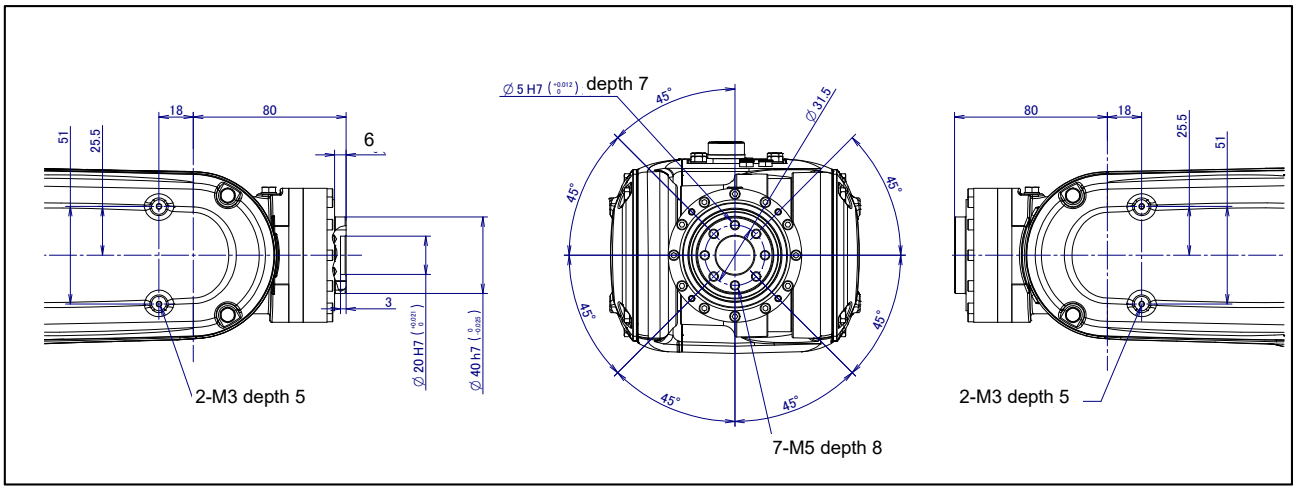


Fig. 4.1 (a) Surface for installing the end effector

NOTE
User tap (2-M3) is for piping and wiring to the end effector.

4.2 EQUIPMENT MOUNTING FACE

As shown in Fig. 4.2 (a), tapped holes are provided to install equipment to the robot.

⚠ CAUTION

1 Never perform additional machining operations such as drilling or tapping on the robot body. This will seriously affect the safety and functions of the robot.
2 Note that the use of a tapped hole not shown in the following figure is not assured. Please do not use existing bolts that fasten the mechanical units to install equipment to the robot.

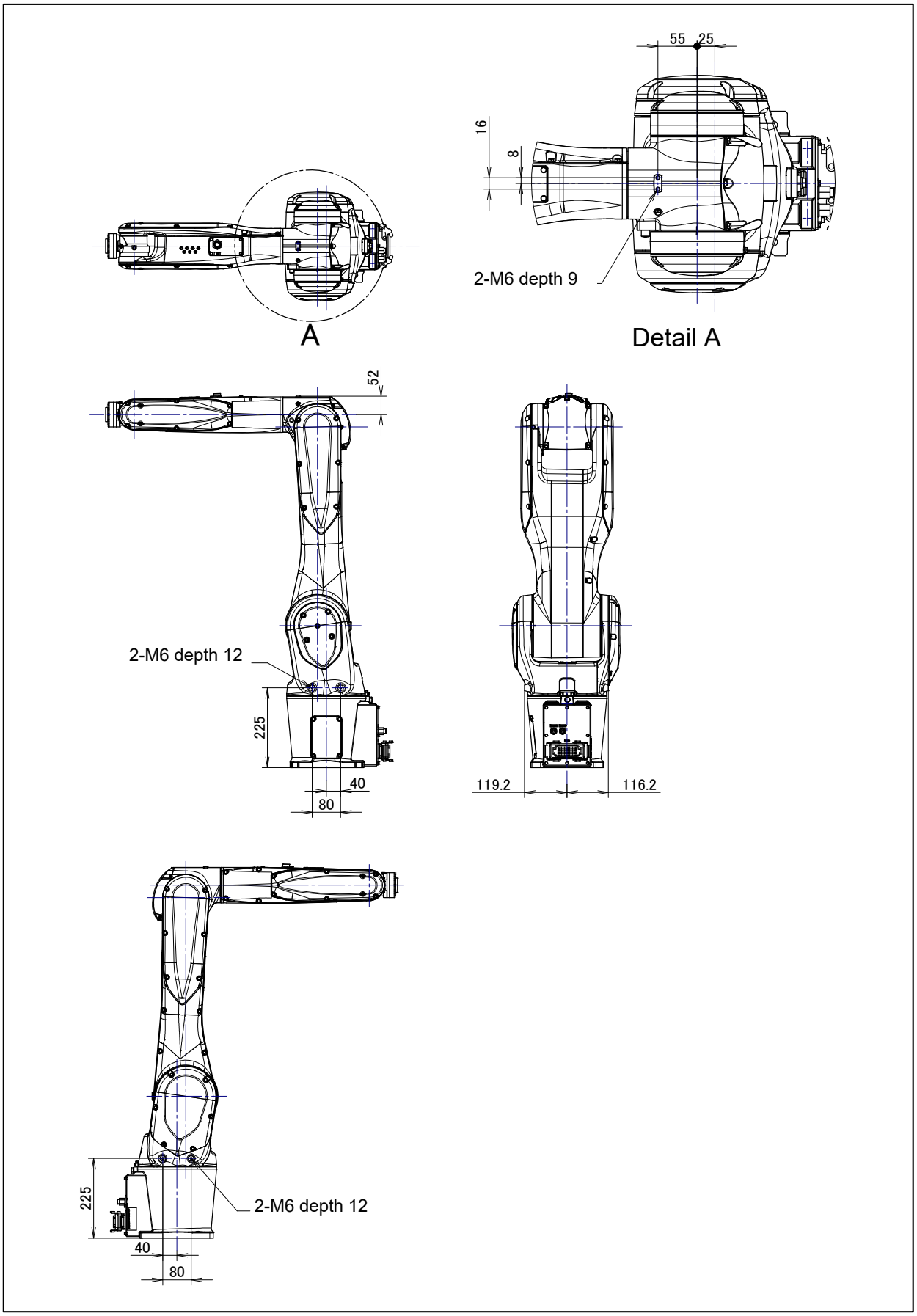


Fig. 4.2 (a) Equipment mounting faces

4.3 LOAD SETTING

⚠ CAUTION

1 Set the load condition parameter before the robot runs. Do not operate the robot when its payload is exceeded. Don't exceed the allowable payload including connection cables. Operation with the robot over payload may result in troubles such as reducer life reduction.

2 When performing load estimation function after parts replacement
If wrist axes (J5/J6-axis) motors or reducers are replaced, estimation accuracy may go down. Perform the calibration for load estimation before performing load estimation. Refer to Chapter 9 "LOAD ESTIMATION" in Optional Function OPERATOR'S MANUAL (B-83284EN-2).

The operation motion performance screens include the MOTION PERFORMANCE screen, MOTION PAYLOAD SET screen, and payload information and equipment information on the robot.

1 Press the [MENU] key to display the screen menu.
2 Select [6 SYSTEM] on the next page,
3 Press the F1 ([TYPE]) key to display the screen switch menu.
4 Select "MOTION." The MOTION PERFORMANCE screen will be displayed.

```
MOTION PERFORMANCE                    JOINT 10%
    Group1
 No.   PAYLOAD[kg]          Comment
  1          10.00    [                    ]
  2           0.00    [                    ]
  3           0.00    [                    ]
  4           0.00    [                    ]
  5           0.00    [                    ]
  6           0.00    [                    ]
  7           0.00    [                    ]
  8           0.00    [                    ]
  9           0.00    [                    ]
 10           0.00    [                    ]


  Active PAYLOAD number =0
[ TYPE]  GROUP  DETAIL  ARMLOAD  SETIND >
```

5 Ten different pieces of payload information can be set using condition No. 1 to 10 on this screen. Place the cursor on one of the numbers, and click F3 (DETAIL). The MOTION PAYLOAD SET screen appears.

```
MOTION PAYLOAD SET                    JOINT 10%

    Group 1
 1 Schedule No[          1]:[Comment          ]
 2 PAYLOAD                  [kg]          10.00
 3 PAYLOAD CENTER  X [cm]                -10.10
 4 PAYLOAD CENTER  Y [cm]                 0.00
 5 PAYLOAD CENTER  Z [cm]                10.74
 6 PAYLOAD INERTIA X [kgfcms^2]           3.157
 7 PAYLOAD INERTIA Y [kgfcms^2]           3.157
 8 PAYLOAD INERTIA Z [kgfcms^2]           1.798

 [TYPE] GROUP NUMBER   DEFAULT   HELP
```

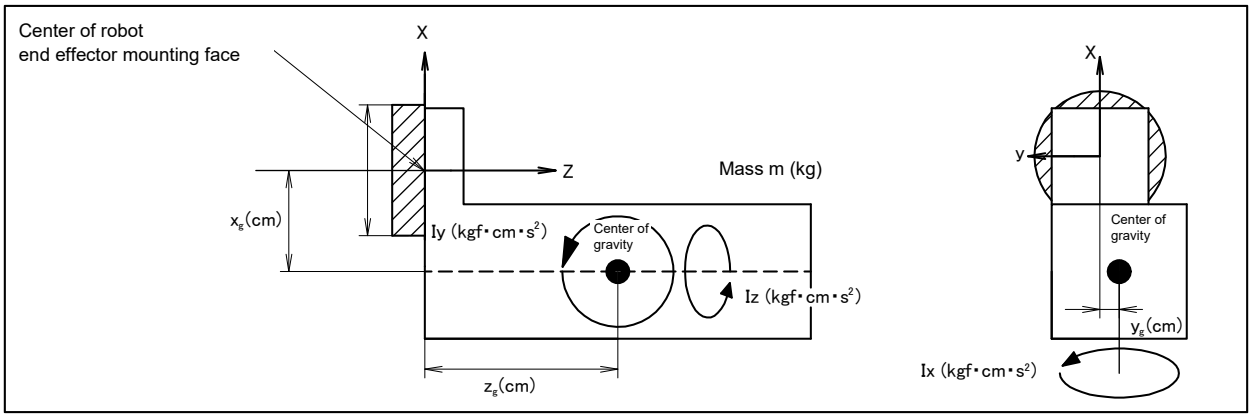


Fig. 4.3 (a) Standard tool coordinate

6 Set the payload, gravity center position, and inertia around the gravity center on the MOTION PAYLOAD SET screen. The X, Y, and Z directions displayed on this screen correspond to the respective standard tool coordinates (with no tool coordinate system set up). When values are entered, the following message will be displayed: “Path and Cycletime will change. Set it?” Respond to the message with F4 ([YES]) or F5 ([NO]).

7 Pressing F3 ([NUMBER]) will bring you to the MOTION PAYLOAD SET screen for another condition number. For a multigroup system, clicking F2 ([GROUP]) will bring you to the MOTION PAYLOAD SET screen for another group.

8 Press the [PREV] key to return to the MOTION PERFORMANCE screen. Click F5 ([SETIND]), and enter the desired payload setting condition number.

9 On the list screen, pressing F4 (ARMLOAD) brings you to the device-setting screen.

```
MOTION ARM LOAD SET          JOINT   100%

     Group 1
  1 J3 CASING LOAD [kg]              2.00


[ TYPE ]   GROUP          DEFAULT      HELP
```

10 Specify the mass of the loads on the J3 casing. When you enter
J3 CASING LOAD [kg] : Mass of the load on the J3 casing,
the confirmation message “Path and Cycle time will change. Set it?” appears. Select F4 YES or F5 NO. Once the mass of a device is entered, it is put in effect by turning the power off and on again.

5 PIPING AND WIRING TO THE END EFFECTOR

⚠ WARNING

- Only use appropriately-specified mechanical unit cables.
- Do not add user cables or hoses inside of the mechanical unit.
- Please do not obstruct the movement of the mechanical unit when cables are added to the outside of the mechanical unit.
- Please do not perform remodeling (adding a protective cover, or secure an additional outside cable) that obstructs the behavior of the cable.
- When external equipment is installed on the robot, make sure that it does not interfere with other parts of the robot.
- Cut and discard any unnecessary length of wire strand of the end effector (hand) cable. Insulate the cable with seal tape. (See Fig. 5 (a))
- If you have end effector wiring and a process that develops static electricity, keep the end effector wiring as far away from the process as possible. If the end effector and process must remain close, be sure to insulate the cable.
- Be sure to seal the connectors of the user cable and terminal parts of all cables to prevent water from entering the mechanical unit. Also, attach the cover to the unused connector.
- Frequently check that connectors are tight and cable jackets are not damaged.
- When precautions are not followed, damage to cables might occur. Cable failure may result in incorrect function of the end effector, robot faults, or damage to robot electrical hardware. In addition, electric shock could occur when touching the power cables.

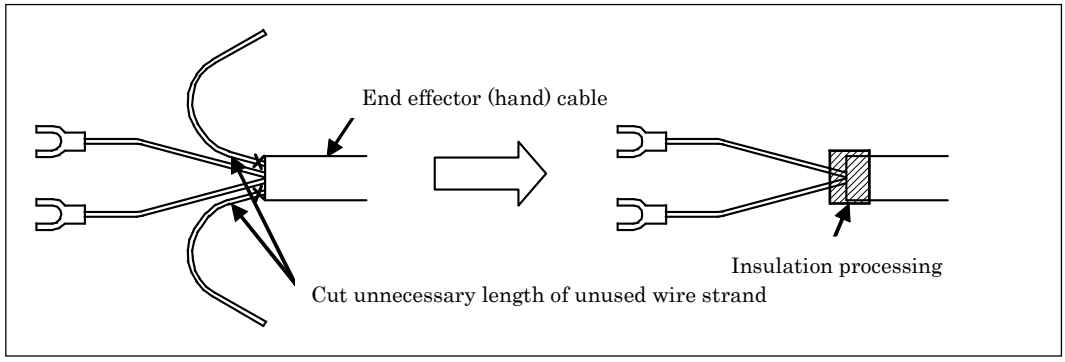


Fig. 5 (a) Treatment method of end effector (hand) cable

5.1 AIR SUPPLY (OPTION)

Air supply holes (Rc1/4) exists on the J1–axis connector panel for end effector as shown in Fig.5.1 (a) and (b). Optional solenoid valves can be mounted as shown in Tables 5.1 (a). Plugs are inserted in all the ports used for supplying air before the robot is shipped. To use the air circuit, you must remove the plugs and connect couplings to the ports.
When the solenoid valve is replaced, the entire manifold should be replaced.

Table 5.1 (a) Optional solenoid valves

Option spec.	Description	Solenoid (Manifold) spec.	Remarks	RO
A05B-1144-H005#ST	Double solenoids x 2	A97L-0218-0160#D2 (manufactured by SMC)	2 position x 2	RO1 to 6

Available section area of the solenoid valve : 1.98mm^2 (CV value : 0.11)

NOTE
1 When the air circuit is not used, reinstall the plugs as originally installed for the purpose of dust and water protection.
2 Attach an air filter with a mesh size of 5μm or better on the upstream side near the robot. Compressed air including much drainage causes valve malfunctions. Take action to prevent the entry of drainage, and also drain the air filter periodically.

