FANUC Robot R-2000*i*A/200T
FANUC Robot R-2000*i*B/200T

MECHANICAL UNIT

OPERATOR'S MANUAL

B-82464EN/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.

This manual can be used with controllers labeled R-30*i*A or R-J3*i*C. If you have a controller labeled R-J3*i*C, you should read R-30*i*A as R-J3*i*C throughout this manual.

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 the "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. Work 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

(1) For emergency or abnormal situations (e.g. persons trapped in or pinched by the robot), brake release unit can be used to move the robot axes without drive power.
Please order following unit and cable.

Name	Specification
Brake release unit	A05B-2450-J350 (Input voltage AC100-115V single phase) A05B-2450-J351 (Input voltage AC200-240V single phase)
Robot connection cable	A05B-2450-J360 (5m) A05B-2450-J361 (10m)
Power cable	A05B-2525-J010 (5m) (AC100-115V Power plug) (*) A05B-2525-J011 (10m) (AC100-115V Power plug) (*) A05B-2450-J364 (5m) (AC100-115V or AC200-240V No power plug) A05B-2450-J365 (10m) (AC100-115V or AC200-240V No power plug)

(*) These do not support CE marking.

(2) Please make sure that adequate numbers of brake release units are available and readily accessible for robot system before installation.
(3) Regarding how to use brake release unit, please refer to Robot controller maintenance manual.

⚠ CAUTION
Robot systems installed without adequate number of brake release units or similar means are not in compliance with EN ISO 10218-1 and the Machinery Directive and therefore cannot bear the CE marking.

⚠ WARNING
Robot arm would fall down by releasing its brake because of gravity. Therefore it is strongly recommended to take adequate measures such as hanging Robot arm by a crane before releasing a brake.

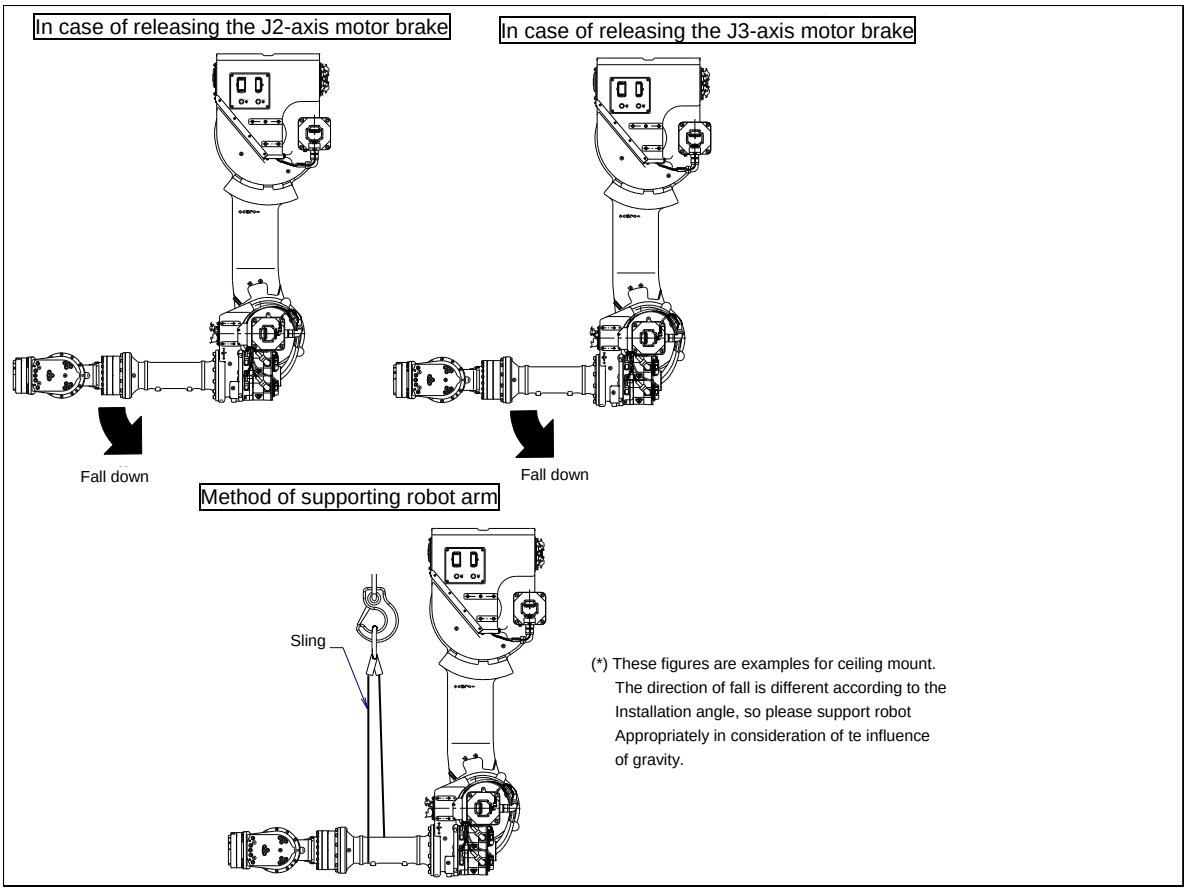


Fig. 3 (a) Releasing J2 and J3 motor brake and measures

4 WARNING & CAUTION LABEL

(1) Greasing and degreasing label

Fig. 4 (a) Greasing and degreasing label

Description

When greasing and degreasing, observe the instructions indicated on this label.

1) Open the grease outlet at greasing.
2) Use a hand pump at greasing.
3) Use designated grease at greasing.

> ⚠ **CAUTION**
> See Section 3.1 ″REPLACING GREASE OF THE DRIVE MECHANISM″ for explanations about specified greases, the amount of grease to be supplied, and the locations of grease and degrease outlets for individual models.

(2) Step-on prohibitive label

Fig. 4 (b) Step-on prohibitive label

Description

Do not step on or climb the robot or controller as it may adversely affect the robot or controller and you may get hurt if you lose your footing as well.

(3) High-temperature warning label

Fig. 4 (c) High-temperature warning label

Description

Be cautious about a section where this label is affixed, as the section generates heat. If you have to inevitably touch such a section when it is hot, use a protective provision such as heat-resistant gloves.

(4) Transportation label

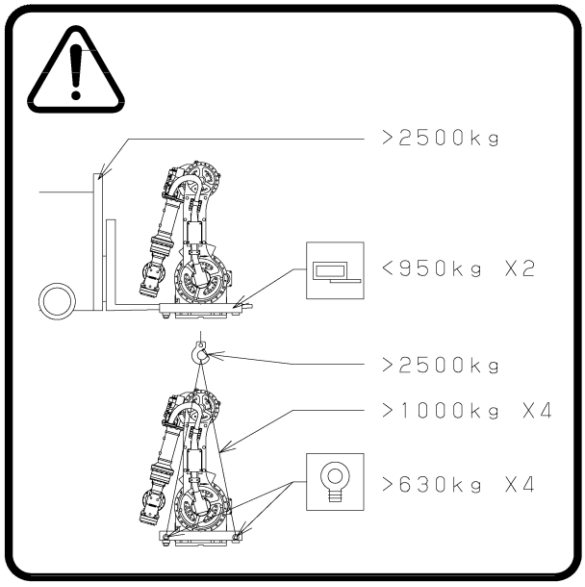


Fig. 4 (d) Transportation label

Description

When transporting the robot, observe the instructions indicated on this label. The above label indicates the following:

1) Using a forklift
- Use a forklift having a load capacity of 2500 kg or greater.
- Keep the total weight of the robot to be transported to within 1900 kg, because the load capacity of the forklift bracket (option) is 9310 N (950 kgf).

2) Using a crane
- Use a crane with a load capacity of 2500 kg or greater.
- Use four slings each with each load capacity of 1000 kg or greater.
- Use four eyebolts with each allowable load of 6174 N (630 kgf) or greater.

(5) Operating space and payload mark label

Below label is added when CE specification is specified.

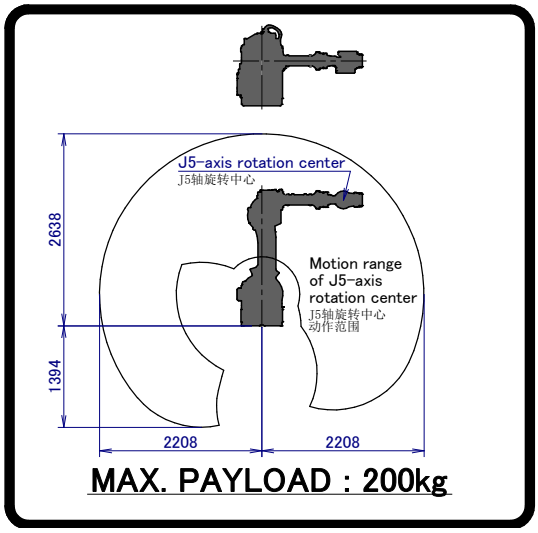


Fig. 4 (e) Operating space and payload mark label

(6) Transportation caution label (When transportation equipment option is specified.)

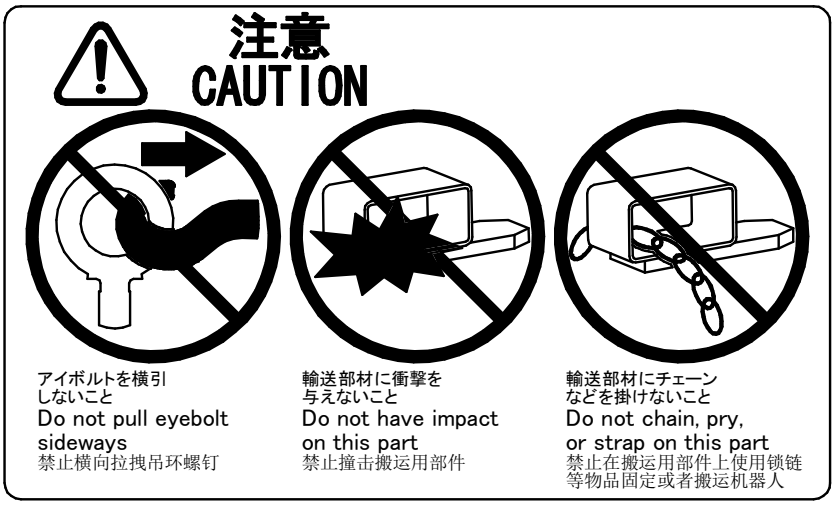


Fig. 4 (f) Transportation caution label

Description

Keep the following in mind when transporting the robot.