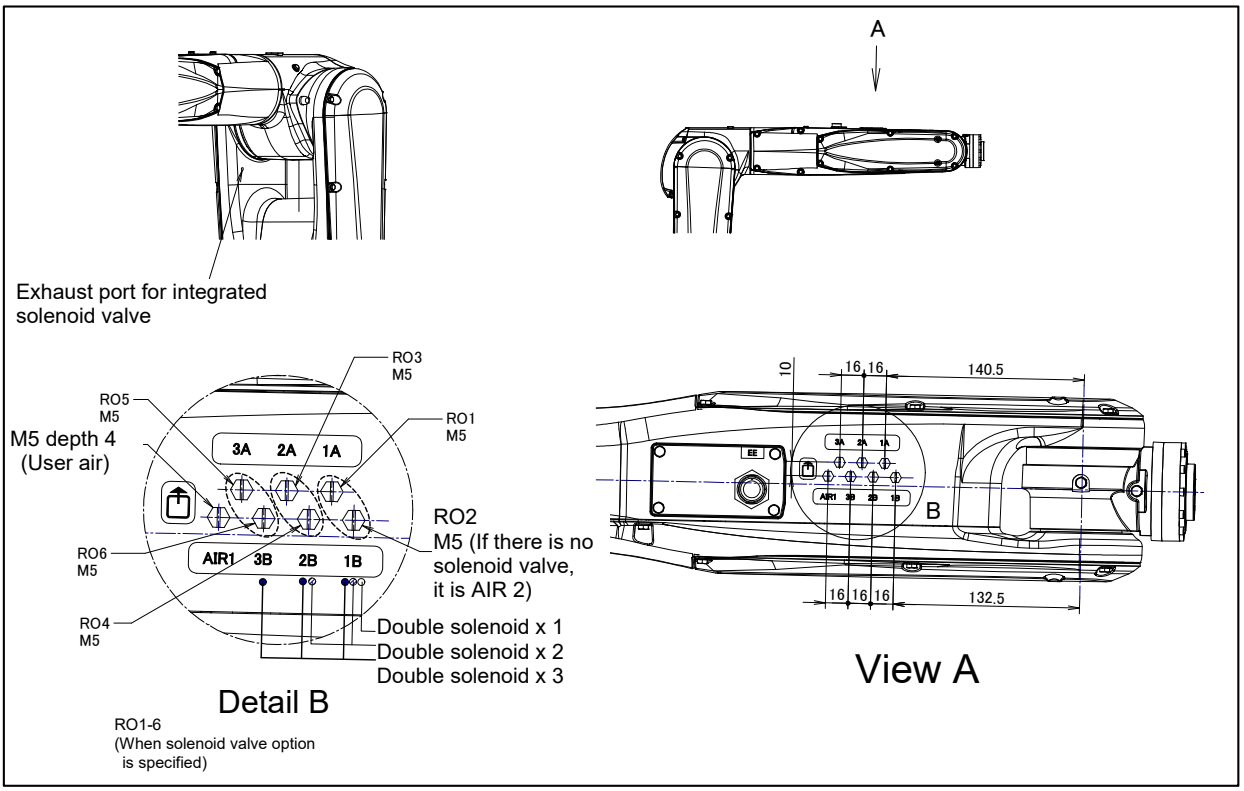


Fig. 5.1 (a) Air supply (J2 arm, J3 arm side)

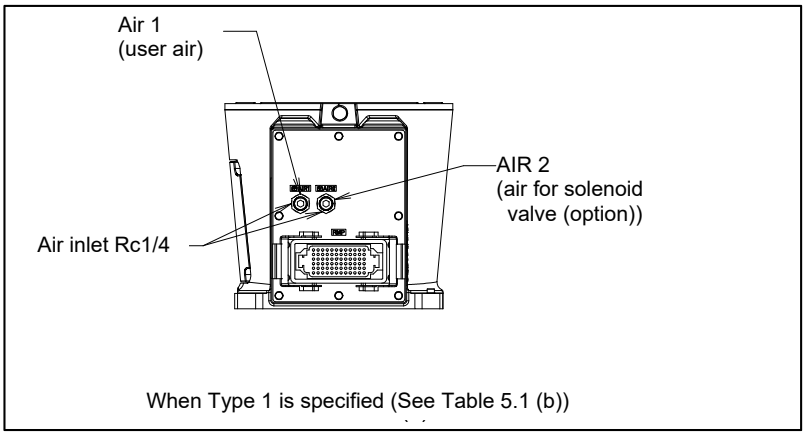


Fig. 5.1 (b) Air supply (back side connector panel)

Table 5.1 (b) Correspondence table for mechanical unit cable

Type	Spec. of mechanical unit cable
Type 1	A05B-1144-H301#ST

Air pressure	Supply air pressure	0.49 to 0.69MPa(5 to 7kgf/cm^2), Setting: 0.49MPa(5kgf/cm^2)
	Amount of consumption	Maximum instantaneous amount 120Nl/min (0.12Nm^3/min)

* The air should be dry. Do not use oiled compressed air.

5.2 INTERFACE FOR OPTION CABLE

⚠ CAUTION

1 The connector to be plugged into the interface and the cable attached to that connector should be prepared by the customer.
2 Please cover the unused connector and air port reliably by a metal cap (option) and a plug. If the covering is loose, unexpected substances will enter into the robot and cause any troubles. At ex-factory, the interfaces are covered by easy caps in order to avoid dust during transportation. Please keep in mind that the cap doesn't work enough as a protect means in factory environment.
3 Please do the waterproof processing of the hand cable surely to prevent the flood in the mechanism.
Moreover, the damage of the cover of the cable causes the flood so replace it, please when it is damaged.

(1) EE interface (RI/RO signal)
Fig. 5.2 (a) shows the pin layout for the EE interface (RI/RO signal).

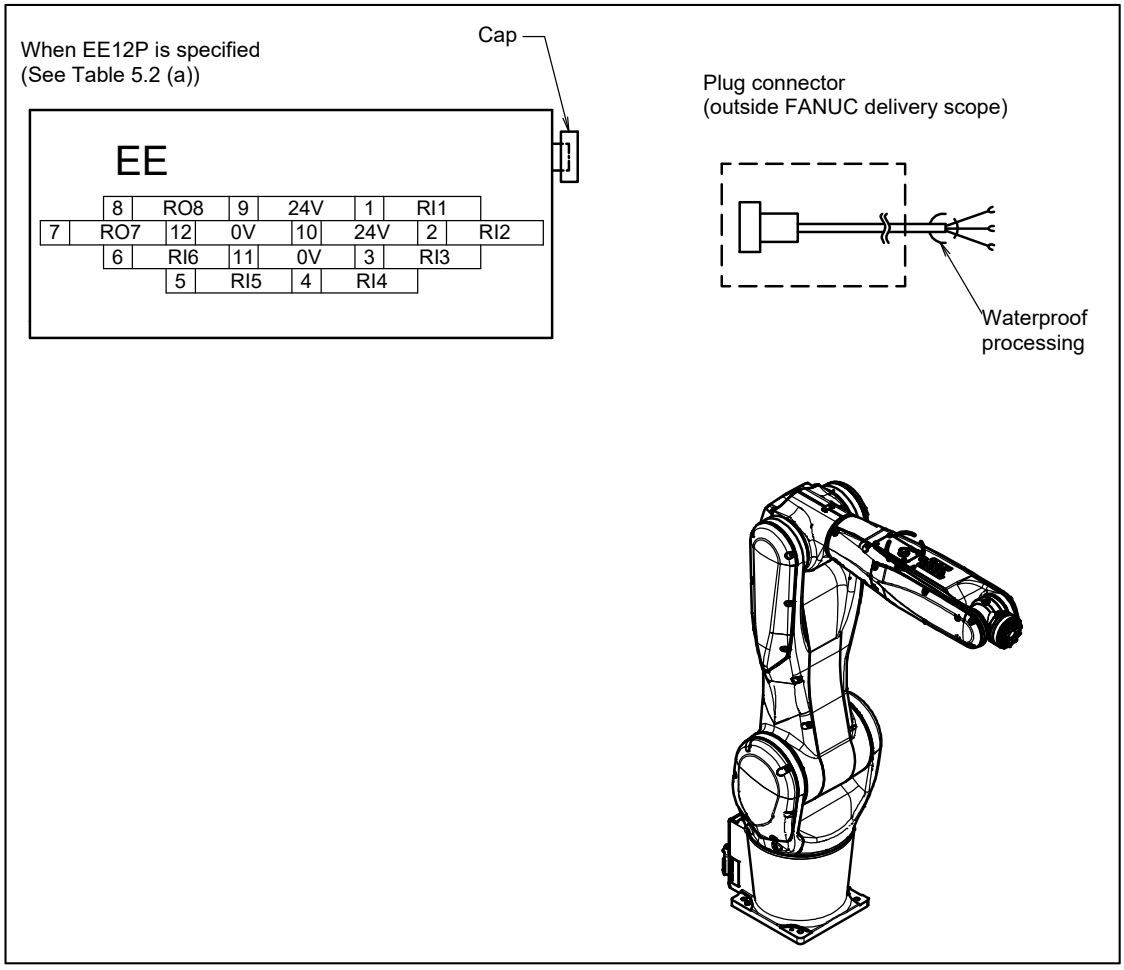


Fig. 5.2 (a) EE interface pin layout (RI/RO signal)

Table 5.2 (a) Correspondence table for mechanical unit cable

EE Type	Spec. of mechanical unit cable
EE12P	A05B-1144-H301#ST

(2) J3 arm interface
Fig. 5.2 (b) shows the J3 arm interface.

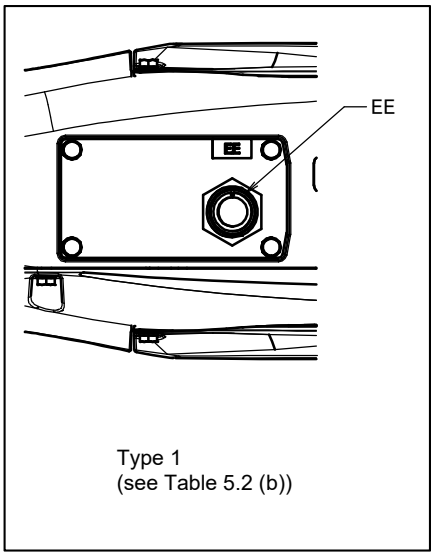


Fig. 5.2 (b) J3 arm interface

Table 5.2 (b) Correspondence table for mechanical unit cable

Type	Spec. of mechanical unit cable
Type 1	A05B-1144-H301#ST

⚠ CAUTION
For wiring peripheral devices to the EE interface, see the sections in the manuals listed below.
a. Section II, chapter 4, “Peripheral Device, Arc Welding, And EE Interfaces” in the “R-30*i*B Mate/R-30*i*B Mate Plus CONTROLLER MAINTENANCE MANUAL” (B-83525EN)
b. Section II, chapter 1, “Electrical Connections” in the “R-30*i*B Mate/R-30*i*B Mate Plus CONTROLLER Open Air MAINTENANCE MANUAL” (B-83555EN)

Connector specifications

Table 5.2 (c) shows the connector parts supported by the end effector interface. Some of these parts are available as an option from FANUC.

Table 5.2 (c) Supported connector (user side)

Maker	Manufacturer specification	Remarks
Hirose Electric Co. Ltd.	Plug: RM15WTPZ-12P(76) Clamp: JR13WCC-*(72)	Straight type connector (12 pins) * indicates an applicable cable diameter selected from the following: * : ϕ5, 6, 7, 8, 9, 10mm (For EE12P See Table 5.2 (a))
	Plug: RM15WTLP-12P(33) Clamp: JR13WCC-*(72)	Elbow type connector (12 pins) * indicates an applicable cable diameter selected from the following: * : ϕ5, 6, 7, 8, 9, 10mm (For EE12P See Table 5.2 (a))

NOTE
For details, such as the dimensions, refer to the related catalogs offered by the respective manufacturers, or contact your local FANUC representative.

Table 5.2 (d) Supported option

Option specification	Remarks
A05B-1137-J057	Straight type connector (12-pins) Applicable cable diameter: 8mm
A05B-1137-J058	Elbow type connector (12-pins) Applicable cable diameter: 9mm
A05B-1142-K054	Cable with elbow type connector (12-pins) Length: 500mm

NOTE
See Appendix C, "OPTIONAL CONNECTOR WIRING PROCEDURE" for explanations about how to wire optional connectors.

6 AXIS LIMIT SETUP

When axis limits are defined, the motion range of the robot can be changed from the standard value. The motion range of the robot axes can be restricted because of:

- Used motion range of the robot is limited.
- Tools and peripheral equipment interfere each other in some areas.
- Length of the cable or hose attached to the application is limited.
  The following method used to prevent the robot from going beyond the necessary motion range.
- Axis limit by DCS (All axes (option))

> ⚠ **WARNING**
> Changing the motion range of any axis affects the operating range of the robot. To avoid trouble, carefully consider any possible effect of the change to the movable range of each axis in advance. Otherwise, it is likely that an unexpected condition will occur; for example, an alarm may occur in a previously taught position.

6.1 SOFTWARE SETTING CHANGE AXIS LIMIT BY DCS (OPTION)

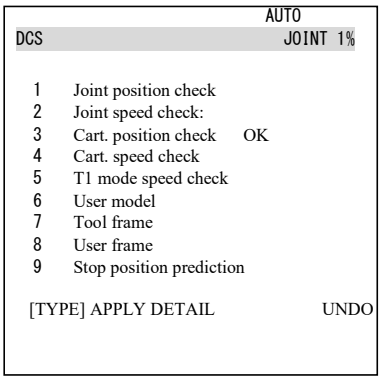
The robot motion can be restricted with DCS (Dual check safety) function by using the following software. For J2/J3-axis, the same effect as an adjustable mechanical stopper can be obtained.
The robot motion can be restricted at any angle and position if it is in robot motion area. DCS functions are certified to meet the requirements of International Standard ISO13849-1 and IEC61508 approved by certificate authority. If only the operating space is set using Joint Position Check, the robot stops after it goes beyond the workspace. When the motor power is shut down, the robot's momentum causes it to move some distance before it completely stops. The actual "Robot Stop Position" will be beyond the workspace. To stop the robot within the robot workspace, use the DCS Stop Position Prediction function. The stop position prediction is disabled by default.

・ DCS position/speed check function (J567)

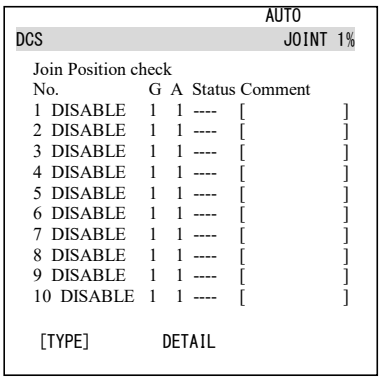
As an example, we shows the procedure to set ±90° for J2-axis in here. Refer to R-30*i*B/R-30*i*B Mate /R-30*i*B Plus Controller Dual check safety function Operator's Manual (B-83184EN) for details of other setting, function and DCS stop position prediction.

Setting procedure

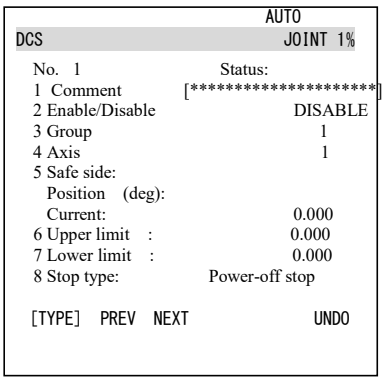
1 Press the [MENU] key to display the screen menu.
2 Press [0 NEXT] and press [6 SYSTEM].
3 Press the F1 ([TYPE]).
4 Select [DCS]. The following screen will be displayed.