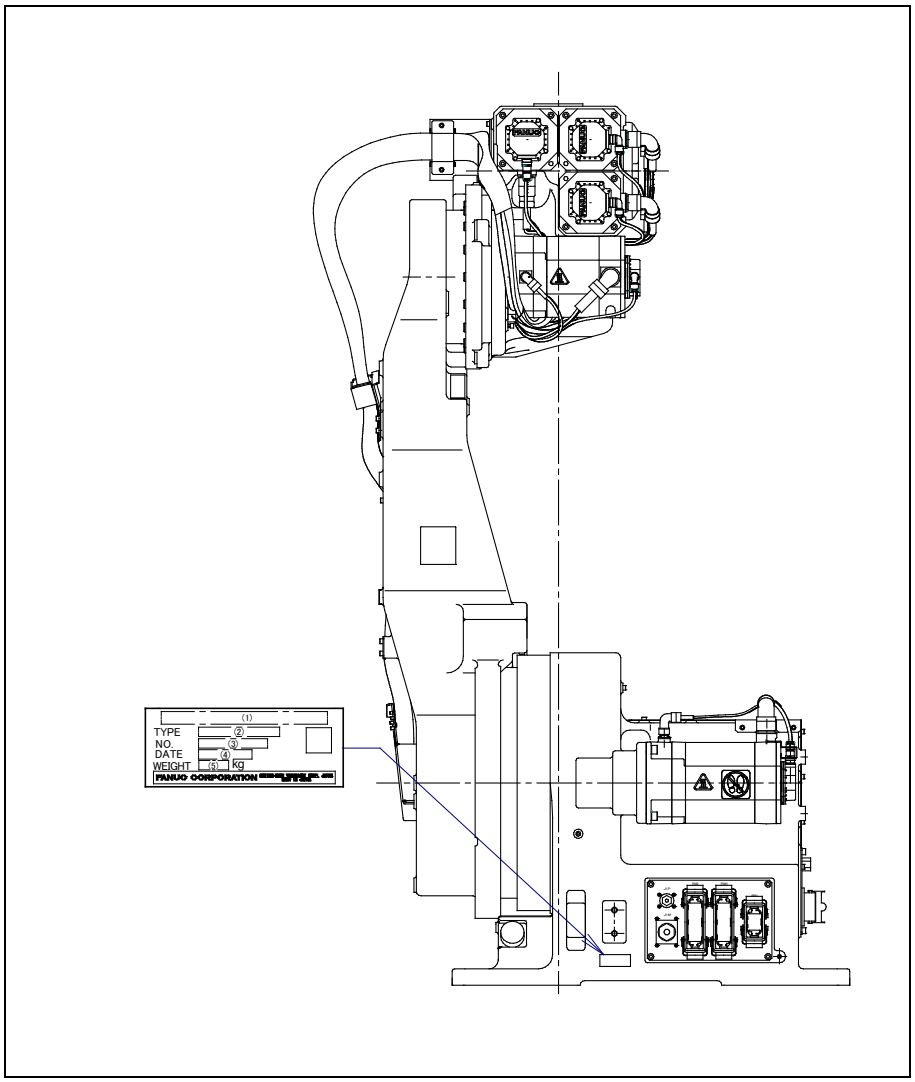
1) Do not pull eyebolts sideways
2) Prevent the forks of the forklift from having impact on a transport member.
3) Do not thread a chain or the like through a transport member.

PREFACE

This manual explains the operation procedures for the mechanical units of the following robot:

Model name	Mechanical unit specification No.	Maximum load
FANUC Robot R-2000*i*A/200T	A05B-1324-B285	200kg
FANUC Robot R-2000*i*B/200T	A05B-1324-B585	200kg

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



Position of label indicating mechanical unit specification number

Table 1(a)

No.	(1)	(2)	(3)	(4)	(5)
CONTENTS	MODEL NAME	TYPE	No.	DATE	WEIGHT kg (Without controller)
LETTERS	FANUC Robot R-2000*i*A/200T	A05B-1324-B285	SERIAL NO. IS PRINTED	PRODUCTION YEAR AND MONTH ARE PRINTED	1100
	FANUC Robot R-2000*i*B/200T	A05B-1324-B585			1100

Specifications

ITEM		R-2000*i*A/200T, R-2000*i*B/200T
Type		Articulated Type
Controlled axes		6 axes (J1, J2, J3, J4, J5, J6)
Installation		Ceiling mount/Wall mount
Motion range	J1-axis	It depends on the specifications of the traveling axis.
	J2-axis	245° (4.28rad)
	J3-axis	406° (7.09rad)
	J4-axis	720°(12.57rad)
	J5-axis	250° (4.36rad)
	J6-axis	720° (12.57rad)
Max motion speed (NOTE 1)	J1-axis	It depends on the specifications of the traveling axis.
	J2-axis	70°/s (1.21rad/s)
	J3-axis	90°/s (1.57rad/s)
	J4-axis	110°/s (1.92rad/s)
	J5-axis	110°/s (1.92rad/s)
	J6-axis	155°/s (2.71rad/s)
Max. load capacity	at wrist	200kg
	at J3 arm	—
	at J2 base	550kg
Allowable load moment at wrist	J4-axis	1274N·m (130kgf·m)
	J5-axis	1274N·m (130kgf·m)
	J6-axis	686N·m (70kgf·m)
Allowable load inertia at wrist	J4-axis	117.6kg·m^2 (1200kgf·cm·s^2)
	J5-axis	117.6kg·m^2 (1200kgf·cm·s^2)
	J6-axis	58.8kg·m^2 (600kgf·cm·s^2)
Drive method		Electric servo drive by AC servo motor
Repeatability		±0.3mm
Weight		1100kg
Acoustic noise level		78.1 dB or less(NOTE 2)
Installation environment		Ambient temperature : 0 – 45℃ (NOTE 3) Ambient humidity Normally : 75%RH or less (No condensation allowed.) Short time (within one month) : Max 95%RH (No condensation allowed.) Height : Up to 1000 meters above the sea level requires, no particular provision for attitude. Vibration acceleration : 4.9m/s^2 (0.5G) or less Free of corrosive gases (NOTE 4)

NOTE

1 During short distance motions, the axis speed may not reach the maximum value stated.
2 This value is the 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
3 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.
4 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 foreign materials.

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-J3*i*B controller	OPERATOR'S MANUAL SPOT TOOL＋ **B-84164EN-1** HANDLING TOOL **B-84164EN-2** SEALING TOOL **B-81464EN-4**	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-82595EN** RIA : **B-82595EN-2**	Intended readers : Maintenance technician, system designer Topics : Installation, start-up, connection, maintenance Use : Installation, start-up, connection, maintenance
R-30*i*A controller	OPERATOR'S MANUAL SPOT TOOL + **B-83124EN-1** HANDLING TOOL **B-83124EN-2** DISPENSE TOOL **B-83124EN-4** ALARM CODE LIST **B-83124EN-6** SERVO GUN FUNCTION **B-82634EN**	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-82595EN** CE : **B-82595EN-1** RIA : **B-82595EN-2**	Intended readers : Maintenance technician, system designer Topics : Installation, start-up, connection, maintenance Use : Installation, start-up, connection, maintenance
R-30*i*B, R-30*i*B Plus controller	OPERATOR'S MANUAL (Basic Function) **B-83284EN** OPERATOR'S MANUAL (Alarm Code List) **B-83284EN-1** Optional Function OPERATOR'S MANUAL **B-83284EN-2** Spot Welding Function OPERATOR'S MANUAL **B-83284EN-4** Dispense Function OPERATOR'S MANUAL **B-83284EN-5** Servo Gun Function OPERATOR'S MANUAL **B-83264EN**	Intended readers : Operator, programmer, maintenance technician, system designer Topics : Robot functions, operations, programming, setup, interfaces, alarms Use : Robot operation, teaching, system design

	Maintenance manual **B-83195EN**	Intended readers : Maintenance engineer, system designer Topics : Installation, start-up, connection, maintenance Use : Installation, start-up, connection, maintenance
AC servo motor (For J1-axis motor)	AC SERVO MOTORαis,αi series DESCRIPTION **B-65262EN**	Intended readers: Maintenance technician, system designer Topics: Specification, usage Use: Confirmation of specification and usage
	FANUC AC SERVO MOTOR αis series FANUC AC SERVO MOTOR αi series FANUC AC SPINDLE MOTOR αi series FANUC SERVO AMPLIFIER αi series Maintenance Manual **B-65285EN**	Intended readers: Maintenance technician, system designer Topics: Setup, troubleshooting, maintenance Use: Setup, troubleshooting, maintenance

NOTE

This manual describes about 5-axes of the robot installed to the J1-axis (running part). Information about the constitution and the operating method of the running part are not included in this manual.
In this manual, the servo motor for the J1-axis is appended to this robot.
“AC SERVO MOTOR αis, αi series DESCRIPTION” describe points of concern to use our servo motor safely. Read it before use the servo motor, and use the servo motor correctly after the each function is understood enough.

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 CONFIGURATION

The configuration of the mechanical unit is shown in Fig. 1 (a).

NOTE
In this robot, the J1 axis is assumed to be the traveling axis to be prepared by the customer, and therefore the robot itself has the J2 to J6 axes.

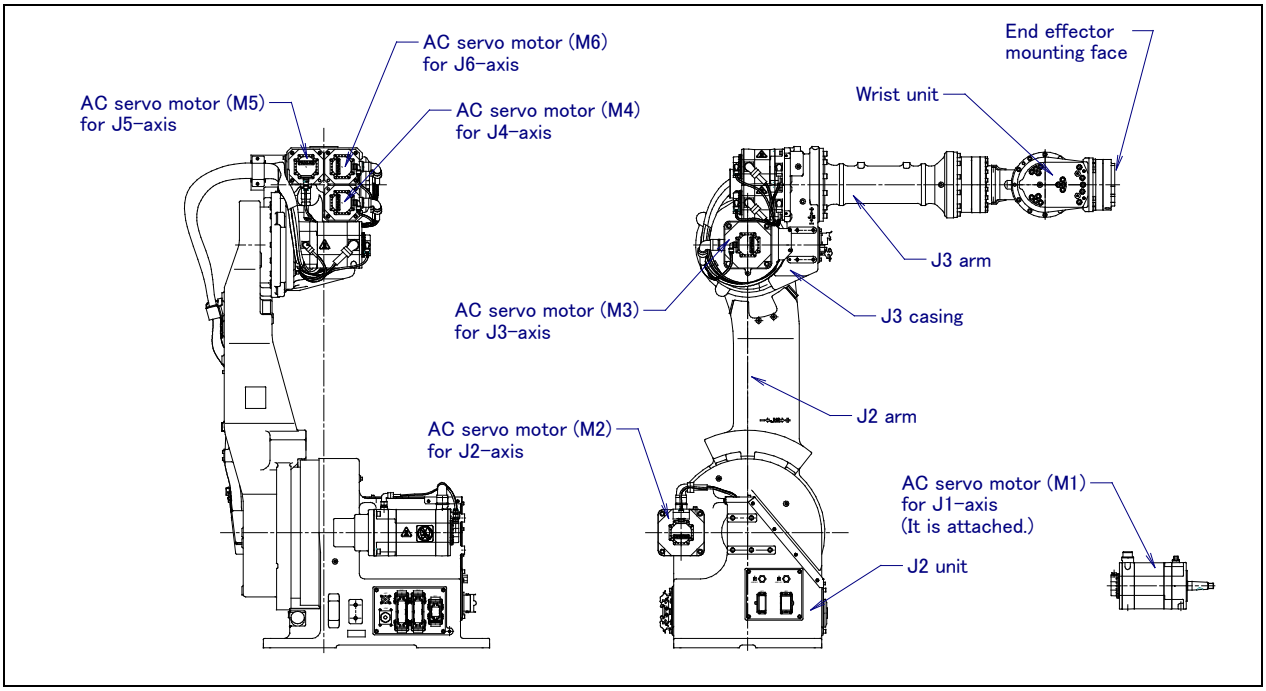


Fig. 1 (a) Mechanical unit configuration

2 CHECKS AND MAINTENANCE

Optimum performance of the robot can be maintained by performing the checks and maintenance procedures presented in this chapter. (See 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 interval should be divided by 2.

2.1 CHECKS AND MAINTENANCE

2.1.1 Daily Checks

Check the following items when necessary before daily system operation.

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 oil seepage, clean it. **⇒"2.2.1 Confirmation of Oil Seepage"**
Air control set	(When air control set is used) **⇒"2.2.2 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: **⇒"4.1 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: **⇒"4.1 TROUBLESHOOTING"(Symptom : Displacement)**
Peripheral equipment for proper operation	Check whether the peripheral equipment operate properly according to commands from the robot and the peripheral equipment.
Brakes for each axis	Check that the droppage of the end effector mounting face is within 0.2 mm when the servo power turned off. If the end effector (hand) drops, perform the measures as described in the following section: **⇒"4.1 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: **⇒"R-30*i*B/R-30*i*B Mate/R-30*i*B Plus/R-30*i*B Mate Plus CONTROLLER OPERATOR'S MANUAL (Alarm Code List)(B-83284EN-1)** **or R-30*i*A/R-30*i*A Mate CONTROLLER OPERATOR'S MANUAL (Alarm Code List)(B-83124EN-6)** **or R-J3*i*B CONTROLLER SPOT TOOL OPERATOR'S MANUAL(B-81464EN-1)** **or R-J3*i*B CONTROLLER HANDLING TOOL OPERATOR'S MANUAL(B-81464EN-2)** **or R-J3*i*B CONTROLLER SEALING TOOL OPERATOR'S MANUAL(B-81464EN-3)"**

2.1.2 Periodic Checks 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 table No.
1 month 320h	3 months 960h	1 year 3840h	1.5 years 5760h	3 years 11520h	4 years 15360h			
○ Only 1st check	○					Cleaning the controller ventilation system	Check whether dust is accumulated in the controller ventilation system. Remove them if any.	18
	○					Check the external damage or peeling paint	Check whether the robot has external damage or peeling paint due to the interference with the peripheral equipment. If an interference occurs, 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 damages of the cable protective sleeves	Check whether the cable protective sleeves of the mechanical unit cable have holes or tears. If damage is found, replace the cable protective sleeve. If the cable protective sleeve is damaged due to the interference with peripheral equipment, eliminate the cause. **⇒"2.2.3 Check the Mechanical Unit Cables and Connectors"**	2
	○					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.	3
	○ Only 1st check	○				Check for damages to the teach pendant cable, the operation box connection cable or the robot connection cable	Check whether the cables connected to the teach pendant, operation box and robot are unevenly twisted or damaged. If damage is found, replace the damaged cables.	17
	○ Only 1st check	○				Check for damage to the mechanical unit cable (movable part)	Observe the movable part of the mechanical unit cable, and check for damage. Also, check whether the cables are excessively bent or unevenly twisted. **⇒"2.2.3 Check the Mechanical Unit Cable and Connectors"**	4
	○ Only 1st check	○				Check for damage to the end effector (hand) cable	Check whether the end effector cables are unevenly twisted or damaged. If damage is found, replace the damaged cables.	5
	○ Only 1st check	○				Check the connection of each axis motor and other exposed connectors	Check the connection of each axis motor and other exposed connectors. **⇒"2.2.3 Check the Mechanical Unit Cable and Connectors"**	6
	○ Only 1st check	○				Retightening the end effector mounting bolts	Retighten the end effector mounting bolts. Refer to the following section for tightening torque information: **⇒"9.3 END EFFECTOR INSTALLATION TO WRIST"**	7

Check and maintenance intervals (Period, Accumulated operating time)						Check and maintenance item	Check points, management and maintenance method	Periodic maintenance table No.
1 month 320h	3 months 960h	1 year 3840h	1.5 years 5760h	3 years 11520h	4 years 15360h			
	○ Only 1st check	○				Retightening the external main bolts	Retighten the bolts which are installed, removed in the inspection, and exposed. Refer to the recommended bolt tightening torque guidelines at the end of the manual. Some bolts are attached with adhesive. If the bolts are tightened with torque greater than the recommended one, the adhesive might be removed. Therefore, follow the recommended bolt tightening torque guidelines when retightening the bolts.	8
	○ Only 1st check	○				Check the fixed mechanical stopper and the adjustable mechanical stopper	Check that there is no evidence of a collision on the fixed mechanical stopper, the adjustable mechanical stopper, and check that the stopper mounting bolts are not loose. **⇒"2.2.4 Check of Fixed Mechanical Stopper and Adjustable Mechanical Stopper"**	9
	○ 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, and the cable protective sleeve).	10
			○			Replacing the mechanical unit batteries	Replace the mechanical unit batteries. Regardless of operating time, replace batteries at 1.5 years. **⇒"3.2 REPLACING THE BATTERIES"**	11
				○		Replacing the grease of drive mechanism	Replace the grease of each axis reducer and gearbox **⇒"3.1 REPLACING GREASE OF THE DRIVE MECHANISM"**	12 to 15
					○	Replacing the mechanical unit cable	Replace the mechanical unit cable. Contact your local FANUC representative for information regarding replacing the cable.	16
					○	Replacing the controller batteries	Replace the controller batteries. Regardless of operating time, replace batteries at 4 years. **⇒Refer to "Chapter 7 Replacing batteries of R-30*i*B/R-30*i*B Plus CONTROLLER MAINTENANCE MANUAL (B-83195EN) R-30*i*A CONTROLLER MAINTENANCE MANUAL (B-82595EN) R-30*i*A CONTROLLER MAINTENANCE MANUAL (For Europe)(B-82595EN-1) R-30*i*A CONTROLLER MAINTENANCE MANUAL (For RIA)(B-82595EN-2) or R-J3*i*B CONTROLLER MAINTENANCE MANUAL (B-81465EN) or R-J3*i*B CONTROLLER MAINTENANCE MANUAL (For Europe) (B-81465EN-1) or R-J3*i*B CONTROLLER MAINTENANCE MANUAL(For RIA) (B-81505EN)"**	19

2.2 CHECK POINTS

2.2.1 Confirmation of Oil Seepage

Check items

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

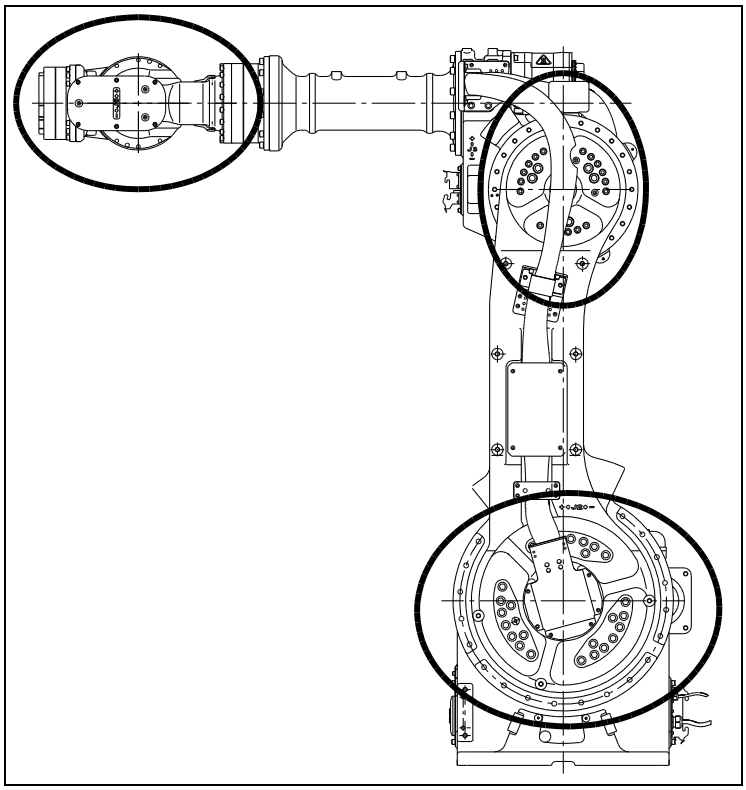


Fig. 2.2.1 (a) Check parts of oil seepage

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 outlet. (When opening the grease outlet, refer to Subsection 3.1 and ensure that grease is not expelled onto the machine or tooling.)

> ⚠ **WARNING**
> Hot grease might eject suddenly when you open the grease outlet. Attach bags for collecting grease, and use appropriate protective equipment such as heat-resistant gloves, protective glasses, a face shield, or a body suit if necessary.

- If you must wipe oil frequently, and opening the grease outlet does not stop the seepage, perform the measures below.
  ⇒" 4.1 TROUBLESHOOTING" (Symptom : Grease leakage)

2.2.2 Confirmation of the Air Control Set (option)

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

Item	Check items	Check points
1	Air pressure	Check the air pressure using the pressure gauge on the air regulator as shown in Fig. 2.2.2 (a). If it does not meet the specified pressure of 0.49 to 0.69 MPa (5-7 kgf/cm^2), adjust it using the regulator pressure-setting handle.
2	Lubricator oil mist quantity	Check the number of oil drops during operation. If it does not meet the specified value (1 drop/10-20 sec), adjust it using the lubricator control knob. The lubricator becomes empty in about 10 to 20 days under normal operation.
3	Lubricator oil level	Check to see that the air control set oil level is within the specified level.
4	Leakage from hose	Check the joints, tubes, etc. for leaks. Retighten the joints or replace parts, as required.
5	Drain	Check drain and release it. If the quantity of the drained liquid is significant, examine the setting of the air dryer on the air supply side.

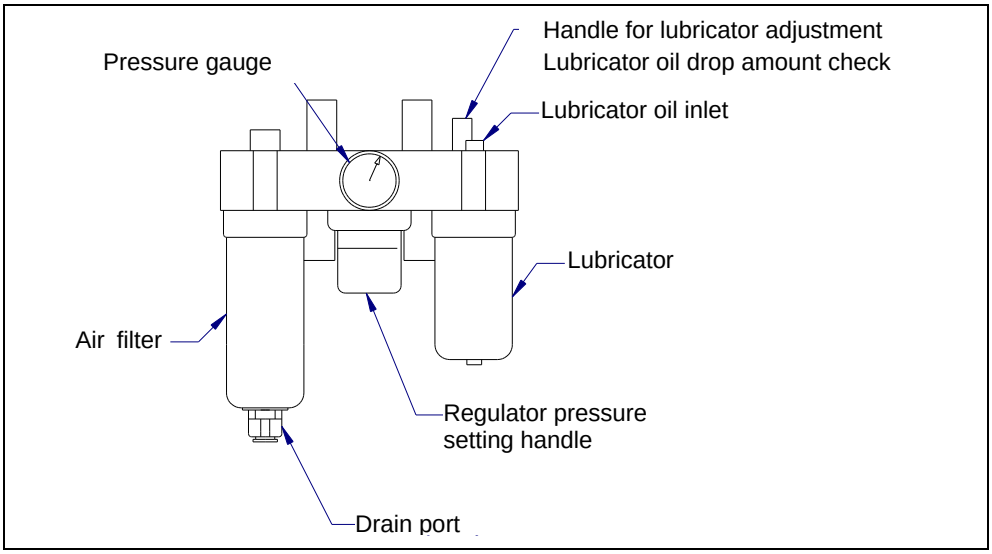


Fig. 2.2.2 (a) Air control set (option)

2.2.3 Check the Mechanical Unit Cables and Connectors

Check points of the mechanical unit cables

Fixed part cables can interfere with the J2, and J3 movable parts and peripheral equipment.