5 Move the cursor to [1 Joint position check], then press the [DETAIL].

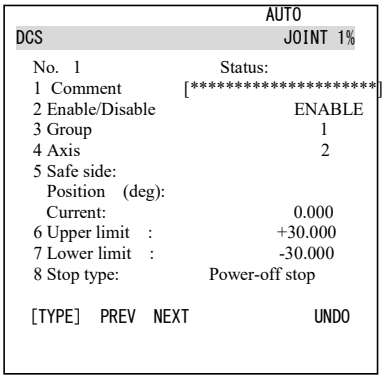


6 Move the cursor to [1], then press the [DETAIL].

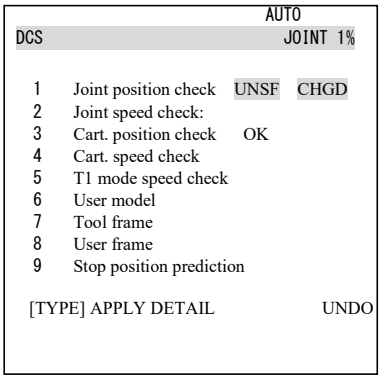


7 Move the cursor to [DISABLE], then press [CHOICE], set the status to [ENABLE].
8 Move the cursor to [Group], then input the robot group number, then press the [ENTER] key.
9 Move the cursor to [Axis], then input “2”, then press the [ENTER] key.
10 Move the cursor to [Upper limit] right side, then input “90”, then press the [ENTER] key.
11 Move the cursor to [Lower limit] right side, then input “-90”, then press the [ENTER] key.

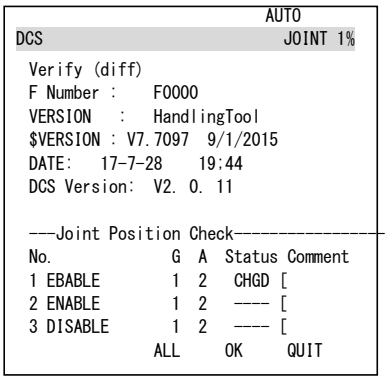
⚠ WARNING
If only the operating space is set using Joint Position Check, the robot stops after it goes beyond the workspace. When the motor power is shut down, the robot's momentum causes it to move some distance before it completely stops. The actual "Robot Stop Position" will be beyond the workspace. To stop the robot within the robot workspace, use the DCS Stop Position Prediction function. The stop position prediction is disabled by default.



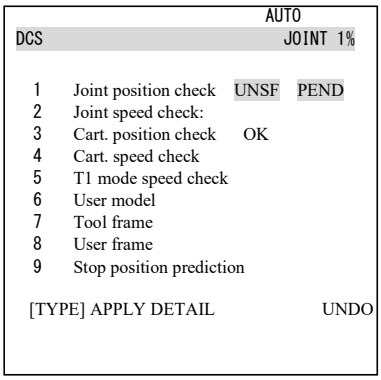
12 Press the [PREV] key two times, back to the first screen.



13 Press the [APPLY].
14 Input 4-digit password, then press the [ENTER] key. (Password default setting is "1111".)
15 The following screen will be displayed, then press the [OK].



[CHGD] on the right side of [1 Joint position check] will change to [PEND].



16 Cycle the power of the controller in the cold start mode so the new settings are enabled.

> ⚠ **WARNING**
> You must cycle the power of the controller to enable the new setting. If you fail to do so, the robot does not work normally and it may injure personnel or damage the equipment.

7 CHECKS AND MAINTENANCE

Optimum performance of the robot can be maintained by performing the checks and maintenance procedures presented in this chapter. (See the APPENDIX A PERIODIC MAINTENANCE TABLE.)

NOTE
The periodic maintenance procedures described in this chapter assume that the FANUC robot is used for up to 3840 hours a year. In cases where robot use exceeds 3840 hours/year, adjust the given maintenance frequencies accordingly. The ratio of actual operating time/year vs. the 3840 hours/year should be used to calculate the new (higher) frequencies. For example, when using the robot 7680 hours a year, the maintenance frequency should be doubled – i.e. the time interval should be divided by 2.

7.1 CHECKS AND MAINTENANCE

7.1.1 Daily Checks

Clean each part, and visually check component parts for damage before daily system operation. Check the following items when necessary.

Check items	Check points and management
Oil seepage	Check to see if there is oil on the sealed part of each joint. If there is an oil seepage, clean it. **⇒"7.2.1 Confirmation of Oil Seepage"**
Air control set	(When air control set is used) **⇒"7.2.2 Confirmation of the Air Control Set"**
Vibration, abnormal noises	Check whether vibration or abnormal noises occur. When vibration or abnormal noises occur, perform measures referring to the following section: **⇒"9.1 TROUBLESHOOTING"(Symptom : Vibration, Noise)**
Positioning accuracy	Check that the taught positions of the robot have not deviated from the previously taught positions. If displacement occurs, perform the measures as described in the following section: **⇒"9.1 TROUBLESHOOTING" (Symptom : Displacement)**
Peripheral equipment for proper operation	Check whether the peripheral equipment operates properly according to commands from the robot and the peripheral equipment.
Brakes for each axis	Check that the end effector drops 2 mm or less when servo power is turned off. If the end effector (hand) drops, perform the measures as described in the following section: **⇒"9.1 TROUBLESHOOTING" (Symptom : Dropping axis)**
Warnings	Check whether unexpected warnings occur in the alarm screen on the teach pendant. If unexpected warnings occur, perform the measures as described in the following manual: **⇒"OPERATOR'S MANUAL (Alarm Code List)(B-83284EN-1)"**

7.1.2 Periodic Check and Maintenance

Check the following items at the intervals recommended below based on the period or the accumulated operating time, whichever comes first. (○ : Item needs to be performed.)

Check and maintenance intervals (Period, Accumulated operating time)						Check and maintenance item	Check points, management and maintenance method	Periodic maintenance No.
1 month 320h	3 months 960h	1 year 3840h	1.5 years 5760h	2 years 7680h	4 years 15360h			
○ Only 1st check	○					Cleaning the controller ventilation system	Confirm that the controller ventilation system is not dusty. If dust has accumulated, remove it.	13
	○					Check for external damage or peeling paint	Check whether the robot has external damage or peeling paint due to contact with the peripheral devices. If unintended contact has occurred, eliminate the cause. Also, if the external damage is serious, and causes a problem in which the robot will not operate, replace the damaged parts.	1
	○					Check for water	Check whether the robot is subjected to water or cutting oils. If water is found, remove the cause and wipe off the liquid.	2
	○ Only 1st check	○				Check for damages to the teach pendant cable, the operation box connection cable or the robot connection cable	Check whether the cable connected to the teach pendant, operation box and robot are unevenly twisted or damaged. If damage is found, replace the damaged cables.	12
	○ Only 1st Check	○				Check for damage to the end effector (hand) cable and external battery cable	Check whether the end effector cables and external batteries cable are unevenly twisted or damaged. If damage is found, replace the damaged cables.	8
	○ Only 1st check	○				Check the exposed connectors	Check the exposed connectors. **⇒"7.2.3 Check the Connectors"**	3
	○ Only 1st check	○				Retightening the end effector mounting bolts	Retighten the end effector mounting bolts. Refer to the following section for tightening torque information: **⇒"4.1 END EFFECTOR INSTALLATION TO WRIST"**	4
	○ Only 1st check	○				Retightening the external main bolts	Retighten the robot installation bolts, bolts that have been removed for inspection, and bolts exposed to the outside. Refer to the recommended bolt tightening torque guidelines at the end of the manual. An adhesive to prevent bolts from loosening is applied to some bolts. If the bolts are tightened with greater than the recommended torque, the adhesive might be removed. Therefore, follow the recommended bolt tightening torque guidelines when retightening the bolts.	5

Check and maintenance intervals (Period, Accumulated operating time)						Check and maintenance item	Check points, management and maintenance method	Periodic maintenance No.
1 month 320h	3 months 960h	1 year 3840h	1.5 years 5760h	2 years 7680h	4 years 15360h			
	○ Only 1st check	○				Check the mechanical stopper	Check that the J1/J3-axis mechanical stopper is not deformed, if it is deformed, replace it with a new one. **⇒"7.2.4 Check of Mechanical Stopper "**	6
	○ Only 1st check	○				Clean spatters, sawdust and dust	Check that spatters, sawdust, or dust does not exist on the robot main body. If dust has accumulated, remove it. Especially, clean the robot movable parts well (each joint). For an arc welding robot Insulation failure might occur when spatter has collected around the wrist flange or welding torch, and there is a possibility of damaging the robot mechanism by the welding current. (See Appendix D)	7
		○				Replacing the mechanical unit batteries	Replace the mechanical unit batteries. Regardless of operating time, replace batteries at 1 year. **⇒"7.3.1 Replacing the batteries"**	9
					○	Replenish grease to each axis reducer	Grease each axis reducer **⇒"7.3.2 Replenish the Grease of the Reducer"**	10
					○	Replacing the mechanical unit cable	Replace the mechanical unit cable Contact your local FANUC representative for information regarding replacing the cable.	11
					○	Replacing the controller batteries	Replace the controller batteries. Regardless of operating time, replace batteries at 4 years. **⇒Chapter 7 Replacing batteries of R-30*i*B Mate/R-30*i*B Mate Plus CONTROLLER MAINTENANCE MANUAL (B-83525EN) R-30*i*B Mate/R-30*i*B Mate Plus CONTROLLER Open Air MAINTENANCE MANUAL (B-83555EN)"**	14

7.2 CHECK POINTS

7.2.1 Confirmation of Oil Seepage

Check items

Check to see whether there is an oil seepage on the rotating parts of each joint axis.

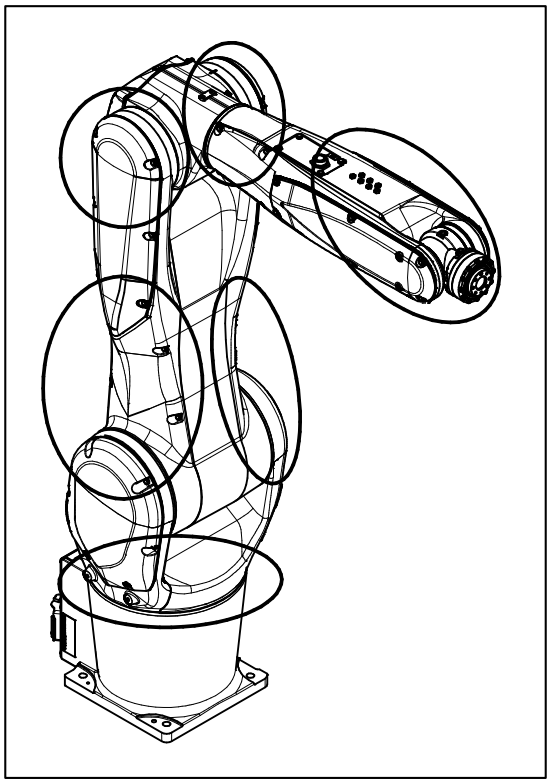


Fig. 7.2.1 (a) Check points of oil seepage

Management

- Oil might accumulate on the outside of the seal lip depending on the movement condition or environment of the axis. If the oil changes to a state of liquid, the oil might fall depending on the axis movement. To prevent oil spots, be sure to wipe away any accumulated oil under the axis components before you operate the robot.
- Also, motors might become hot and the internal pressure of the grease bath might rise by frequent repetitive movement and use in high temperature environments. In these cases, normal internal can be restored by venting the grease inlet. (When opening the grease inlet, refer to Subsection .7.3.2 and ensure that grease is not expelled onto the machine or tooling.)
- If you must wipe oil frequently, and opening the grease outlet does not stop the seepage, perform the measures below.

  ⇒"9.1 TROUBLESHOOTING" (symptom : Grease leakage)

7.2.2 Confirmation of the Air Control Set (option)

When an air control set is used, check the items below.

Item	Check items		Check points
1	When air control set is provided.	Air pressure	Check air pressure using the pressure gauge on the air control set as shown in Fig.7.2.2 (a). If it does not meet the specified pressure of 0.49MPa (5 kgf/cm²), adjust it using the regulator pressure setting handle.
2		Leakage from hose	Check the joints, tubes, etc. for leaks. Repair leaks, or replace parts, as required.
3		Drain	Check the drain and empty it. When the quantity of liquid in the drain is excessive, examine the setting of the air dryer on the air supply side.

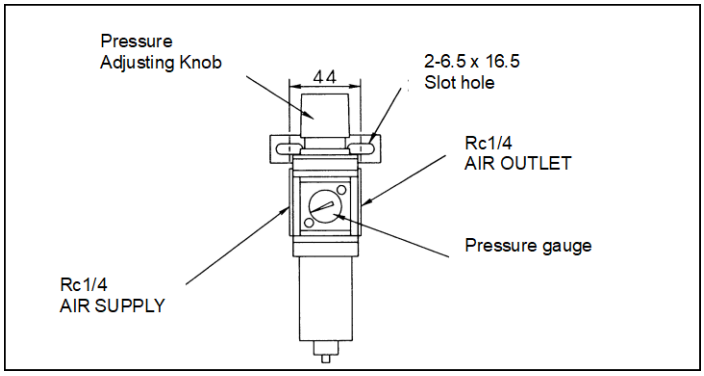


Fig. 7.2.2 (a) Air control set (option)

7.2.3 Check the Connectors

Inspection points of the connectors

- Robot connection cables, earth terminal and user cables

Check items

- Circular connector : Check the connector for tightness by turning it manually.
- Square connector : Check the connector for engagement of its lever.
- Earth/Ground terminal : Check the terminal for tightness.

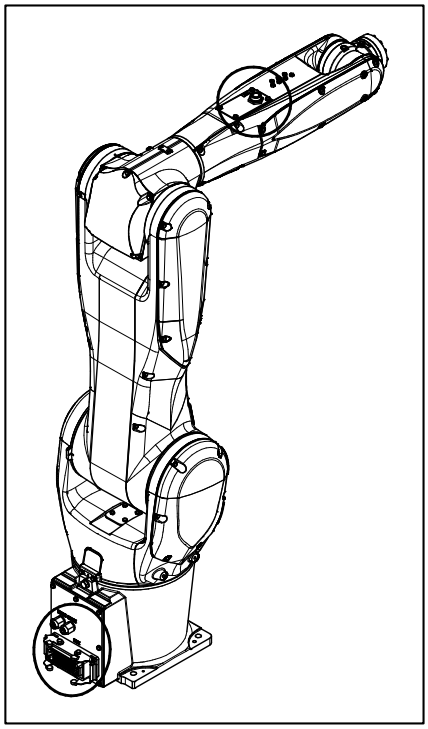


Fig. 7.2.3 (a) Connector Inspection points

7.2.4 Check of Mechanical Stopper

- Check the J1/J3-axis mechanical stopper is not deformed, if it is deformed, replace it with a new one.

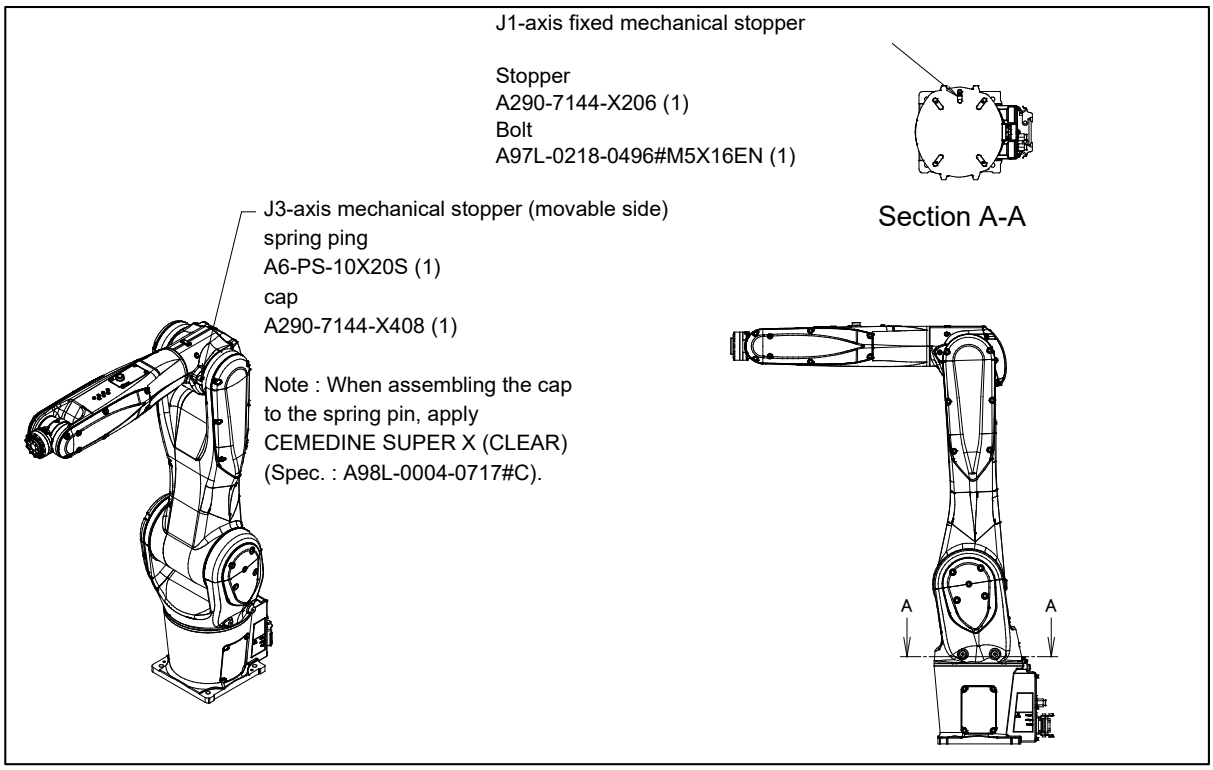


Fig. 7.2.4 (a) Check of mechanical stopper

7.3 MAINTENANCE

7.3.1 Replacing the Batteries (1 year Periodic Inspection If Built-in Batteries Are Specified)

The position data of each axis is preserved by the backup batteries. If built-in batteries are in use, replace them every year. Also use the following procedure to replace them when the backup battery voltage drop alarm occurs.

Procedure of replacing the battery (if built-in batteries are specified)

1 Press the EMERGENCY STOP button to prohibit the robot motion.

> ⚠ **CAUTION**
> Be sure to keep the power turning on. Replacing the batteries with the power turned off causes all current position data to be lost. Therefore, mastering will be required again.

2 Remove the battery case cap. (Fig. 7.3.1 (a)) If it cannot be removed, tap it on the side with a plastic hammer.
3 Loosen the plate screw and take off the lid of the battery box and replace the batteries. The batteries can be taken out by pulling the stick which is in the center of the battery box.
4 Assemble them by reversing the sequence. Pay attention to the direction of batteries.
It is necessary to replace the gasket.

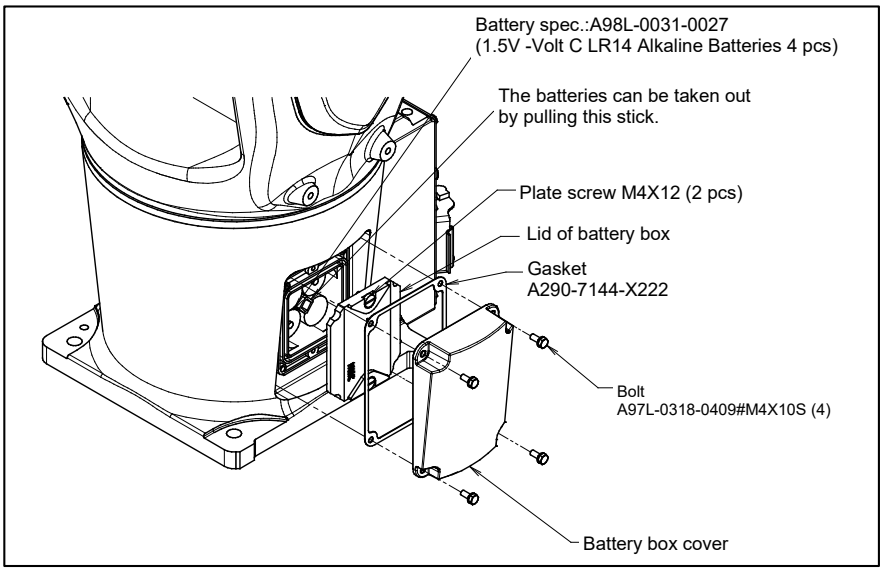


Fig. 7.3.1 (a) Replacing the battery (if built-in batteries are specified)

7.3.2 Replenish the Grease of the Reducer (4 years (15360 hours) checks)

Supply reducer grease every four years or 15360 hours by using the following procedures.

For the grease name and quantity, see the Table 7.3.2 (a).

Table 7.3.2 (a) Grease for 4-year (15360 hours) periodical greasing

Greasing point	Quantity	Model	Specified grease
J1-axis reducer	2.7g (3ml)	LR-10iA/10	Spec: A98L-0040-0230
J2-axis reducer	2.7g (3ml)		
J3-axis reducer	1.8g (2ml)		
J4-axis reducer	1.8g (2ml)		
J5-axis reducer	1.8g (2ml)		
J6-axis reducer	1.8g (2ml)		

For grease replacement, use the arbitrary postures.

⚠ CAUTION

1 The following maintenance kits are prepared for the greasing.
   - Greasing kit: A05B-1142-K021
     (This a set of greasing syringe and grease in tube. (90g))
   - Grease in tube: A05B-1139-K022
     (grease in tube. (90g))

2 Failure to follow proper lubrication procedures may cause the suddenly increase of the grease bath internal pressure and the damage to the seal, which could lead to grease leakage and abnormal operation. When greasing, observe the following cautions.
   1 Use specified grease. Use of non-approved grease may damage the reducer or lead to other problems.
   2 To prevent slipping accidents and catching fire, completely remove any excess grease from the floor or robot.
   3 Please fill a necessary amount to the injection syringe after softening grease in the tube massaging it by the hand when you use the grease greasing kit. Please install the nozzle in the point of the injection syringe. Please remove the nozzle and do the cap when you do not use the injection syringe.

1 Turn off controller power.
2 Remove the seal bolts from the grease inlet.
3 Supply a regulated amount of grease by using the injection syringe. Please note that grease might come out immediately after the grease has been supplied, or during the greasing. Even in this case, please do not supply grease beyond the regulated amount specified.
4 Replace the seal bolts with new ones. When reusing a seal bolt, be sure to seal it with seal tape.

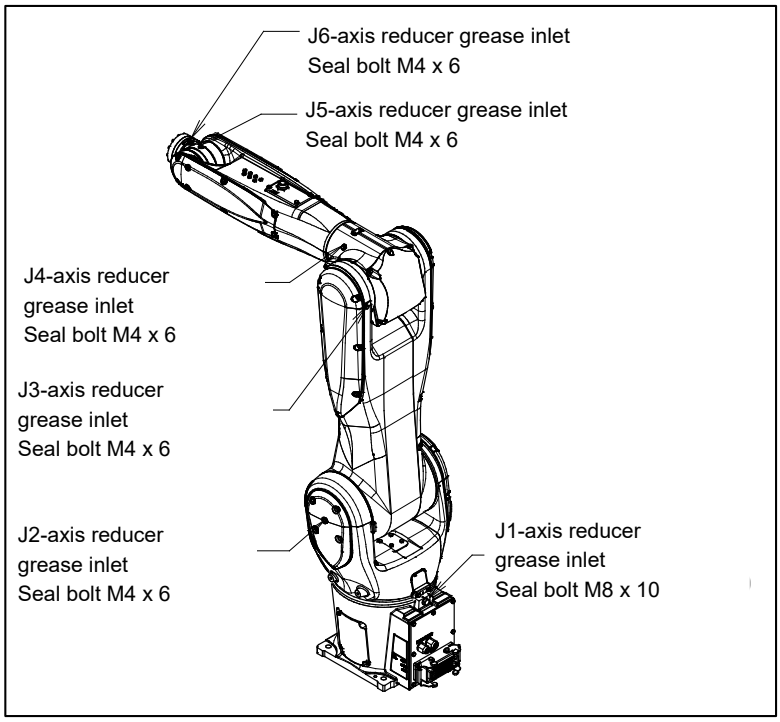


Fig. 7.3.2 (a) Applying grease of the reducer

Table 7.3.2 (b) Spec. of seal bolts

Parts name	Specifications	Remarks
Seal bolt	A97L-0318-0410#040606EN	J2 to J6-axis grease inlet 5 pcs/1 robot
Seal bolt	A97L-0318-0410#081010S	J1-axis grease inlet

7.4 STORAGE

When storing the robot, place it on a level surface with the same posture that was used for transportation. (See Section 1.1.)

8 MASTERING

Mastering associates the angle of each robot axis with the pulse count value supplied from the absolute Pulsecoder connected to the corresponding axis motor. To be specific, mastering is an operation for obtaining the pulse count value; corresponding to the zero position.

> ⚠ **CAUTION**
> In case of performing mastering with gravity compensation (option) is enabled, if load setting (See Section 4.3) is not correct, it will influence the precision of the mastering.

8.1 OVERVIEW

The current position of the robot is determined according to the pulse count value supplied from the Pulsecoder on each axis.
Mastering is factory-performed. It is unnecessary to perform mastering in daily operations. However, mastering becomes necessary after:

- Motor replacement.
- Pulsecoder replacement
- Reducer replacement
- Cable replacement
- Batteries for pulse count backup in the mechanical unit have gone dead

> ⚠ **CAUTION**
> Robot data (including mastering data) and Pulsecoder data are backed up by their respective backup batteries. Data will be lost if the batteries die. Replace the batteries in the controller and mechanical units periodically. An alarm will alert you when battery voltage is low.

Types of Mastering

Table 8.1 (a) describes the following mastering methods.

Table 8.1 (a) Type of mastering

Fixture position mastering	This is performed using a mastering fixture before the machine is shipped from the factory.
Zero-position mastering (witness mark mastering)	This is performed with all axes set at the 0-degree position. A zero-position mark (witness mark) is attached to each robot axis. This mastering is performed with all axes aligned to their respective witness marks.
Quick mastering	This is performed at a user-specified position. The corresponding count value is obtained from the rotation count of the Pulsecoder connected to the relevant motor and the rotation angle within one rotation. Quick mastering uses the fact that the absolute value of a rotation angle within one rotation will not be lost. (All axes at the same time)
Quick mastering for single axis	This is performed at a user-specified position for one axis. The corresponding count value is obtained from the rotation count of the Pulsecoder connected to the relevant motor and the rotation angle within one rotation. Quick mastering uses the fact that the absolute value of a rotation angle within one rotation will not be lost.
Single-axis mastering	This is performed for one axis at a time. The mastering position for each axis can be specified by the user. This is useful in performing mastering on a specific axis.
Mastering data entry	Mastering data is entered directly.

Once mastering is performed, you must carry out positioning (calibration). Positioning is an operation in which the controller reads the pulse count value to sense the current position of the robot.

This section describes zero-position mastering, quick mastering, quick mastering for single axis, single-axis mastering, and mastering data entry. For more detailed mastering (fixture position mastering), contact your local FANUC representative.

> **⚠ CAUTION**
> 1 If mastering is performed incorrectly, the robot may behave unexpectedly. This is very dangerous. For this reason, the Master/Cal screen is designed to appear only when the $MASTER_ENB system variable is 1 or 2. After performing positioning, press F5, ([DONE]) on the Master/Cal screen. The $MASTER_ENB system variable is then reset to 0 automatically, and the Master/Cal screen will disappear.
> 2 Before performing mastering, it is recommended that you back up the current mastering data.
> 3 When the motion range is mechanically 360 degrees or more, if any of the axes (J1-axis and J4-axis) to which the cables are connected is turned one turn beyond the correct mastering position when mastering occurs, the cables in the mechanical unit are may be damaged. If the correct rotation position is not clear because the axis is moved too much during mastering, remove the connector panel or cover, check the states of the internal cables, and perform mastering in the correct position.

8.2 RESETTING ALARMS AND PREPARING FOR MASTERING

Before performing mastering because a motor has been replaced, it is necessary to release the relevant alarm and display the positioning menu.

Alarm displayed

"SRVO-062 BZAL" or "SRVO-075 Pulse not established"

Procedure

1 Display the positioning menu by following the steps 1 to 6.
   1 Press the [MENU] key.
   2 Press [0 NEXT] and select [6 SYSTEM].
   3 Press F1 ([TYPE]), and select [Variable] from the menu.
   4 Place the cursor on $MASTER_ENB, then key in "1" and press the [ENTER] key.
   5 Press F1 ([TYPE]), and select [Master/Cal] from the menu.
   6 Select the desired mastering type from the [Master/Cal] menu.

2 To reset the "SRVO-062 BZAL" alarm, follow steps 1 to 5.
   1 Press the [MENU] key.
   2 Press [0 NEXT] and select [6 SYSTEM].
   3 Press F1 ([TYPE]), and select [Master/Cal] from the menu.
   4 Press F3 ([RES_PCA]), then press F4 ([YES]).
   5 Cycle power of the controller.

3 To reset the "SRVO-075 Pulse not established" alarm, follow the steps 1 to 2.
   1 After cycling controller power, the message "SRVO-075 Pulse not established" appears again.
   2 Move the axis for which the message mentioned above has appeared in either direction till the alarm disappears when you press the [RESET] key.

8.3 ZERO POSITION MASTERING

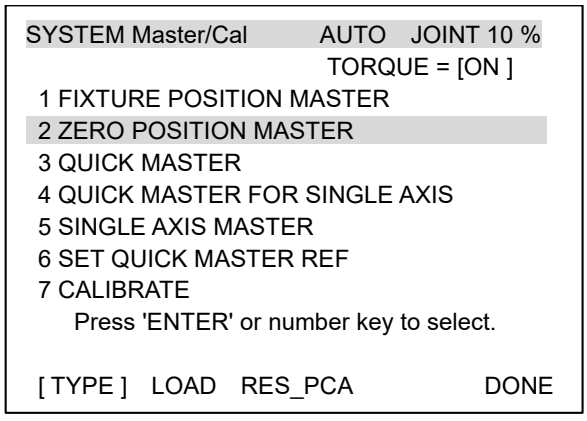
Zero-position mastering (witness mark mastering) is performed with all axes set at the 0-degree position. A zero-position mark (witness mark) is attached to each robot axis. (Fig.8.3 (a)) This mastering is performed with all axes set at the 0-degree position using their respective witness marks.
Zero-position mastering involves a visual check, and might not be highly accurate. It should be used only as a quick-fix method.

Zero-position Mastering Procedure

1 Press the [MENU] key to display the screen menu.
2 Select [0 NEXT] and press [6 SYSTEM].
3 Press F1 [TYPE]. Then select [Variables] from the menu.
4 If $DMR_GRP [group]. $GRAV_MAST=1, set the gravity compensation to enabled, if it is 0, set the gravity compensation to disabled. In addition release the brake control.

NOTE
Gravity compensation can be set to enabled/disabled by setting the system variables as follows:
$PARAM_GROUP[group].$SV_DMY_LNK[8] : FALSE or TRUE
Brake control can be released by setting the system variables as follows:
$PARAM_GROUP.SV_OFF_ALL : FALSE
$PARAM_GROUP.SV_OFF_ENB[*] : FALSE (for all axes)
After changing the system variables, cycle power of the controller.
(Mastering can be performed without setting of gravity compensation. However, it will affect precision.)

5 Press the [MENU] key to display the screen menu.
6 Select [0 NEXT] and press [6 SYSTEM].
7 Press F1 [TYPE], display the screen change menu.
8 Select [Master/Cal]. The positioning screen will be displayed.