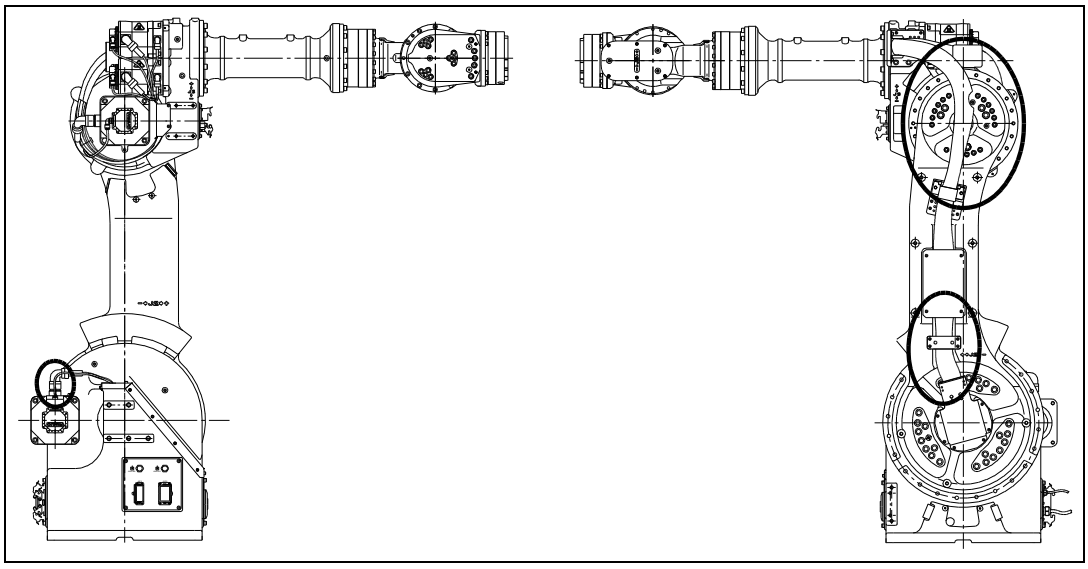


Fig. 2.2.3 (a) Inspection points of the mechanical unit cables

Check items

＜Cable protective sleeve＞

- Check that no holes or tears exist on the cable protective sleeve.
- If there is damage as shown in Fig. 2.2.3 (b), replace the cable protective sleeves.

Fig. 2.2.3 (b) Damage on the cable protective sleeve

＜Cables＞

- Check that there is no wear or damage on the coating.
- If the inside wire strands are exposed due to wear or damage, replace the cables.

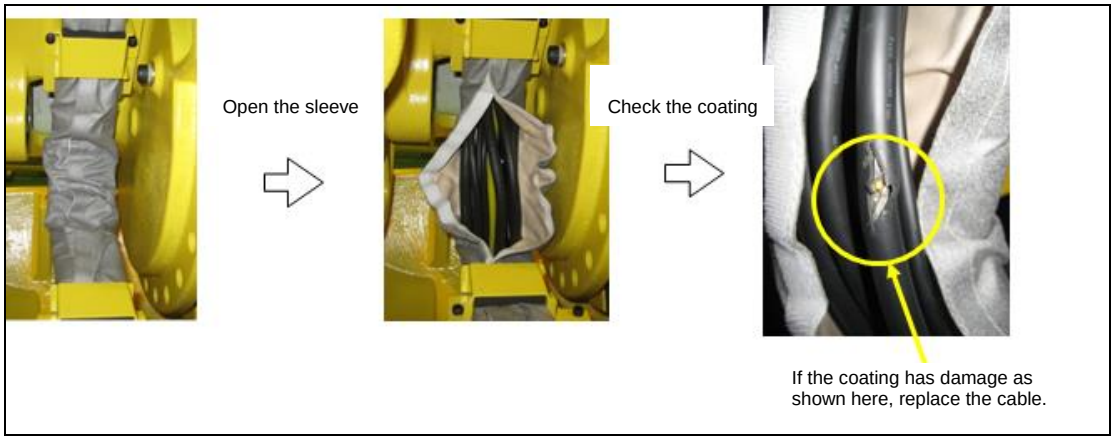


Fig. 2.2.3 (c) Cable check method

Inspection points of the connectors

- Power/brake connectors of the motor exposed externally
- Robot connection cables, earth terminal and user cables

Check items

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

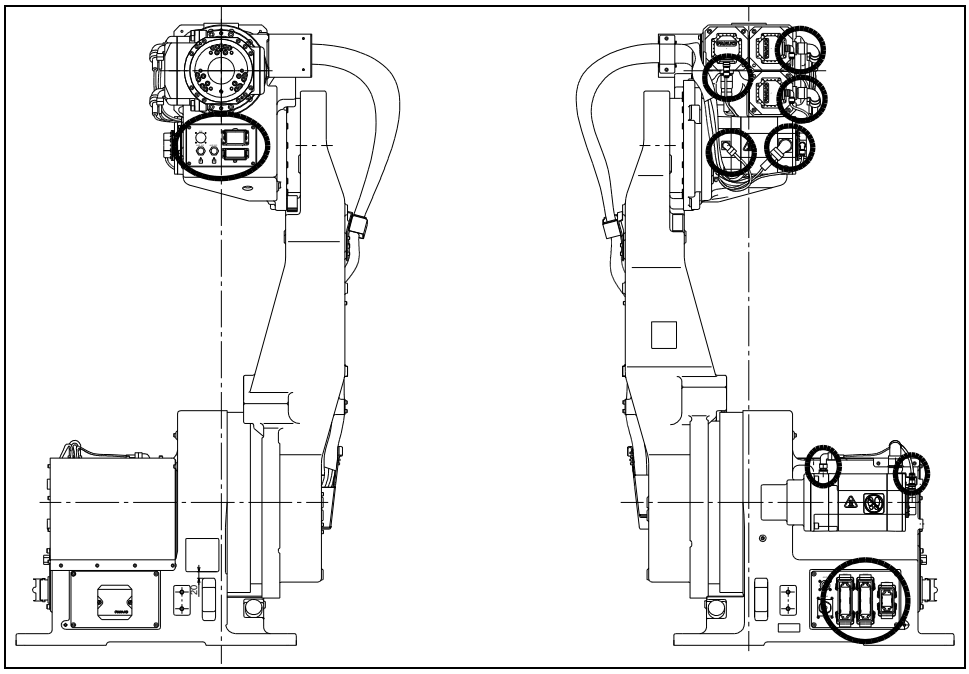


Fig. 2.2.3 (d) Connector Inspection points

2.2.4 Check of Fixed Mechanical Stopper and Adjustable Mechanical Stopper

- Check that there is no evidence of a collision on the mechanical stopper and the adjustable mechanical stopper. If there is evidence of a collision on the stopper, replace the parts.
- Check the tightness of the stopper mounting bolts. If they are loose, retighten them.
- Refer to Subsection 5.1.3 for details regarding the adjustable mechanical stopper.

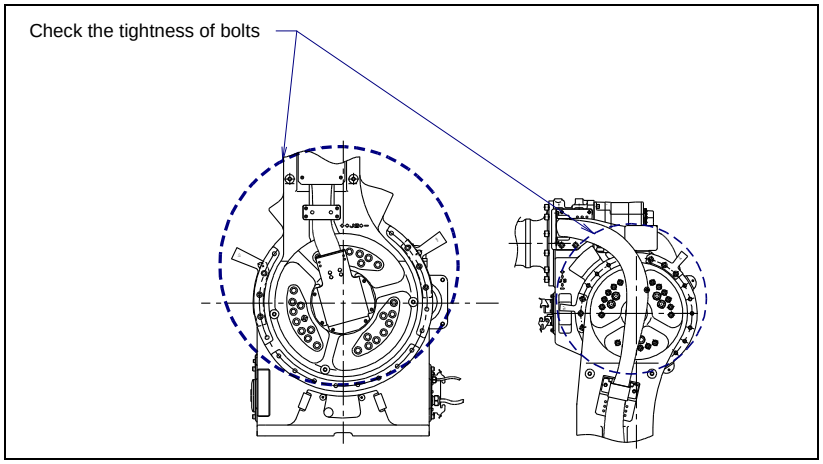


Fig. 2.2.4 (a) Check of fixed mechanical stopper and adjustable mechanical stopper

3 PERIODIC MAINTENANCE

3.1 REPLACING GREASE OF THE DRIVE MECHANISM

According to below, replace the grease of the J2, J3-axis reducer, J4-axis gearbox and the wrist at the intervals based on every 3 years or 11520 hours, whichever comes first. See Table 3.1 (a) for the grease name and the quantity.

Table 3.1 (a) Grease for 3-year periodical replacement

Supply position	Grease name	Quantity	Gun tip pressure
J2-axis reducer	Spec.: A98L-0040-0174	12400g (13950ml)	0.15 MPa or less (NOTE)
J3-axis reducer		2160g (2440ml)	
J4-axis gearbox		1440g (1620ml)	
Wrist 1		3500g (4000ml)	
Wrist 2		350g (400ml)	

NOTE
When a manual pump is used for greasing, the standard rate is two pumping cycles per three seconds.

⚠ WARNING
Hot grease might eject suddenly when you open the grease outlet. Attach bags for collecting grease, and use appropriate protective equipment such as heat-resistant gloves, protective glasses, a face shield, or a body suit if necessary.

For grease replacement or replenishment, use the postures indicated below.

Table 3.1 (b) Postures for greasing (Ceiling mount)

Supply position	Posture				
	J2	J3	J4	J5	J6
J2-axis reducer	−90°	Arbitrary	Arbitrary	Arbitrary	Arbitrary
J3-axis reducer	0°	+180°			
J4-axis gearbox	Arbitrary				
Wrist			0°	0°	0°

Table 3.1 (c) Postures for greasing (Wall mount)

Supply position	Posture				
	J2	J3	J4	J5	J6
J2-axis reducer	0°	Arbitrary	Arbitrary	Arbitrary	Arbitrary
J3-axis reducer		+90°			
J4-axis gearbox	Arbitrary				
Wrist			0°	0°	0°

NOTE
When removing (or attaching) the cap of the grease nipple of the J2-axis reducer grease inlet, use a tool such as long-nose pliers and lightly hold the cap.

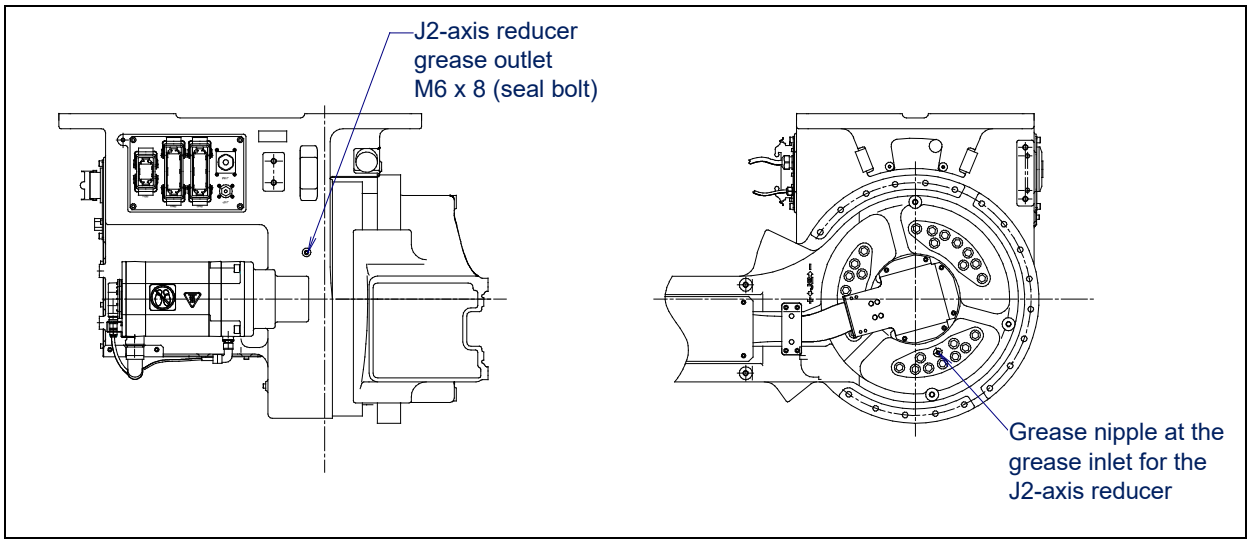


Fig. 3.1 (a) Replacing grease of J2-axis reducer (on ceiling mount)