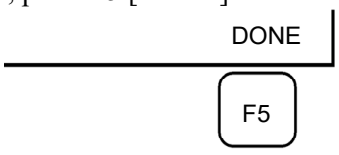
9 Jog the robot into a posture for mastering.
10 Select [2 ZERO POSITION MASTER]. Press F4 [YES].

```
SYSTEM Master/Cal          AUTO   JOINT 10 %
                                  TORQUE = [ON ]
 1 FIXTURE POSITION MASTER
 2 ZERO POSITION MASTER
 3 QUICK MASTER
 4 QUICK MASTER FOR SINGLE AXIS
 5 SINGLE AXIS MASTER
 6 SET QUICK MASTER REF
 7 CALIBRATE
 Robot Mastered! Mastering Data:
    <0> <11808249> <38767856>
    <9873638> <12200039> <2000319>
 [ TYPE ]   LOAD   RES_PCA                DONE
```

11 Select [7 CALIBRATE] and press F4 [YES]. Mastering will be performed automatically. Alternatively, turn off the controller power and on again. Turning on the power always causes positioning to be performed.

```
SYSTEM Master/Cal          AUTO   JOINT 10 %
                                  TORQUE = [ON ]
 1 FIXTURE POSITION MASTER
 2 ZERO POSITION MASTER
 3 QUICK MASTER
 4 QUICK MASTER FOR SINGLE AXIS
 5 SINGLE AXIS MASTER
 6 SET QUICK MASTER REF
 7 CALIBRATE
 Robot Calibrated! Cur Jnt Ang(deg):
    <    0.0000> <    0.0000> <    0.0000>
    <    0.0000> <    0.0000> <    0.0000>
```

12 After positioning is completed, press F5 [DONE].



13 Return the setting of the gravity compensation.
14 Return brake control to original setting, and cycle power of the controller.

Table 8.3 (a) Posture with position marks aligned

Axis	Position
J1-axis	0 deg
J2-axis	0 deg
J3-axis	0 deg (When J2-axis is 0 deg.)
J4-axis	0 deg
J5-axis	0 deg
J6-axis	0 deg

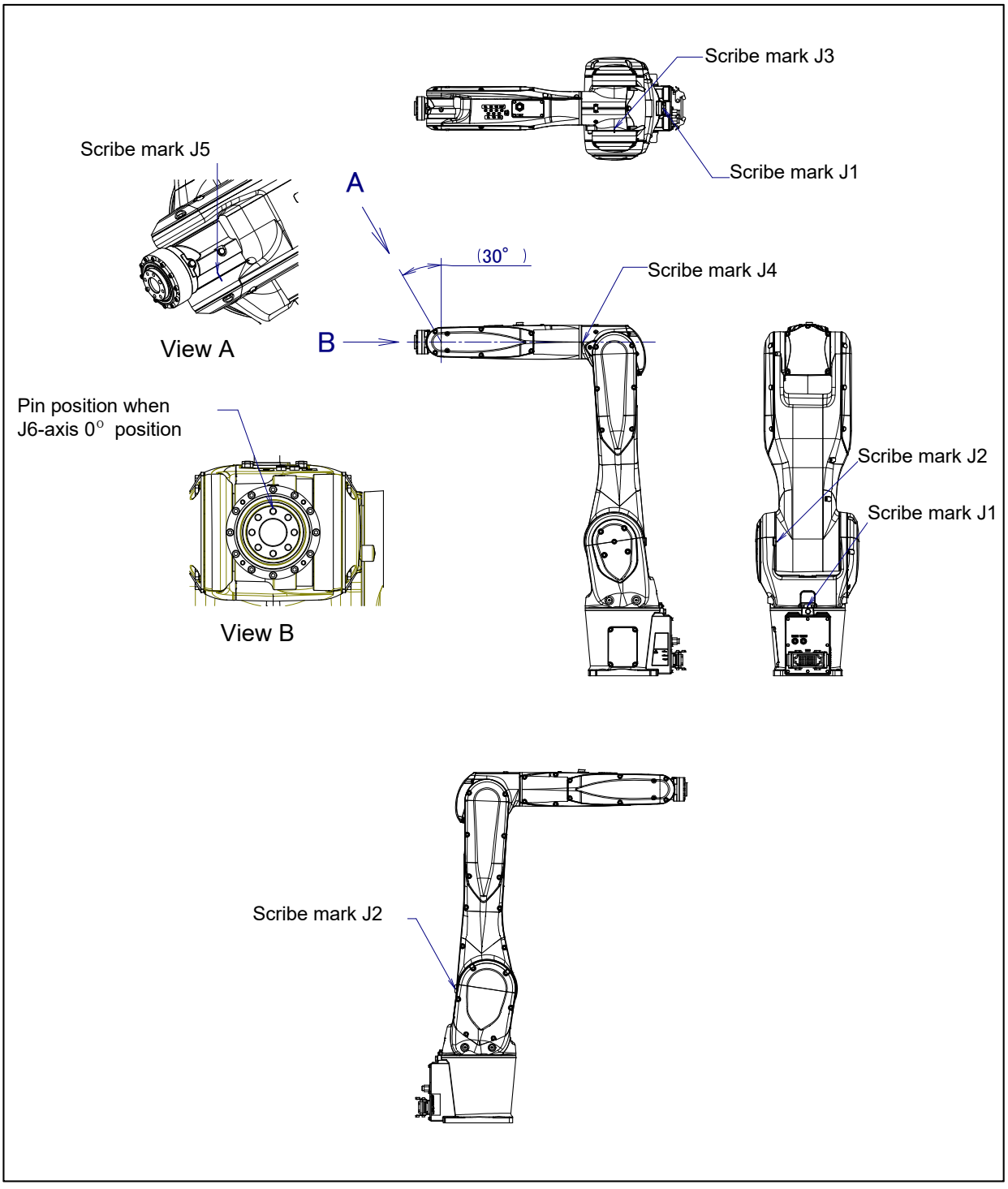


Fig. 8.3 (a) Marking position

8.4 QUICK MASTERING

Quick mastering is performed at a user-specified position for each axis. The pulse count value is obtained from the rotation times of the Pulsecoder connected to the relevant motor and the rotation angle within one rotation. Quick mastering uses the fact that the absolute value of a rotation angle within one rotation will not be lost.

Quick mastering is factory-performed at the position indicated in Table 8.3 (a). If possible, do not change the setting.

If it is impossible to set the robot at the position mentioned above, it is necessary to re-set the quick mastering reference position using the following method. (It would be convenient to set up a marker that can work in place of the witness mark.)

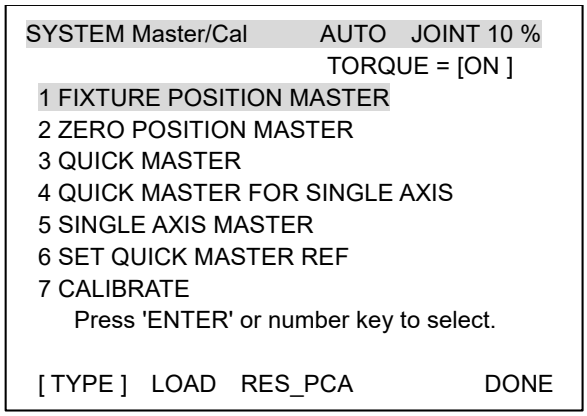
⚠ CAUTION
1 Quick mastering can be used, if the pulse count value is lost, for example, because a low voltage has been detected on the backup battery for the pulse counter.
2 Quick mastering cannot be used, after the Pulsecoder is replaced or after the mastering data is lost from the robot controller.

Procedure for Recording the Quick Mastering Reference Position

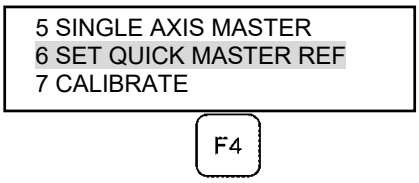
1 Press the [MENU] key to display the screen menu.
2 Select [0 NEXT] and press [6 SYSTEM].
3 Press F1 [TYPE]. Then select [Variables] from the menu.
4 If $DMR_GRP[group].$GRAV_MAST=1, set the gravity compensation to enabled, if it is 0, set the gravity compensation to disabled. In addition release the brake control.

NOTE
Gravity compensation can be set to enabled/disabled by setting the system variables as follows:
$PARAM_GROUP[group].$SV_DMY_LNK[8] : FALSE or TRUE
Brake control can be released by setting the system variables as follows:
$PARAM_GROUP.SV_OFF_ALL : FALSE
$PARAM_GROUP.SV_OFF_ENB[*] : FALSE (for all axes)
After changing the system variables, cycle power of the controller.
(Mastering can be performed without setting of gravity compensation. However, it will affect precision.)

5 Select [6 SYSTEM].
6 Select [Master/Cal]. The positioning screen will be displayed.



7 Jog the robot to the quick mastering reference position.
8 Select [6 SET QUICK MASTER REF] and press F4 [YES]. Quick mastering reference position is saved.



9 Return the setting of the gravity compensation.
10 Return brake control to original setting, and cycle power of the controller.

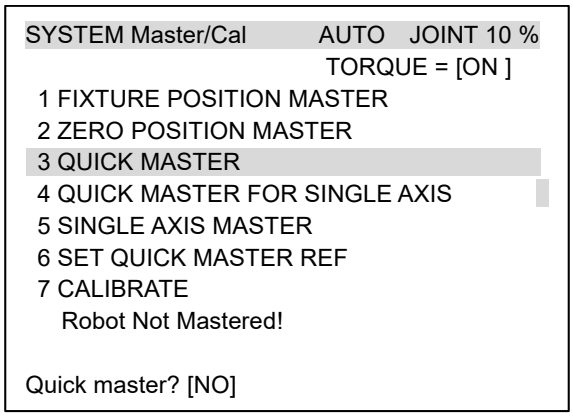
> ⚠ **CAUTION**
> If the robot has lost mastering data due to mechanical disassembly or repair, you cannot perform this procedure. In this case, perform Fixture position mastering or Zero position mastering to restore mastering data.

Procedure of Quick Mastering

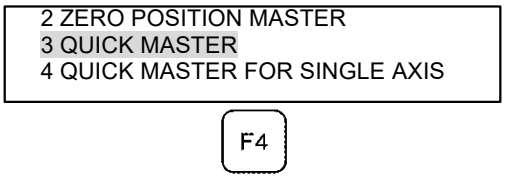
1 Press the [MENU] key to display the screen menu.
2 Select [0 NEXT] and press [6 SYSTEM].
3 Press F1 [TYPE]. Then select [Variables] from the menu.
4 If $DMR_GRP[group].$GRAV_MAST=1, set the gravity compensation to enabled, if it is 0, set the gravity compensation to disabled. In addition release the brake control.

NOTE
Gravity compensation can be set to enabled/disabled by setting the system variables as follows:
$PARAM_GROUP[group].$SV_DMY_LNK[8] : FALSE or TRUE
Brake control can be released by setting the system variables as follows:
$PARAM_GROUP.SV_OFF_ALL : FALSE
$PARAM_GROUP.SV_OFF_ENB[*] : FALSE (for all axes)
After changing the system variables, cycle power of the controller.
(Mastering can be performed without setting of gravity compensation. However, it will affect precision.)

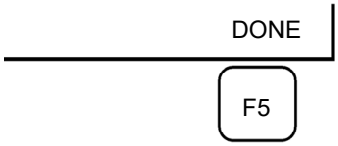
5 Display the Master/Cal screen.



6 Jog the robot to the quick mastering reference position.
7 Move the cursor to [3 QUICK MASTER] and press [ENTER]. Press F4 [YES]. Quick mastering data is memorized.



8 Move the cursor to [7 CALIBRATE] and press the [ENTER] key. Calibration is executed. Calibration can also be executed by cycling power.
9 After completing the calibration, press F5 Done.



10 Return the setting of the gravity compensation.
11 Return brake control to original setting, and cycle power of the controller.

8.5 QUICK MASTERING FOR SINGLE AXIS

Quick mastering for a single axis is performed at a user-specified position for one axis. The pulse count value is obtained from the rotation times of the Pulsecoder connected to the relevant motor and the rotation angle within one rotation. Quick mastering uses the fact that the absolute value of a rotation angle within one rotation will not be lost.

Quick mastering is factory-performed at the position indicated in Table 8.3 (a). If possible, do not change the setting.

If setting the robot at the position mentioned above is impossible, you must re-set the quick mastering reference position using the following method. (It would be convenient to set up a marker that can work in place of the witness mark.)

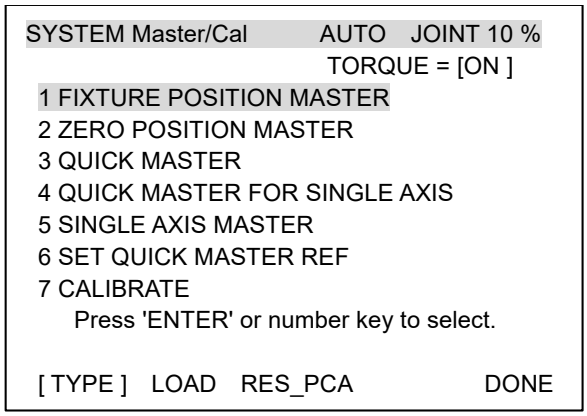
⚠ CAUTION
1 Quick mastering can be used, if the pulse count value is lost, for example, because a low voltage has been detected on the backup battery for the pulse counter.
2 Quick mastering cannot be used, after the Pulsecoder is replaced or after the mastering data is lost from the robot controller.

Procedure for Recording the Quick Mastering Reference Position

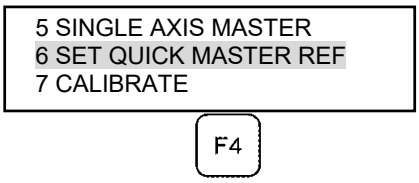
1 Press the [MENU] key to display the screen menu.
2 Select [0 NEXT] and press [6 SYSTEM].
3 Press F1 [TYPE]. Then select [Variables] from the menu.
4 If $DMR_GRP[group].$GRAV_MAST=1, set the gravity compensation to enabled, if it is 0, set the gravity compensation to disabled. In addition release the brake control.

NOTE
Gravity compensation can be set to enabled/disabled by setting the system variables as follows:
$PARAM_GROUP[group].$SV_DMY_LNK[8] : FALSE or TRUE
Brake control can be released by setting the system variables as follows:
$PARAM_GROUP.SV_OFF_ALL : FALSE
$PARAM_GROUP.SV_OFF_ENB[*] : FALSE (for all axes)
After changing the system variables, cycle power of the controller.
(Mastering can be performed without setting of gravity compensation. However, it will affect precision.)

5 Select [6 SYSTEM].
6 Select [Master/Cal]. The positioning screen will be displayed.



7 Jog the robot to the quick mastering reference position.
8 Select [6 SET QUICK MASTER REF] and press F4 [YES]. Quick mastering reference position is saved.



9 Return the setting of the gravity compensation.
10 Return brake control to original setting, and cycle power of the controller.

> ⚠ **CAUTION**
> If the robot has lost mastering data due to mechanical disassembly or repair, you cannot perform this procedure. In this case, perform Fixture position mastering or zero –position mastering to restore mastering data.

Procedure of Quick Mastering for single axis

1 Press the [MENU] key to display the screen menu.
2 Select [0 NEXT] and press [6 SYSTEM].
3 Press F1 [TYPE]. Then select [Variables] from the menu.
4 If $DMR_GRP[group].$GRAV_MAST=1, set the gravity compensation to enabled, if it is 0, set the gravity compensation to disabled. In addition release the brake control.

> **NOTE**
> Gravity compensation can be set to enabled/disabled by setting the system variables as follows:
> $PARAM_GROUP[group].$SV_DMY_LNK[8] : FALSE or TRUE
> Brake control can be released by setting the system variables as follows:
> $PARAM_GROUP.SV_OFF_ALL : FALSE
> $PARAM_GROUP.SV_OFF_ENB[*] : FALSE (for all axes)
> After changing the system variables, cycle power of the controller.
> (Mastering can be performed without setting of gravity compensation. However, it will affect precision.)