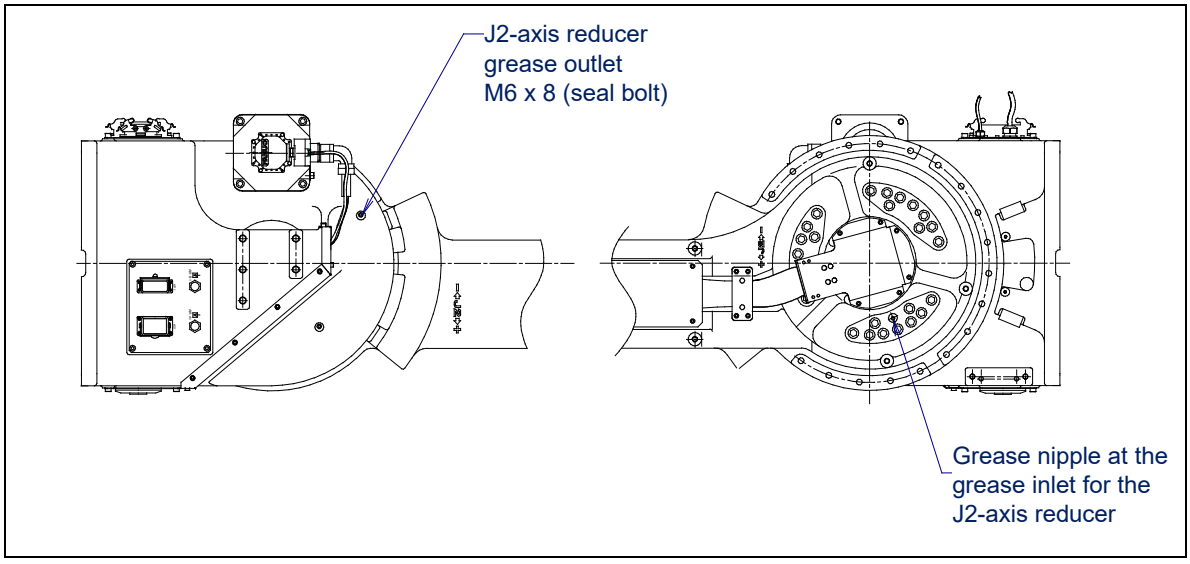


Fig. 3.1 (b) Replacing grease of J2-axis reducer (on wall mount)

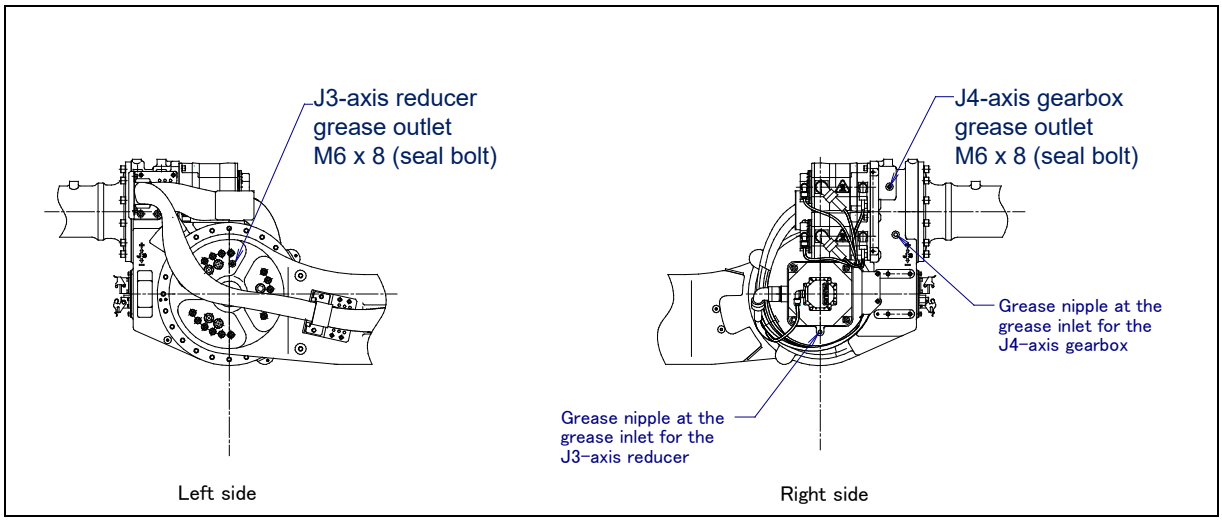


Fig. 3.1 (c) Replacing grease of J3-axis reducer and J4-axis gearbox (on ceiling/wall mount)

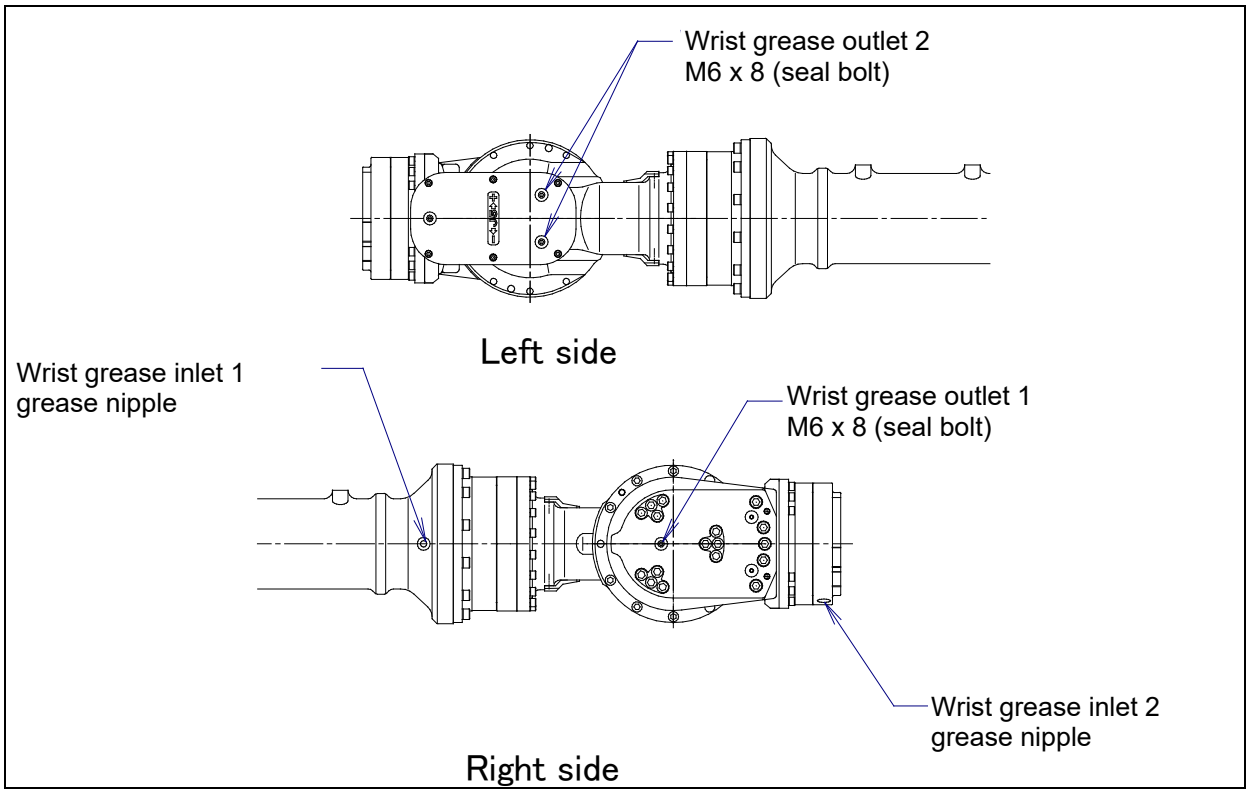


Fig. 3.1 (d) Replacing grease of wrist

3.1.1 Grease Replacement Procedure for the J2/J3-axis reducer and J4-Axis Gearbox

1 Move the robot to the greasing posture described in Table 3.1 (b) and (c).
2 Turn off controller power.
3 Remove the seal bolt from the grease outlet.
4 Supply new grease until new grease is output from the grease outlet.
5 After applying grease, release remaining pressure within the grease bath as described in the procedure in Subsection 3.1.3.

NOTE
The position of the grease outlet of the J2-axis gearbox varies depending on the robot installation angle.

3.1.2 Grease Replacement Procedure for the Wrist

1 Move the robot to the greasing posture described in table 3.1 (b) and (c).
2 Turn off controller power.
3 Remove the seal bolt from wrist grease outlet 1.
4 Supply new grease through the wrist grease inlet 1 until new grease is output from wrist grease outlet 1.
5 Attach the seal bolt onto wrist grease outlet 1. When reusing the seal bolt, be sure to seal the seal bolt with seal tape.
6 Remove the seal bolt from wrist grease outlet 2.
7 Supply new grease through the wrist grease inlet 2 until new grease is output from wrist grease outlet 2.
8 After applying grease, release remaining pressure within the grease bath as described in the procedure in Subsection 3.1.3.

⚠ CAUTION

Failure to follow proper greasing 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 Before starting to grease, remove the seal bolts of the grease outlet to allow the grease to come out.
2 Supply grease slowly, using a manual pump.
3 Whenever possible, avoid using an air pump, which is powered by the factory air supply.
If the use of an air pump is unavoidable, supply grease with the pump at a pressure lower than or equal to the gun tip pressure (see Table 3.1 (a)).
4 Use specified grease. Use of non-approved grease may damage the reducer or lead to other problems.
5 After greasing, release remaining pressure from the grease bath using the procedure given in Subsection 3.1.3, and then close the grease outlet.
6 To prevent slipping accidents and catching fire, completely remove all any excess grease from the floor or robot.

3.1.3 Procedure for Releasing Remaining pressure from the Grease Bath

Release remaining pressure as described below.
Under the grease inlets and outlets, attach bags for collecting grease so that grease does not spatter when it comes out of the inlets or outlets.

Grease replacement position	Motion angle	OVR	Operating time	Open point
J2-axis reducer	90° or more	50%	20 minutes	A
J3-axis reducer	70° or more	50%	20 minutes	A
J4-axis gearbox	J4 : 60° or more J5 : 120° or more J6 : 60° or more	100%	20 minutes	B
Wrist	J4 : 60° or more J5 : 120° or more J6 : 60° or more	100%	10 minutes	C

In the case of A
Open the grease inlets and outlets and perform continuous operation.

In the case of B
Open the grease outlets only and perform continuous operation.

In the case of C
Open all of the grease inlets and outlets shown below and perform continuous operation.