5 Display the Master/Cal screen.

```
SYSTEM Master/Cal          AUTO   JOINT 10 %
                                  TORQUE = [ON ]
 1 FIXTURE POSITION MASTER
 2 ZERO POSITION MASTER
 3 QUICK MASTER
 4 QUICK MASTER FOR SINGLE AXIS
 5 SINGLE AXIS MASTER
 6 SET QUICK MASTER REF
 7 CALIBRATE
   Robot Not Mastered!

Quick master? [NO]
```

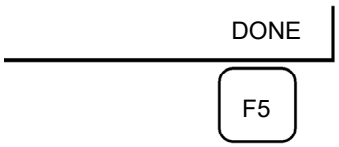
6 Select [4 QUICK MASTER FOR SINGLE AXIS]. You will see the quick master for single axis screen.

```
SINGLE AXIS MASTER              AUTO    JOINT 10%
                                                1/9
    ACTUAL   POS    (MSTR POS)      (SEL)   [ST]
J1          0.000   (      0.000)   (0)     [2]
J2          0.000   (      0.000)   (0)     [2]
J3          0.000   (      0.000)   (0)     [2]
J4          0.000   (      0.000)   (0)     [2]
J5          0.000   (      0.000)   (0)     [2]
J6          0.000   (      0.000)   (0)     [0]
E1          0.000   (      0.000)   (0)     [0]
E2          0.000   (      0.000)   (0)     [0]
E3          0.000   (      0.000)   (0)     [0]

                                                EXEC
```

7 Move the cursor to the [SEL] column for the unmastered axis and press the numeric key [1]. Setting of [SEL] is available for one or more axes.

```
SINGLE AXIS MASTER              AUTO    JOINT 10%
                                                1/9
    ACTUAL   POS    (MSTR POS)      (SEL)   [ST]
J5          0.000   (      0.000)   (0)     [2]
J6          0.000   (      0.000)   (0)     [0]

                                                EXEC
```

8 Jog the robot to the quick mastering reference position.
9 Press F5 [EXEC]. Mastering is performed. So, [SEL] is reset to 0, and [ST] is re-set to 2.
10 Move the cursor to [7 CALIBRATE] and press the [ENTER] key. Calibration is executed. Calibration can also be executed by cycling power.
11 After completing the calibration, press F5 Done.



12 If gravity compensation is disabled, set it to enabled.
13 Return brake control to original setting, and cycle power of the controller.

8.6 SINGLE AXIS MASTERING

Single axis mastering is performed for one axis at a time. The mastering position for each axis can be specified by the user.
Single axis mastering can be used, if mastering data for a specific axis is lost, for example, because a low voltage has been detected on the pulse counter backup battery or because the Pulsecoder has been replaced.

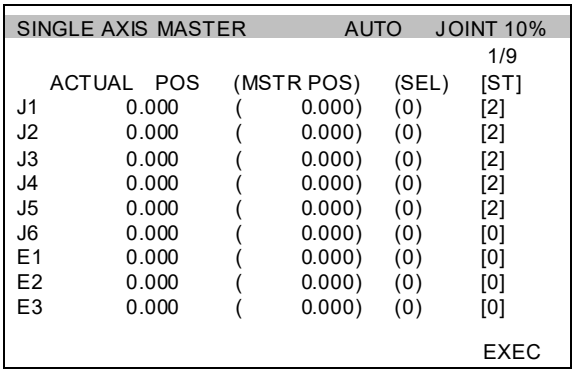


Table 8.6 (a) Items set in single axis mastering

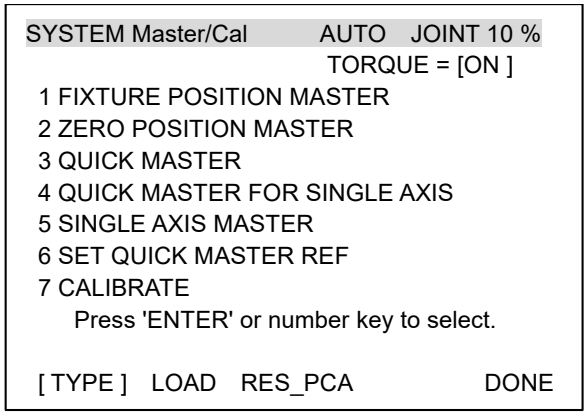
Item	Description
Current position (ACTUAL AXIS)	The current position of the robot is displayed for each axis in degree units.
Mastering position (MSTR POS)	A mastering position is specified for an axis to be subjected to single axis mastering. It would be convenient to set to it to the 0_ position.
SEL	This item is set to 1 for an axis to be subjected to single axis mastering. Usually, it is 0.
ST	This item indicates whether single axis mastering has been completed for the corresponding axis. It cannot be changed directly by the user. The value of the item is reflected in $EACHMST_DON (1 to 9). 0 :Mastering data has been lost. Single axis mastering is necessary. 1 :Mastering data has been lost. (Mastering has been performed only for the other interactive axes.) Single axis mastering is necessary. 2 :Mastering has been completed.

Procedure of Single axis mastering

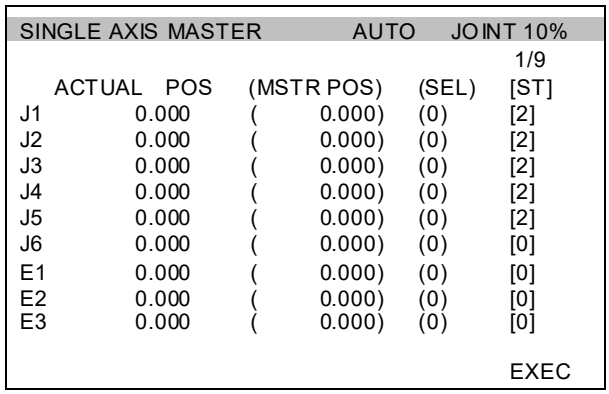
1 Press the [MENU] key to display the screen menu.
2 Select [0 NEXT] and press [6 SYSTEM].
3 Press F1 [TYPE]. Then select [Variables] from the menu.
4 If $DMR_GRP[group].$GRAV_MAST=1, set the gravity compensation to enabled, if it is 0, set the gravity compensation to disabled. In addition release the brake control.

NOTE
Gravity compensation can be set to enabled/disabled by setting the system variables as follows:
$PARAM_GROUP[group].$SV_DMY_LNK[8] : FALSE or TRUE
Brake control can be released by setting the system variables as follows:
$PARAM_GROUP.SV_OFF_ALL : FALSE
$PARAM_GROUP.SV_OFF_ENB[*] : FALSE (for all axes)
After changing the system variables, cycle power of the controller.
(Mastering can be performed without setting of gravity compensation. However, it will affect precision.)

5 Select [6 SYSTEM].
6 Select [Master/Cal]. The positioning screen will be displayed.



7 Select [5 SINGLE AXIS MASTER]. The following screen will be displayed.



8 Move the cursor to the [SEL] column for the unmastered axis and press the numeric key [1]. Setting of [SEL] is available for one or more axes.
9 Turn off brake control, then jog the robot to the mastering position.
10 Enter axis data for the mastering position.
11 Press F5 [EXEC]. Mastering is performed. So, [SEL] is reset to 0, and [ST] is re-set to 2 or 1.

SINGLE AXIS MASTER AUTO JOINT 10%

6/9

	ACTUAL POS	(MSTR POS)	(SEL)	[ST]
J1	0.000	(0.000)	(0)	[2]
J2	0.000	(0.000)	(0)	[2]
J3	0.000	(0.000)	(0)	[2]
J4	0.000	(0.000)	(0)	[2]
J5	0.000	(0.000)	(0)	[2]
J6	90.000	(0.000)	(1)	[0]
E1	0.000	(0.000)	(0)	[0]
E2	0.000	(0.000)	(0)	[0]
E3	0.000	(0.000)	(0)	[0]

EXEC

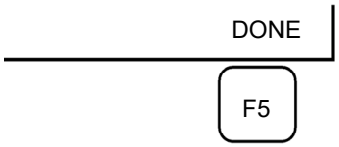
12 When single axis mastering is completed, press the [PREV] key to resume the previous screen.

SYSTEM Master/Cal AUTO JOINT 10 %
TORQUE = [ON]

1 FIXTURE POSITION MASTER
2 ZERO POSITION MASTER
3 QUICK MASTER
4 QUICK MASTER FOR SINGLE AXIS
5 SINGLE AXIS MASTER
6 SET QUICK MASTER REF
7 CALIBRATE
Press 'ENTER' or number key to select.

[TYPE] LOAD RES_PCA DONE

13 Select [7 CALIBRATE], then press F4 [YES]. Positioning is performed. Alternatively, turn off the controller power and on again. Positioning is performed.
14 After positioning is completed, press F5 [DONE].



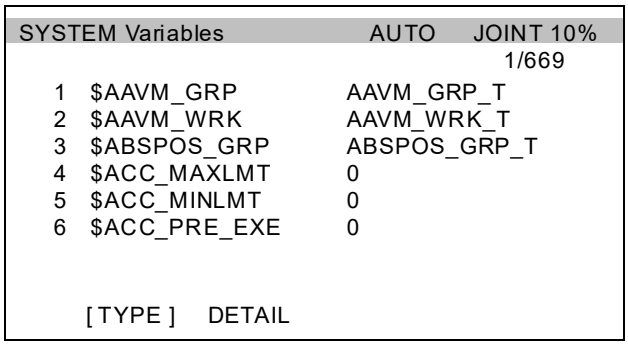
15 Return the setting of the gravity compensation.
16 Return brake control to original setting, and cycle power of the controller.

8.7 MASTERING DATA ENTRY

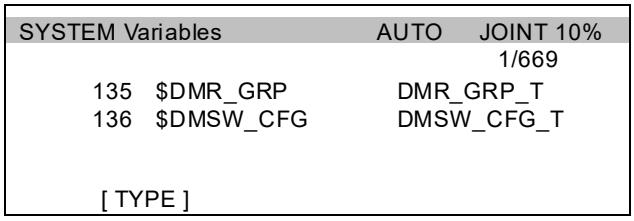
This function enables mastering data values to be assigned directly to a system variable. It can be used if mastering data has been lost but the pulse count is preserved.

Mastering data entry method

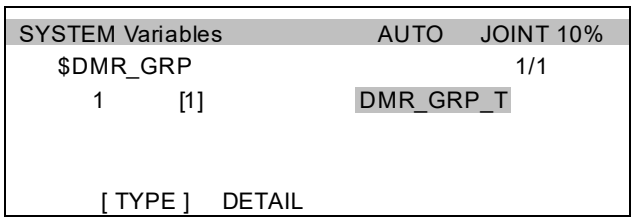
1 Press the [MENU] key, then press [0 NEXT] and select [6 SYSTEM].
2 Press F1 [TYPE]. Select [Variables]. The system variable screen will be displayed.

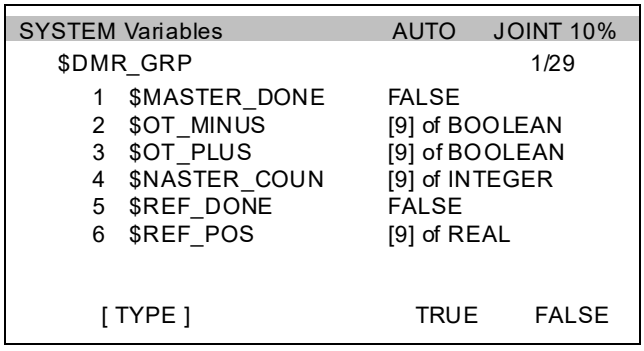


3 Change the mastering data.
The mastering data is saved to the $DMR_GRP.$MASTER_COUN system variable.

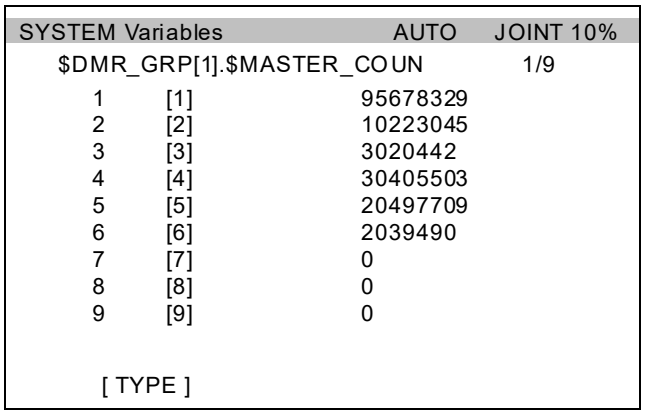


4 Select $DMR_GRP.

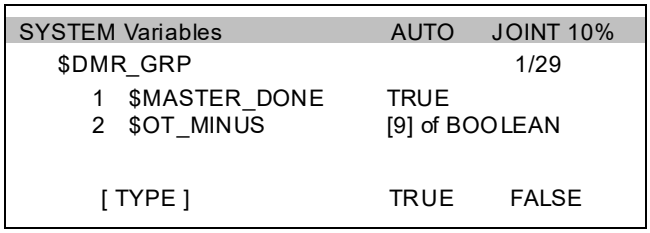




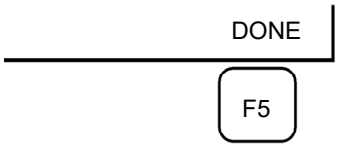
5 Select $MASTER_COUN, and enter the mastering data you have recorded.



6 Press the [PREV] key.
7 Set $MASTER_DONE to TRUE.



8 Display the positioning screen, and select [7 CALIBRATE], then press F4 [YES].
9 After completing positioning, press F5 [DONE].



8.8 VERIFYING MASTERING

1 How to verify that the robot is mastered properly:
Usually, positioning is performed automatically when the power is turned on. To check whether mastering has been performed correctly, examine if the current displayed position matches the actual robot position by using one or more of the procedures described below:
(1) Reproduce a particular point in a program. Check whether the point agrees with the specified position.
(2) Set all axes of the robot to their 0-degree (0 rad) positions. Check that the zero-degree position marks indicated in Section 8.3 of the OPERATOR'S MANUAL are aligned. There is no need to use a visual aid.
If the displayed and actual positions do not match, the counter value for a Pulsecoder may have been invalidated as a result of an alarm described in 2. Alternatively, the mastering data in system variable $DMR_GRP.$MASTER_COUN may have been overwritten as a result of an operation error or some other reason.
Compare the data with the values indicated on the supplied data sheet. This system variable is overwritten whenever mastering is performed. Whenever mastering is performed, record the value of the system variable on the data sheet.

2 Alarm types displayed during mastering and their solution method:
(1) BZAL alarm
This alarm is displayed if the Pulsecoder's backup battery voltage decreases to 0 V while the power to the controller is disconnected. Furthermore, if the Pulsecoder connector is removed for cable replacement, etc. this alarm is displayed as the voltage decreases to 0. Check to see if the alarm will disappear by performing a pulse reset (See Section 8.2.). Then, cycle controller power and check if the alarm disappears or not.
The battery may be drained if the alarm is still displayed. Perform a pulse reset, and turn off and on the controller power after replacing the battery. Note that, if this alarm is displayed, all the original data held by the Pulsecoder will be lost. Mastering is required.
(2) BLAL alarm
This alarm is displayed if the voltage of the Pulsecoder's backup battery has fallen to a level where backup is no longer possible. If this alarm is displayed, replace the battery with a new one immediately while keeping the power turned on. Check whether the current position data is valid, using the procedure described in 1.
(3) Alarm notification like CKAL, RCAL, PHAL, CSAL, DTERR, CRCERR, STBERR, and SPHAL may have trouble with Pulsecoder, contact your local FANUC representative.

9 TROUBLESHOOTING

The source of mechanical unit problems may be difficult to locate because of overlapping causes. Problems may become further complicated, if they are not corrected properly. Therefore, you must keep an accurate record of problems and take proper corrective actions.

9.1 TROUBLESHOOTING

Table 9.1 (a) lists the major troubleshooting that may occur in the mechanical unit and their probable causes. If you cannot pinpoint a failure cause or which measures to apply, contact your local FANUC representative. For troubleshooting except the mechanical unit, refer to "CONTROLLER MAINTENANCE MANUAL (B-83525EN etc.)" and Alarm Code List (B-83284EN-1).

Table 9.1 (a) Troubleshooting

Symptom	Description	Cause	Measure
Vibration Noise	- The J1 base lifts off the floor plate as the robot operates. - There is a gap between the J1 base and floor plate. - The J1 base retaining bolt is loose.	[J1 base fastening] - It is likely that the robot J1 base is not securely fastened to the floor plate. - Probable causes are a loose bolt, an insuffcient degree of surface flatness, or contamination caught between the robot and floor plate. - If the robot is not securely fastened to the floor plate, the J1 base lifts the floor plate as the robot operates, allowing the base and floor plates to strike each other. That, in turn, leads to vibration.	- If a bolt is loose, apply LOCTITE and tighten it to the appropriate torque. - Adjust the floor plate surface flatness to within the specified tolenrance. - If there is any contamination between the J1 base and floor plate, remove it.
	- The rack or floor plate vibrates during operation of the robot.	[Rack or floor] - It is likely that the rack or floor is not rigid enough. - If they are not rigid enough, counterforce deforms the rack or floor, and is responsible for the vibration.	- Reinforce the rack or floor to make it more rigid. - If reinforcing the rack or floor is impossible, modify the robot control program; doing so might reduce the vibration.
	- Vibration becomes more serious when the robot adopts a specific posture. - If the operating speed of the robot is reduced, vibration stops. - Vibration is most noticeable when the robot is accelerating. - Vibration occurs when two or more axes operate at the same time.	[Overload] - It is likely that the load on the robot is greater than the maximum rating. - It is likely that the robot control program is too demanding for the robot hardware. - It is likely that the ACCELERATION value is excessive.	- Check the maximum load that the robot can handle once more. If the robot is found to be overloaded, reduce the load, or modify the robot control program. - Vibration in a specific portion can be reduced by modifying the robot control program while slowing the robot and reducing its acceleration (to minimize the influence on the entire cycle time).

Symptom	Description	Cause	Measure
Vibration Noise (Continued)	- Vibration was first noticed after the robot collided with an object or the robot was overloaded for a long period. - Cyclical vibration and noise occur.	[Gear, bearing, or reducer] - It is likely that the collision or overload applied an excessive force to the drive system, thus damaged the geartooth surface or rolling surface of a bearing, or reducer. - It is likely that prolonged use of the robot while overloaded caused fretting of the gear tooth surface or rolling surface of a bearing, or reducer due to resulting metal fatigue. - It is likely that foreign material caught in a gear, bearing, or within a reducer caused damage on the gear tooth surface or rolling surface of the bearing, or reducer. - It is likely that foreign material caught in a gear, bearing, or within a reducer caused vibration. - It is likely that, because the grease has not been replaced for a long period, fretting occurred on the gear tooth surface or rolling surface of a bearing, or reducer due to metal fatigue.	- Operate one axis at a time to determine which axis is vibrating. - Remove the motor, and replace the gear, the bearing, and the reducer. For the spec. of parts and the method of replacement, contact your local FANUC representative. - Using the robot within its maximum rating prevents problems with the drive mechanism. - Supplying the specified grease at the recommended interval will prevent problems.

Symptom	Description	Cause	Measure
Vibration Noise (Continued)	- The cause of problem cannot be identified from examination of the floor, rack, or mechanical unit.	[Controller, cable, and motor] - If a failure occurs in a controller circuit, preventing control commands from being supplied to the motor normally, or preventing motor information from being sent to the controller normally, vibration might occur. - Pulse coder defect may be the cause of the vibration as the motor cannot propagate the accurate position. - If the motor becomes defective, vibration might occur because the motor cannot deliver its rated performance. - If a power line in a movable cable of the mechanical unit has an intermittent break, vibration might occur because the motor cannot accurately respond to commands. - If a Pulsecoder wire in a movable part of the mechanical unit has an intermittent break, vibration might occur because commands cannot be sent to the motor accurately. - If a robot connection cable has an intermittent break, vibration might occur. - If the power cable between them has an intermittent break, vibration might occur. - If the power source voltage drops below the rating, vibration might occur. - The robot may vibrate when the invalid value parameter was set. - If the noise occurs on a belt driving axis, damage of the bel may cause the noise.	- Refer to the Controller Maintenance Manual for troubleshooting related to the controller and amplifier. - Replace the motor of the axis that is vibrating, and check whether vibration still occurs. For the method of replacement, contact your local FANUC representative. - If vibration occurs only when the robot assumes a specific posture, it is likely that there is a mechanical problem. - Check whether the cable jacket of the robot connection cable is damaged. If so, replace the connection cable, and check whether vibration still occurs. - Check whether the power cable jacket is damaged. If so, replace the power cable, and check whether vibration still occurs. - Check that the robot is supplied with the rated voltage. - Check that the robot control parameter is set to a valid value. If it is set to an invalid value, correct them. Contact your local FANUC representative for further information if necessary. - Contact your local FANUC representative if performing the belt check.
	- There is some relationship between the vibration of the robot and the operation of a machine near the robot.	[Noise from a nearby machine] - If the robot is not grounded properly, electrical noise may be induced on the grounding wire, preventing commands from being transferred accurately, thus leading to vibration. - If the robot is grounded at an unsuitable point, its grounding potential becomes unstable, and noise is likely to be induced on the grounding line, thus leading to vibration.	- Connect the grounding wire firmly to ensure a reliable ground potential and prevent extraneous electrical noise.

Symptom	Description	Cause	Measure

Rattling	- While the robot is not supplied with power, pushing it with the hand causes part of the mechanical unit to wobble.
	- There is a gap on the mounting face of the mechanical unit.
		[Mechanical unit coupling bolt]
		- It is likely that overloading or a collision has loosened a mounting bolt in the robot mechanical unit.
			- Check that the following bolts for each axis are tight. If any of these bolts is loose, apply LOCTITE and tighten it to the appropriate torque.
			  - Motor retaining bolt
			  - Reducer retaining bolt
			  - Base retaining bolt
			  - Arm retaining bolt
			  - Casting retaining bolt
			  - End effector retaining bolt

Motor overheating	- The motor overheated due to a rise in temperature in the installation area. - After changing the Robot control program or the load, the motor overheated.	[Ambient temperature] - It is likely that the motor overheated when the ambient temperature rose, and could not dissipate the heat. [Operating condition] - It is likely that the overcurrent is above the specified permissive average current.	- Reducing the ambient temperature is the most effective means of preventing overheating. - If there is a source of heat near the motor, it is advisable to install shielding to protect the motor from heat radiation. - Relaxing the robot control program and load condition is an effective way to reduce the average current. Thus, prevent overheating. - The teach pendant can be used to monitor the average current. Check the average current when the robot control program is running.
	- After a control parameter (load setting etc.) was changed, the motor overheated.	[Parameter] - If data input for a workpiece is invalid, the robot cannot be accelerate or decelerate normally, so the average current increases, leading to the motor overheating.	- As for load setting, Input an appropriate parameter referring to Section 4.3.

Symptom	Description	Cause	Measure
Motor overheating	- Symptom other than stated above	[Mechanical unit problems] - It is likely that problems occurred in the mechanical unit drive mechanism, thus placing an excessive load on the motor. [Motor problems] - It is likely that a failure of the motor brake resulted in the motor running with the brake applied, thus placing an excessive load on the motor. - It is likely that a failure of the motor prevented it from delivering its rated performance, thus causing an excessive current to flow through the motor.	- Repair the mechanical unit while referring to the above descriptions of vibration, noise, and rattling. - Check that, when the servo system is energized, the brake is released. If the brake remains applied to the motor all the time, replace the motor. - If the average current falls after the motor is replaced, it indicates that the first motor was faulty.

Grease leakage	- Grease is leaking from the mechanical unit.	[Poor sealing]
		- Probable causes are a crack in the casting, a broken O-ring, a damaged oil seal, or a loose seal bolt.
		- A crack in a casting can occur due to excessive force that might be caused in a collision.
		- An O-ring can be damaged if it is pinched or cut during disassembling or re-assembling.
		- An oil seal might be damaged if extraneous dust scratches the lip of the oil seal.
		- A loose seal bolt might allow grease to leak along the threads.
			- If a crack develops in the casting, sealant can be used as a quick-fix to prevent further grease leakage. However, the component should be replaced as soon as possible, because the crack might extend.
			- O-rings are used in the locations listed below.
			  - Motor coupling section
			  - Reducer coupling section
			  - Wrist coupling section
			  - J3 arm coupling section
			  - Inside the wrist
			- Oil seals are used in the locations stated below.
			  - Inside the reducer
			  - Inside the wrist
			- Seal bolts are used in the locations stated below.
			  - Grease inlet and outlet

Symptom	Description	Cause	Measure

Dropping axis	- An axis drops because the brake does not function.
	- An axis drops gradually when it should be at rest.
		[Brake drive relay and motor]
		- It is likely that brake drive relay contacts are stuck to each other to keep the brake current flowing, thus preventing the brake from operating when the motor is deenergized.
		- It is likely that the brake shoe has worn out or the brake main body is damaged, preventing the brake from operating efficiently.
		- It is likely that oil or grease has entered the motor, causing the brake to slip.
			- Check whether the brake drive relays contacts are stuck to each other or not. If they are found to be stuck, replace the relays.
			- Replace the motor after confirming whether the following symptoms have occurred.
			  - Brake shoe is worn out
			  - Brake main body is damaged
			  - Oil soaked through the motor

Displace-ment	- The robot moves to a point other than the taught position. - The repeatability is not within the tolerance.	[Mechanical unit problems] - If the repeatability is unstable, probable causes are a failure in the drive mechanism or a loose bolt. - If the repeatability becomes stable it is likely that a collision imposed an excessive load, leading to slipping on the base surface or the mating surface of an arm or reducer. - It is likely that the Pulsecoder is faulty.	- If the repeatability is unstable, repair the mechanical unit by referring to the above descriptions of vibration, noise, and rattling. - If the repeatability is stable, correct the taught program. The problem will not reoccur unless another collision occurs. - If the Pulsecoder is faulty, replace the motor.
	- Displacement occurs only in specific peripheral unit.	[Peripheral unit displacement] - It is likely that an external force was applied to the peripheral unit, thus shifting its position relative to the robot.	- Correct the setting of the peripheral unit position. - Correct the taught program.
	- Displacement occurred after a parameter was changed.	[Parameter] - It is likely that the mastering data was rewritten in such a way that the robot origin was shifted.	- Re-enter the previous mastering data, which is known to be correct. - If correct mastering data is unavailable, perform mastering again.

Symptom	Description	Cause	Measure
CLALM alarm occurred. Move error excess alarm occurred.	- Ambient temperature of the robot installation location is low, CLALM alarm is displayed on the teach pendant screen. - Ambient temperature of the robot installation position is low, "Move error excess" alarm is displayed on the teach pendant screen.	[Peripheral temperature] - When the robot is used in a low temperature environment that is near to 0ºC, or the robot is not operated for a long time in an environment that is less than 0ºC, there will be a large viscous resistance of the drive train immediately after starting which will cause the alarm.	- Perform a warm up operation or a low speed operation for several minutes.
	- After changing the motion program or the load condition, the CLALM alarm is displayed. - After changing the motion program or the load condition, the "Move error excess" alarm is displayed.	- It is likely that a robot collision occurred.	- If a robot collision has occurred, press the [RESET] key while pressing the [SHIFT] key. Then, jog the robot in the opposite direction while pressing the [SHIFT] key. - Check the motion program.

		[Overload]
		- It is likely that load exceeded the permissible value.
		- It is likely that the motion program is too severe for the robot.
		  - Excessive motion due to a large acceleration.
		  - Tight motion such as reverse motion using "CNT".
		  - Linear motion occurs near singularity point where axes revolve in high speed.
			- Check the permissible value of the robot payload. If the load exceeds the permissible value, reduce the load or change the motion program.
			- Consider minimizing the cycle time by reducing the speed or acceleration, and changing the motion program.
			- Check that the load setting is performed correctly.

	- None of the symptoms stated above are the problem.	- It is likely the vibration occurred.	- Refer to the Symptoms: Vibration, Noise section of this troubleshooting for more information.
		- It is likely that rated voltage is not supplied due to the voltage drop.	- Check that the robot is supplied with the proper rated voltage.
BZAL alarm occured	- BZAL is displayed on the controller screen	- It is likely that the voltage of the memory backup battery is low. - It is likely that the Pulsecoder cable is defective.	- Replace the battery. - Replace the cable.

APPENDIX

A PERIODIC MAINTENANCE TABLE

FANUC Robot LR-10*i*A/10 Periodic Maintenance Table

Items		Accumulated operating time (H)	Check time	Grease amount	First check 320	3 months 960	6 months 1920	9 months 2880	1 years 3840	4800	5760	6720	2 years 7680	8640	9600	10560
Mechanical unit	1	Check for external damage or peeling paint	0.1H	—		○	○	○	○	○	○	○	○	○	○	○
	2	Check for water	0.1H	—		○	○	○	○	○	○	○	○	○	○	○
	3	Check the exposed connector.(loosening)	0.2H	—		○			○				○			
	4	Tighten the end effector bolt.	0.2H	—		○			○				○			
	5	Tighten the cover and main bolt.	2.0H	—		○			○				○			
	6	Check the mechanical stopper.	0.1H	—		○			○				○			
	7	Clean spatters, sawdust and dust	1.0H	—		○	○	○	○	○	○	○	○	○	○	○
	8	Check hand cable and external battery cable (option)	0.1H	—		○			○				○			
	9	Replacing batteries *3	0.1H	—					●				●			
	10	Greasing the reducers.	0.5H	14ml												
	11	Replacing cable of mechanical unit	4.0H	—												
Controller	12	Check the robot cable, teach pendant cable and robot connecting cable	0.2H	—		○			○				○			
	13	Cleaning the controller ventilation system	0.2H	—	○	○	○	○	○	○	○	○	○	○	○	○
	14	Replacing batteries *1 *3	0.1H	—												

*1 Refer to the “REPLACING UNITS Chapter of “MAINTENANCE” in the following manuals.
R-30*i*B Mate/R-30*i*B Mate Plus CONTROLLER MAINTENANCE MANUAL (B-83525EN)
R-30*i*B Mate/R-30*i*B Mate Plus CONTROLLER Open Air MAINTENANCE MANUAL (B-83555EN)

*2 ●: requires order of parts
○: does not require order of parts

*3 Regardless of the operating time, replace the mechanical unit batteries at 1 year, replace controller batteries at 4 years.

3 years 11520	12480	13440	14400	4 years 15360	16320	17280	18240	5 years 19200	20160	21120	22080	6 years 23040	24000	24960	25920	7 years 26880	27840	28800	29760	8 years 30720	Item
○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○		1
○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○		2
○				○				○				○				○					3
○				○				○				○				○					4
○				○				○				○				○					5
○				○				○				○				○					6
○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○		7
○				○				○				○				○					8
●				●				●				●				●					9
				●																	10
				●																	11
○				○				○				○				○					12
○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○		13
				●																	14

Overhaul

B STRENGTH OF BOLT AND BOLT TORQUE LIST

NOTE

When applying LOCTITE to a part, spread the LOCTITE on the entire length of the engaging part of the female thread. If applied to the male threads, poor adhesion can occur, potentially loosening the bolt. Clean the bolts and the threaded holes and wipe off any oil on the engaging section. Make sure that there is no solvent left in the threaded holes. When finished, remove all the excess LOCTITE when you are finished screwing the bolts into the threaded holes.