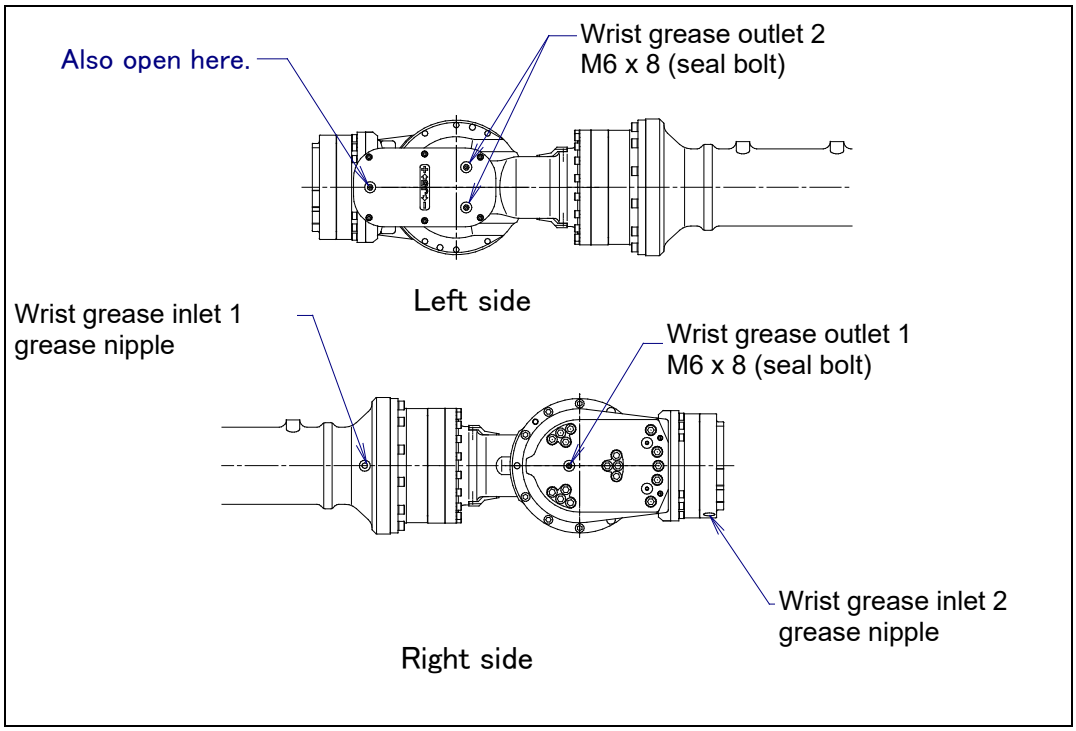


Fig. 3.1.3 (a) Open points for releasing remaining pressure from the wrist

If the above operation cannot be performed due to the environment of the robot, adjust the operating time according to the operating angle. (If only half of the predetermined motion angle can be set, perform an operation for a period of time twice as long as the specified time.) After completion of the operation, attach the seal bolts and grease nipples to the grease inlets and outlets. When reusing the seal bolts and grease nipples, be sure to seal them with seal tape.

3.2 REPLACING THE BATTERIES

The position data of each axis is preserved by the backup batteries. The batteries need to be replaced every 1.5 year. Also use the following procedure to replace the batteries when the backup battery voltage drop alarm occurs.

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

> **⚠ CAUTION**
> Be sure to keep controller power turned 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.
3 Take out the old batteries from the battery case.
4 Insert new batteries into the battery case. Pay attention to the direction of batteries.
5 Close the battery case cap.

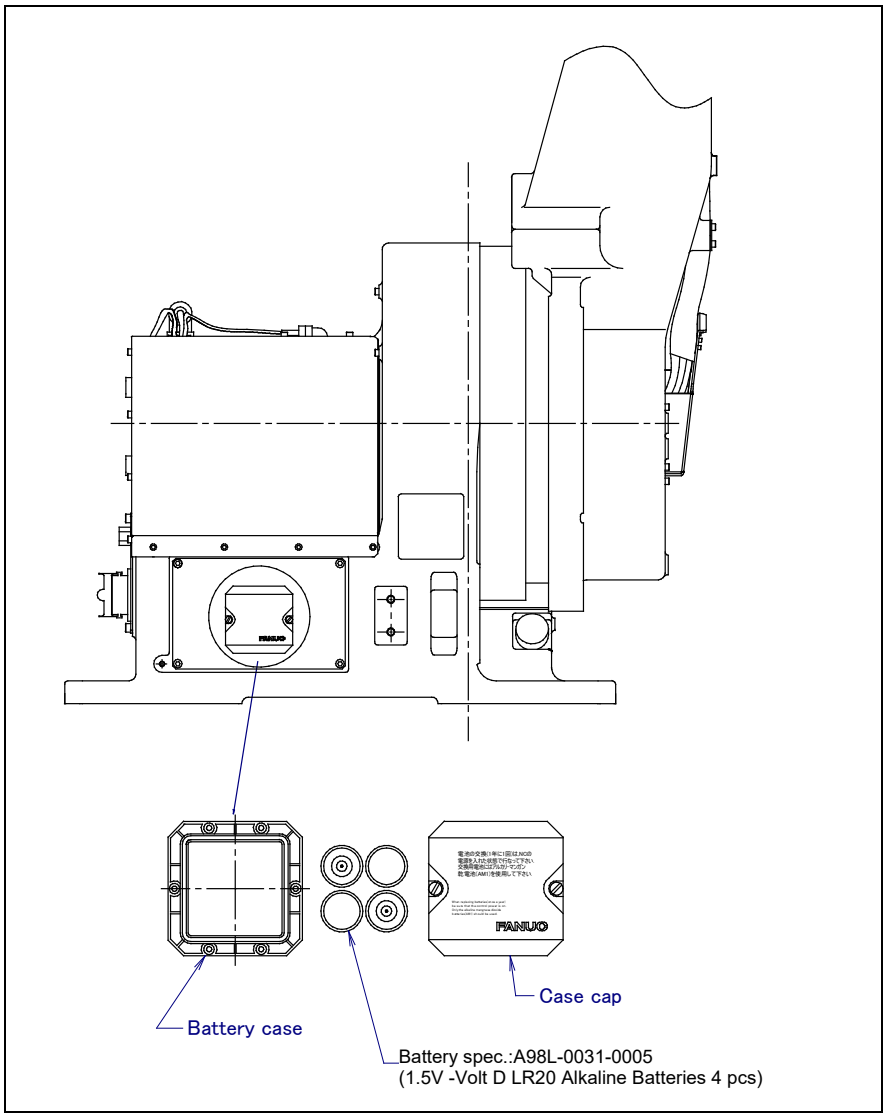


Fig. 3.2 (a) Replacing batteries

4 TROUBLESHOOTING

The source of mechanical unit problems may be difficult to be identified 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.

4.1 TROUBLESHOOTING

Table 4.1(a) shows the major troubleshooting symptoms that may occur in the mechanical unit and their probable causes. If you cannot pinpoint a failure cause or which measures to take, contact your local FANUC representative. For troubleshooting except the mechanical unit, refer to “CONTROLLER MAINTENANCE MANUAL (B-83195EN etc.)” and Alarm Code List (B-83284EN-1) etc.

Table 4.1 (a) Troubleshooting

Symptom	Description	Cause	Measure
Vibration Noise	- As the robot operates, the J2 base lifts off the J1-axis traveling unit. - There is a gap between the J2 base and J1-axis traveling unit. - The J2 base retaining bolt is loose.	[J2 base fastening] - The J2 base of the robot may not be fastened to the J1-axis traveling unit. - There may be a loose bolt, an insufficient degree of surface flatness of the J1-axis traveling unit, or foreign material caught between the base and unit. - If the J2 base of the robot is not fastened to the J1-axis traveling unit, the J2 base lifts off the J1-axis traveling unit as the robot operates, generating impact which, in turn, leads to vibration.	- If any bolt is loose, use a threadlocker and tighten the bolt securely to the appropriate torque. - Adjust the surface flatness of the J1-axis traveling unit to within the specified tolerance. - Check for any foreign material between the base and unit, and remove it if any. - Apply adhesive between the J2 base and J1 unit.
	- As the robot operates, the J1-axis traveling unit or rail vibrates.	[J1-axis traveling unit or rail] - The J1-axis traveling unit or rail may not be rigid enough. - If the J1-axis traveling unit or rail is not rigid enough, reaction during robot operation can deform the J1-axis traveling unit or rail, which can lead to vibration.	- Reinforce the J1-axis traveling unit or rail to make it more rigid. - If it is impossible to reinforce the J1-axis traveling unit or rail, modifying the robot control program can reduce 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.	- 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 or noise was first noticed after the robot collided with an object or the robot was overloaded for a long period. - The grease of the vibrating or noise occurring axis has not been exchanged for a long period. - Cyclical vibration and noise occur.	[Gear, bearing, or reducer] - It is likely that collision or overload applied an excessive force on the drive mechanism, thus damaging the gear tooth surface or rolling surface of a bearing, or reducer. - Prolonged overloaded use may cause fretting fatigue on the gear tooth surface or the rolling surface of bearing and reducer. - 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 cause vibration. - It is likely that, because the grease has not been changed 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. - Find the source of the vibration while referring to the drive mechanism drawing of each axis given in the related maintenance manual. - Remove the motor, and check whether there are any fretting on a gear tooth surface. If any fretting is found, replace the gear. Note) Even a small amount of damage on a gear tooth surface can generate a large amount of noise. Therefore, it is necessary to check each gear tooth surface carefully. - Check whether any other gear in the drive mechanism is abnormal. If all the gears are found to be satisfactory, the reducer must be replaced. - If there is foreign material caught in a gear, or if a gear tooth is missing, replace the gear. Also, remove all the grease from the gearbox and wash the inside of the gearbox. - After replacing the gear or reducer, add an appropriate amount of grease. - If nothing changes after a gear or reducer is replaced, it is likely that a bearing is damaged. - Using the robot within its maximum rating prevents problems with the drive mechanism. - Using the specified grease at the recommended interval will prevent problems.
	- There is an unusual sound after replacement of grease. - There is an unusual sound after a long period of time. - There is an unusual sound during operation at low speed.	- There may be an unusual sound when using other than the specified grease. - Even for the specified grease, there may be an unusual sound during operation at low speed immediately after replacement or after a long period of time.	- Use the specified grease. - When there is an unusual sound even for specified grease, perform operation for one or two days on an experiment. Generally, an usual sound will disappear.

Symptom	Description	Cause	Measure
Vibration Noise (Continued)	- The cause of problem cannot be identified from examination of the J1-axis rail unit, rail, or mechanical section.	[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. - Pulsecoder defect may be the cause of the vibration as the motor cannot propagate the accurate position to the controller. - 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 supply cable is about to be snapped, vibration might occur. - If the power source voltage drops below the rating, vibration might occur. - It may vibrate when an invalid value parameter was set.	- 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 a cable in the mechanical unit is broken. - Shake the movable part cable while the robot is at rest, and check whether an alarm occurs. If an alarm or any other abnormal condition occurs, replace the mechanical unit cable. - Check whether the 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 it. Contact FANUC for further information if necessary.

Symptom	Description	Cause	Measure
Vibration Noise (Continued)	- 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 is 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.
	- There is an abnormal noise after replacing grease. - There is an abnormal noise after a long time. - There is an abnormal noise during operation at low speed.	- There may be an abnormal noise when using other than the specified grease. - Even for the specified grease, there may be an abnormal noise during operation at low speed immediately after replacement or after a long time.	- Use the specified grease. - When there is an abnormal noise even when using the specified grease, operate for one or two days as an experiment. Generally, any abnormal noise will disappear.
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 surface of the mechanical unit.	[Mechanical section coupling bolt] - It is likely that overloading or a collision has loosened a mounting bolt in the robot mechanical section.	- 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 - Reducer shaft retaining bolt - Base retaining bolt - Arm retaining bolt - Casting retaining bolt - End effector retaining bolt

Symptom	Description	Cause	Measure
Motor overheating	- The ambient temperature of the installation location increases, causing the motor to overheat. - After a cover was attached to the motor, the motor overheated. - After the robot control program or the load was changed, the motor overheated.	[Ambient temperature] - It is likely that a rise in the ambient temperature or attaching the motor cover prevented the motor from releasing heat efficiently, thus leading to overheating. [Operating condition] - It is likely that the robot was operated with the maximum average current exceeded.	- The teach pendant can be used to monitor the average current. Check the average current when the robot control program is running. The allowable average current is specified for the robot according to its ambient temperature. Contact FANUC for further information. - Relaxing the robot control program and conditions can reduce the average current, thus preventing overheating. - Reducing the ambient temperature is the most effective means of preventing overheating. - Having the surroundings of the motor well ventilated enables the motor to release heat efficiently, thus preventing overheating. Using a fan to direct air at the motor is also effective. - If there is a source of heat near the motor, it is advisable to install shielding to protect the motor from heat radiation.
	- After a control parameter was changed, the motor overheated.	[Parameter] - If data input for a workpiece is invalid, the robot cannot be accelerated or decelerated normally, so the average current increases, leading to overheating.	- As for load setting, Input an appropriate parameter referring to Section 9.5.
	- Symptom other than stated above	[Mechanical section 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.