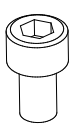
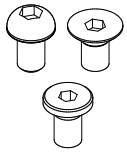
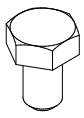
Use the following strength bolts. Comply with any bolt specification instructions.
Hexagon socket head bolt made of steel:

Size M22 or less: Tensile strength 1200N/mm^2 or more
Size M24 or more: Tensile strength 1000N/mm^2 or more
All size plated bolt: Tensile strength 1000N/mm^2 or more

Hexagon bolt, stainless bolt, special shape bolt (button bolt, low-head bolt, flush bolt .etc.)
Tensile strength 400N/mm^2 or more

Refer to the following tables if the bolts tightening torque is not specified.

Recommended bolt tightening torques **Unit: Nm**

Nominal diameter	Hexagon socket head bolt (steel)		Hexagon socket head bolt (stainless steel)		Hexagon socket head button bolt Hexagon socket head flush bolt Low-head bolt (steel)		Hexagon bolt (steel)	
	Tightening torque		Tightening torque		Tightening torque		Tightening torque	
	Upper limit	Lower limit	Upper limit	Lower limit	Upper limit	Lower limit	Upper limit	Lower limit
M3	1.8	1.3	0.76	0.53	———	———	———	———
M4	4.0	2.8	1.8	1.3	1.8	1.3	1.7	1.2
M5	7.9	5.6	3.4	2.5	4.0	2.8	3.2	2.3
M6	14	9.6	5.8	4.1	7.9	5.6	5.5	3.8
M8	32	23	14	9.8	14	9.6	13	9.3
M10	66	46	27	19	32	23	26	19
M12	110	78	48	33	———	———	45	31
(M14)	180	130	76	53	———	———	73	51
M16	270	190	120	82	———	———	98	69
(M18)	380	260	160	110	———	———	140	96
M20	530	370	230	160	———	———	190	130
(M22)	730	510	———	———	———	———	———	———
M24	930	650	———	———	———	———	———	———
(M27)	1400	960	———	———	———	———	———	———
M30	1800	1300	———	———	———	———	———	———
M36	3200	2300	———	———	———	———	———	———
								

C OPTIONAL CONNECTOR WIRING PROCEDURE

Source of information: Hirose Electric Co., Ltd.

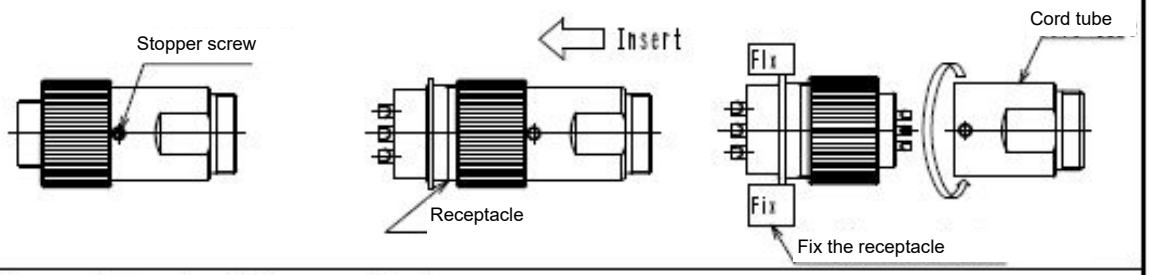
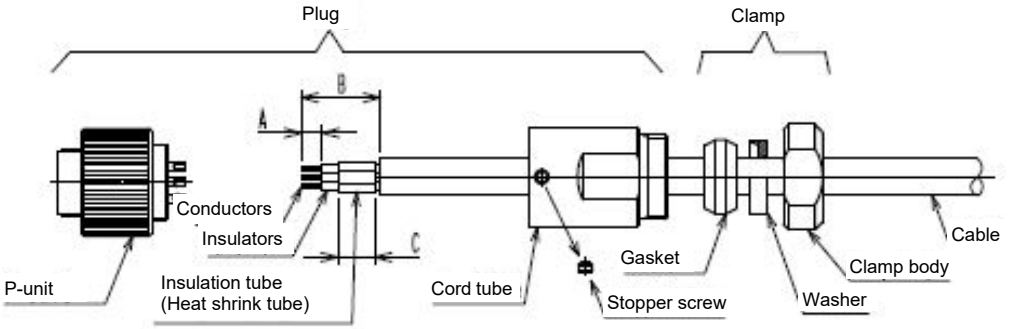
No.	Procedure
1	[Disassembly of connector] Disassemble the connector in the order describe on the figures below. 1.Remove the stopper screw. 2. Insert the plug into the receptacle. 3. Remove the cord tube. 
2	[Component assembly, cable preparation] For the assembly of the connector, as well as the clamp, proceed as described on the figure below. *Refer to the Table-1.2 for dimensions concerning the cable preparation.  Notes) (1) Do not damage conductor and insulator while handling. (2) Assure the direction of washer. (3) Be careful not to lose the stopper screws as it is a very small component.

Table 1. Solder type

Shell size	A [mm]	B[mm]	C[mm]
13	(3)	(12)	(8)
16	(3)	(14)	
21	(3)	(17)	
25	(3)	(20)	

Table 2. Crimping type

Shell size	Number of poles	A [mm]	B[mm]
16	10	3.5 to 4	(19)
21	10	4 to 4.5	(22)
25	24	3.5 to 4	(25)

Note) The dimension A for JR25W*HA-4* is (5.5).

3

[Soldering, tube fixation, distance adjustment]

Solder the cable and cover the soldered area with the insulation tube. Adjust the length of the cable.
*Fixing the P-unit by plugging it to the applicable receptacle can make the assembly process easier.

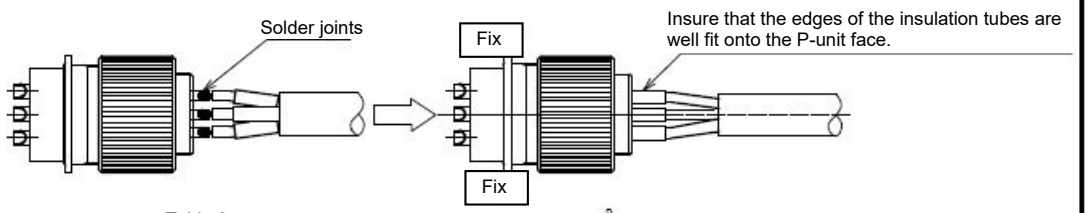
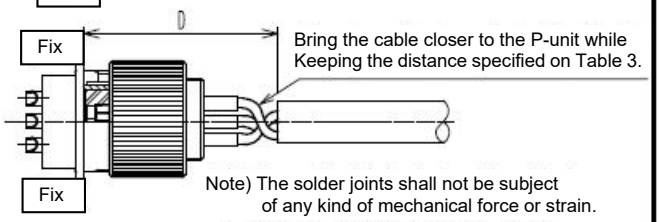


Table 3.

Shell size	D [mm]
13	37 max
16	39 max
21	42 max
25	45 max



Note) The solder joints shall not be subject of any kind of mechanical force or strain.

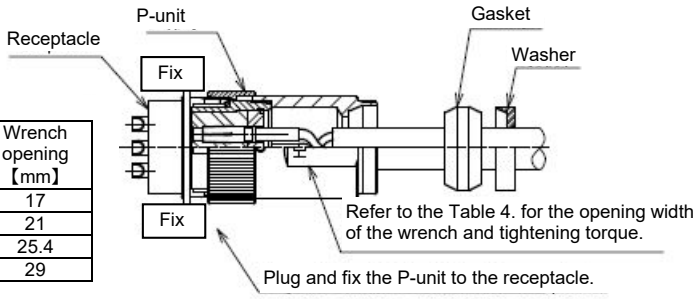
4

[Tightening of the cord tube]

Plug the P-unit into the receptacle and tighten cord tube to the P-unit.

Table 4.

Shell size	Tightening torque 【N・m】	Wrench opening 【mm】
13	2 to 2.5	17
16	3 to 3.5	21
21	4 to 4.5	25.4
25	5 to 5.5	29



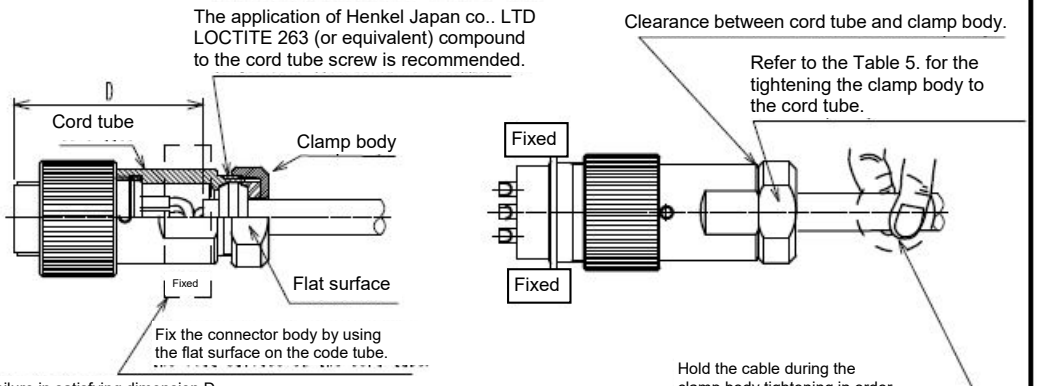
5

[Tightening of the clamp body]

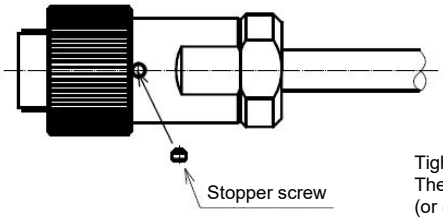
After assembling the gasket and washer to the cord tube, tighten the clamp body to the cord tube.
*This operation becomes easier if the P-unit is plugged in to the receptacle.

Table 5.

Shell size	Tightening torque 【N・m】
13	2 to 2.5
16	3 to 3.5
21	4 to 4.5
25	5 to 5.5



Note) Failure in satisfying dimension D
(distance between connector edge and cable insulation).
may cause insufficient compression between the gasket and the cable.
resulting in a bad sealing performance.

6	[Tightening of the stopper screw] Tighten the set screw to cord tube.  Tightening torque of the stopper screw : 0.2 to 0.25 N・m. The application of Henkel Japan co,.LTD LOCTITE 263 (or equivalent) compound is recommended.
7	[Confirmation of the sealing performance] After connector assembly procedure is completed, inject compressed air into the connector from the mating side 18kPa for 30 seconds. Insure that there are no air bubbles originating from the connector.

D INSULATION ABOUT ARC WELDING ROBOT

The arc welding robot performs welding, using a welding torch attached to its end effector mounting face via a bracket. Because a high welding current flows through the welding torch, the insulating material must not permit bolting directly from the welding torch bracket to mounting face plate.

If no due consideration is taken, a poor insulation caused by a pileup of spatter can allow the welding current to leak into robot mechanical units, possibly damaging the motor or melting the mechanical unit cable jackets.

D.1 INSULATION AT THE WRIST

Please be careful to the following contents.

- Insulate the end effector mounting surface. Insulation material which is inserted between the end effector mounting surface and the welding torch bracket must be different, and bolt them separately referring to Fig. D.1 (a).
- Insert the insulating material between the torch bracket and faceplate to ensure the two are electrically isolated. When installing the insulating material, be sure to set the crack in the torch holder away from that of the insulating material to prevent spatter from getting in the cracks.
- Allow a sufficient distance (at least 5 mm) at the insulating materials in case a pileup of spatter should occur.

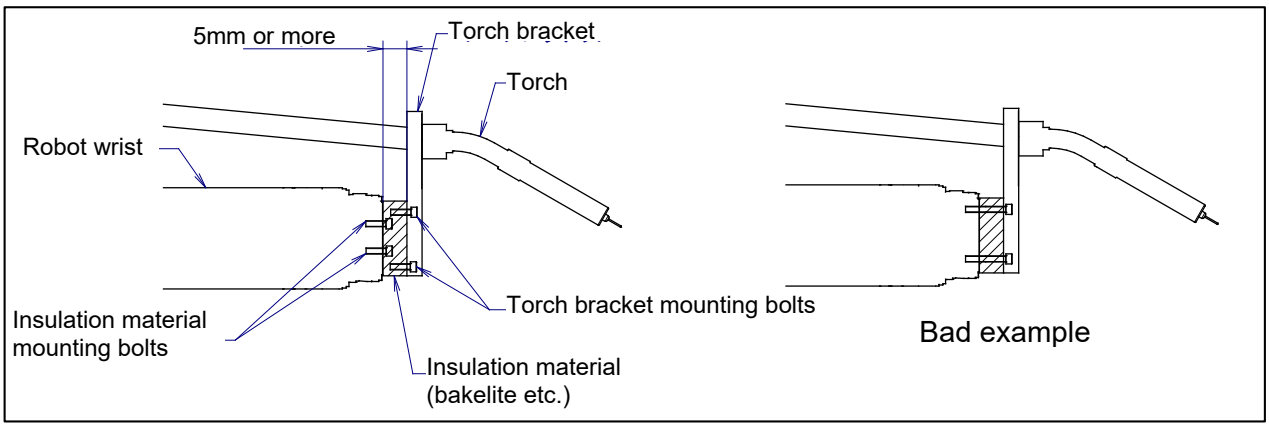


Fig. D.1 (a) Insulation at the wrist

- Even after the insulation is reinforced, it is likely that, if a pileup of spatter grows excessively, current may leak. Periodically remove the spatter.

D.2 INSULATION AT THE ADDITIONAL AXIS

If welding fixtures are installed to the additional axis, Perform insulation against between welding fixtures and the additional axis to prevent welding electric current intrusion. If the follower unit is used, perform insulation against between welding fixtures and follower unit to prevent welding electric current intrusion into the housing.

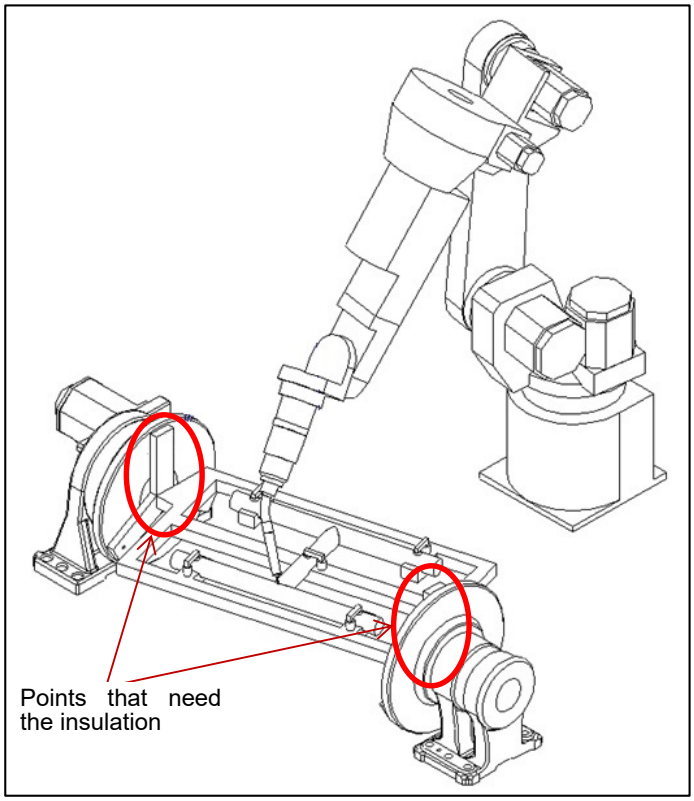


Fig. D.2 (a) Insulation at the additional axis

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