Symptom	Description	Cause	Measure

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 collision.
		- An O-ring can be damaged if it is trapped 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.
		- Problems with the grease nipple or 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. Refer to the relevant parts manual for detailed descriptions of their replacement.
			  - Motor coupling section
			  - Reducer (case and shaft) coupling section
			  - Wrist coupling section
			  - J3 arm coupling section
			  - Inside the wrist
			- Oil seals are used in the locations stated below. Refer to the relevant parts manual for detailed descriptions of their replacement.
			  - J2-axis cable pipe joint
			  - Inside the reducer
			  - Inside the wrist
			- Seal bolts are used in the locations stated below. Refer to the relevant parts manual for detailed descriptions of their replacement.
			  - motor mounting section for J3-axis
			  - Grease drain outlet
			- Replace the grease nipple.

Dropping axis	- An axis falls because the brake went out.
	- An axis falls while standing still.
		[Brake drive relay and motor]
		- It is likely that brake drive relays are stuck to each other and keep the brake current flowing, thus preventing the brake from operating when the motor is reenergized.
		- 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 soak through the motor, causing the brake to slip.
			- Check whether the brake drive relays stuck each other or not. If they are found to be stuck, replace the relay.
			- Replace the motor confirmed following symptoms.
			  - Brake shoe is worn out
			  - Brake main body is damaged
			  - Grease or oil soak through the motor

Symptom	Description	Cause	Measure
Displacement	- 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, and so on. - If the repeatability is stable, it is likely that collision by an excessive load caused slip on the mounting face of each axis arm, and 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 "ACC (value)". ・ 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.
		- Angle of robot mounting surface is not set correctly.	- According to "Angle of Mounting Surface Setting", set the angle of robot mounting surface correctly.
BZAL alarm occurred	- BZAL is displayed on the teach pendant 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.

5 ADJUSTMENTS

Each part of the mechanical unit is carefully adjusted at the factory before shipment. Therefore it is usually unnecessary for the customer to make adjustments at the time of delivery. However, after a long period of use or after parts are replaced, adjustments may be required.

5.1 AXIS LIMITS SETUP

Axis limits define the motion range of the robot. The operating range of the robot axes can be restricted because of:

- Work area limitations
- Tooling and fixture interference points
- Cable and hose lengths

There are three methods used to prevent the robot from going beyond the necessary motion range. These are

- Axis limit by DCS (All axes (option))(R-2000*i*B/200T only)
- Axis limit by adjustable mechanical stopper (J2, J3-axis (option))
- Axis limit by adjustable mechanical stopper and switches (J2, J3-axis (option))

> ⚠ **WARNING**
> 1 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.
> 2 For J2/J3-axis, use the adjustable mechanical stoppers or DCS function so that damage to peripheral equipment and injuries to human bodies can be avoided.
> 3 Mechanical stoppers are physical obstacles. For J2, J3-axis, it is possible to re-position the adjustable mechanical stoppers. But the robot cannot move beyond them. For J5 -axis, the mechanical stoppers are fixed. For the J4 and J6-axes, only DCS-specified limits are available.
> 4 For changing J2 andJ3-axes interference angles, only adjustable mechanical stoppers are available; DCS specified movable range cannot be changed.
> 5 Adjustable mechanical stoppers (J2 and J3-axes) are deformed in a collision to stop the robot. Once a stopper is subject to a collision, it can no longer assure its original strength and, therefore, may not stop the robot. When this happens, replace it with a new one.

Upper Limits

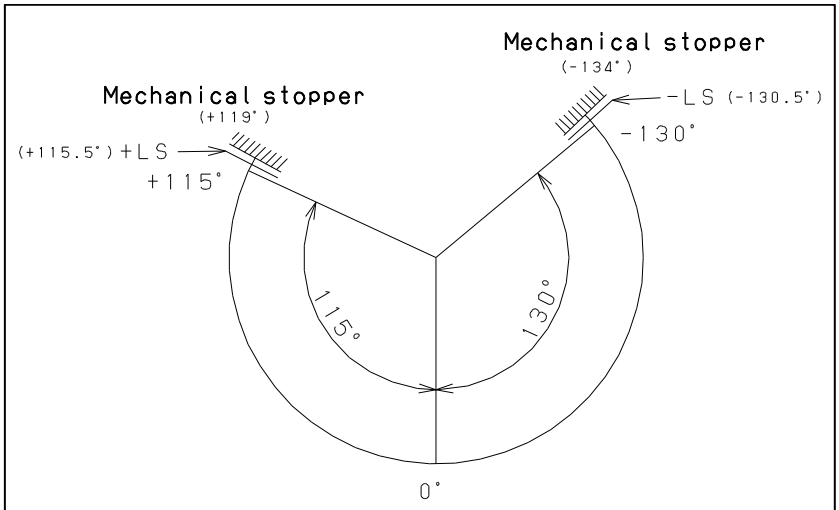
Displays the upper limits of each axis, or the axis limits in a positive direction.

Lower Limits

Displays the lower limits of each axis, or the axis limits in a negative direction.

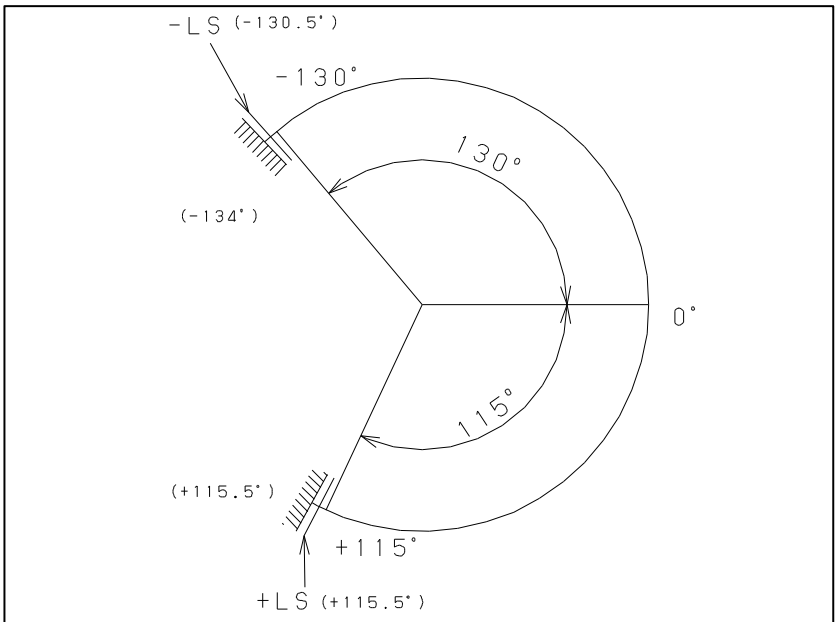
5.1.1 Zero Point Position and Motion Limit

Zero point and software motion limit are provided for each controlled axis. The robot cannot exceed the software motion limit unless there is a failure of the system causing loss of zero point position or there is a system error.
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.
Fig. 5.1.1 (a) to (h) show the zero point and motion limit, LS detection position, and mechanical stopper position of each axis.



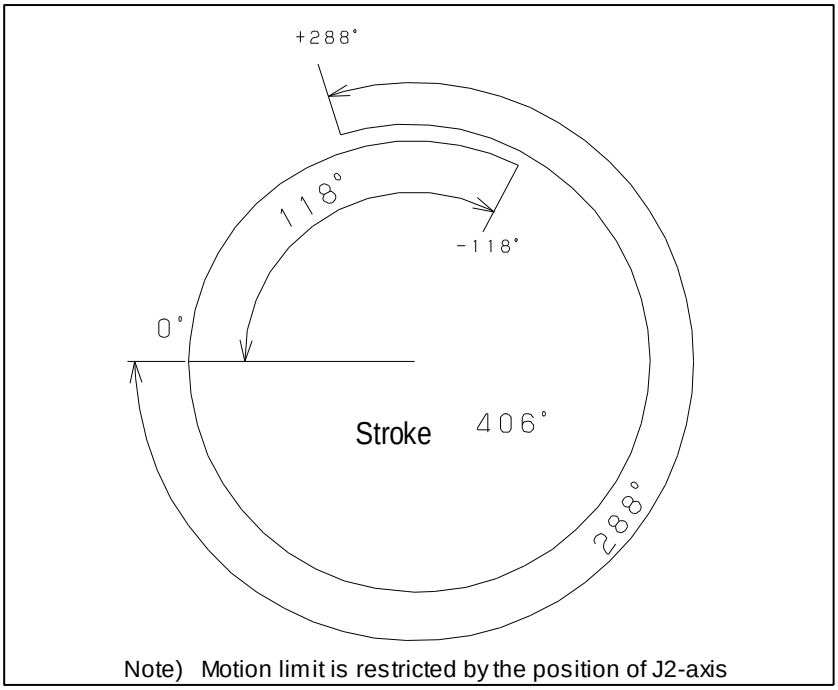
Note) The limit switch (LS) of J2-axis is an option.
Motion limit is restricted by the position of the J3-axis.

Fig. 5.1.1 (a) J2-axis (on ceiling mount)



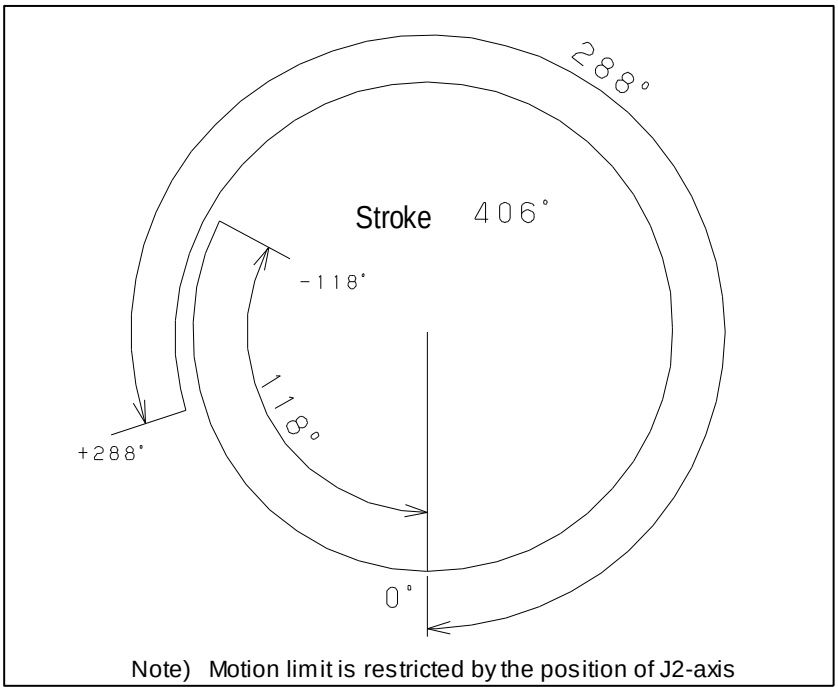
Note) The limit switch (LS) of J2-axis is an option.
Motion limit is restricted by the position of the J3-axis.

Fig. 5.1.1 (b) J2-axis (on wall mount)



Note) Motion limit is restricted by the position of J2-axis

Fig. 5.1.1 (c) J3-axis (on ceiling mount)



Note) Motion limit is restricted by the position of J2-axis

Fig. 5.1.1 (d) J3-axis (on wall mount)

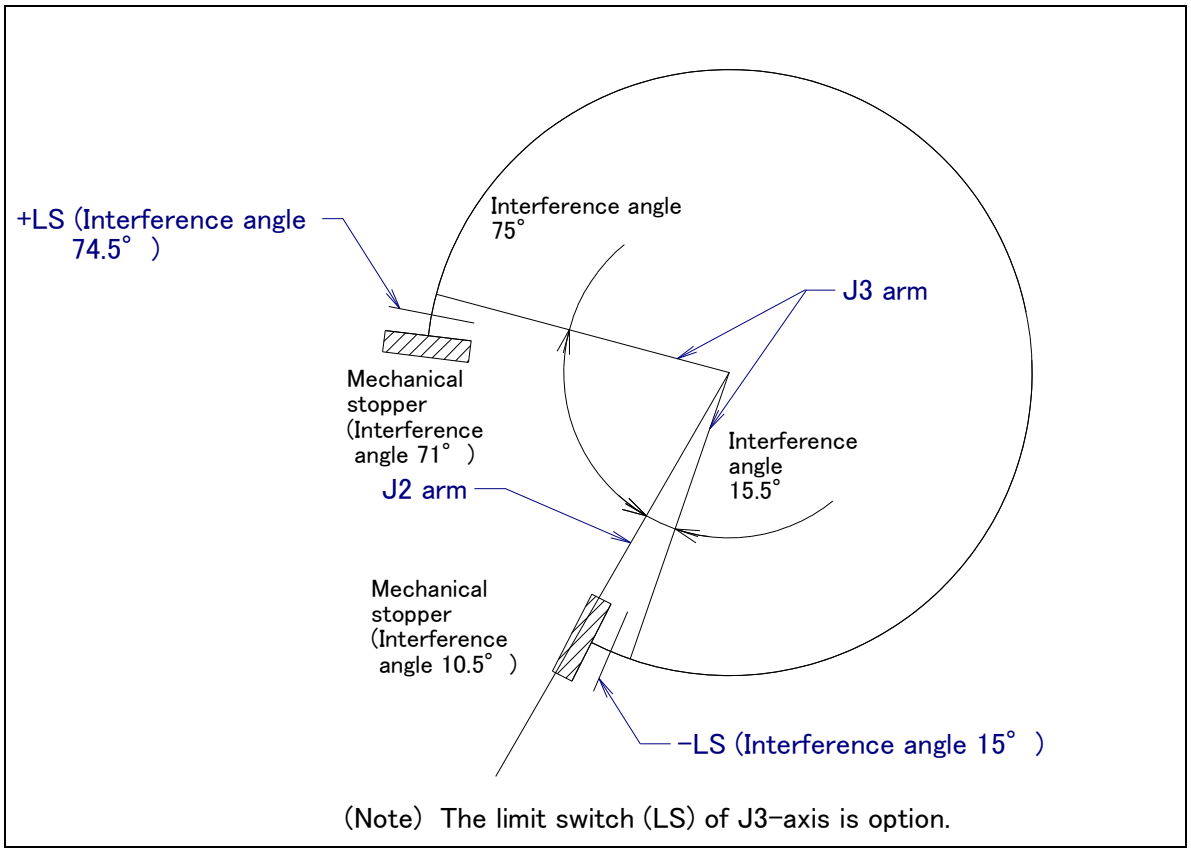


Fig. 5.1.1 (e) J2/J3-axis interference angle

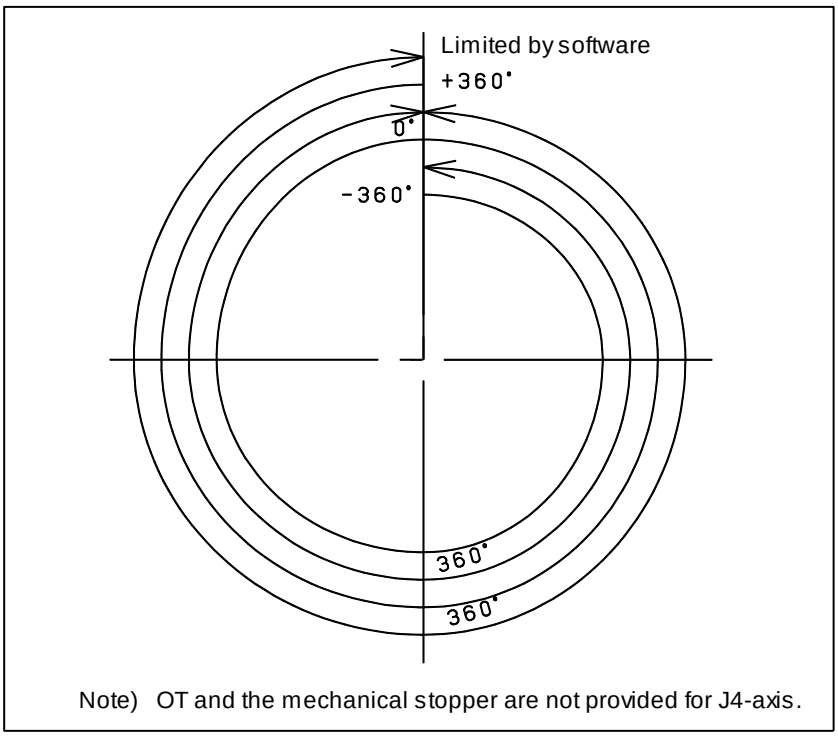


Fig. 5.1.1 (f) J4-axis

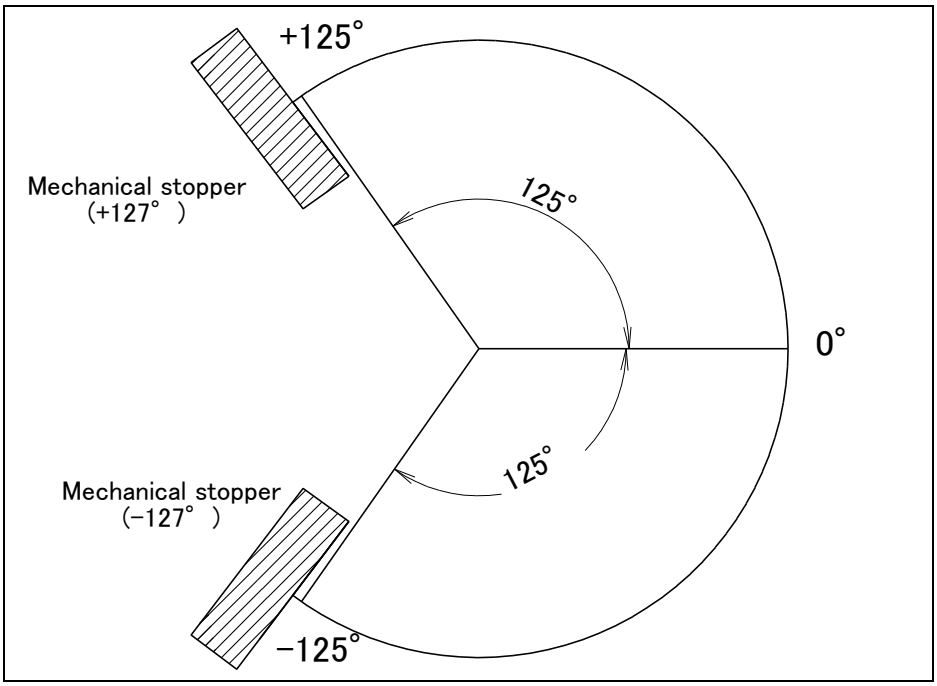


Fig. 5.1.1 (g) J5-axis

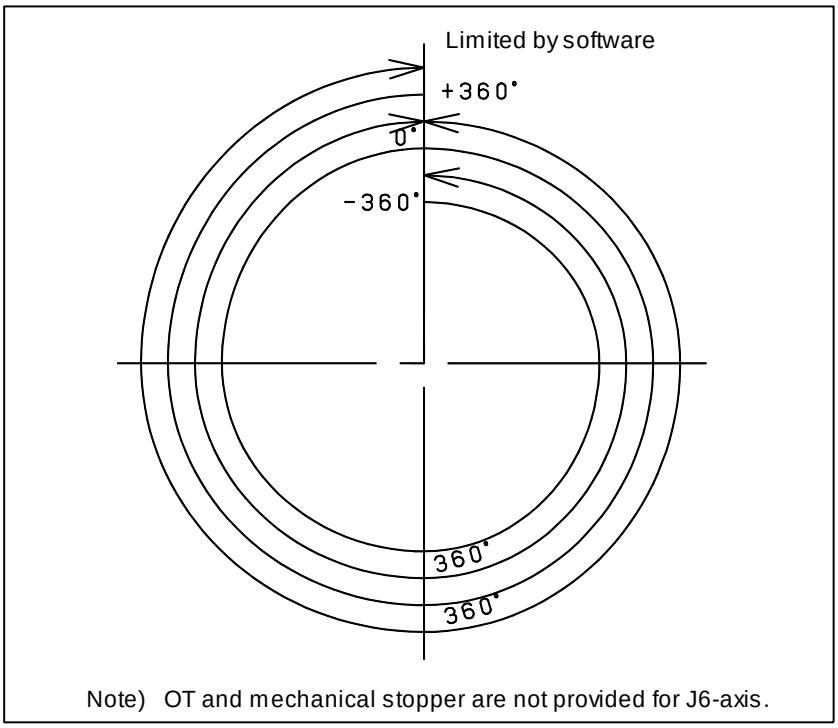


Fig. 5.1.1 (h) J6-axis

5.1.2 CHANGE AXIS LIMIT BY DCS (OPTION) (R-2000*i*B/200T only)

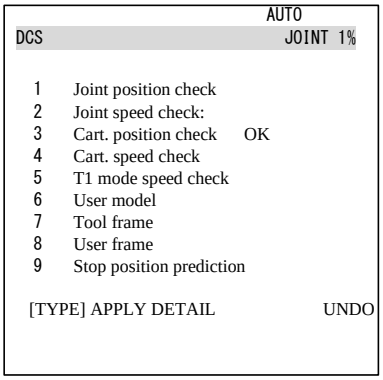
The robot motion can be restricted with DCS (Dual check safety) function by using the following software. For J2/J3-axis, the same effect as adjustable mechanical stopper described in Subsection 5.1.3 can be obtained. The robot motion can be restricted at any angle and position if it is in robot motion area. DCS functions are certified to meet the requirements of International Standard ISO13849-1 and IEC61508 approved by notified body. 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)

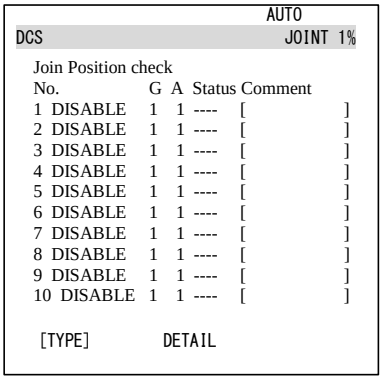
As an example, we shows the procedure to set ±30° for J2-axis in here. Refer to R-30*i*B/R-30*i*B Mate /R-30*i*B Plus/R-30*i*B Mate Plus/R-30*i*B Compact Plus/R-30*i*B Mini Plus Controller Dual check safety function Operator's Manual (B-83184EN) or R-30*i*A/R-30*i*A Mate Controller Dual check safety function Operator's Manual (B-83104EN) for details of other setting, function and DCS stop position prediction.

Setting procedure

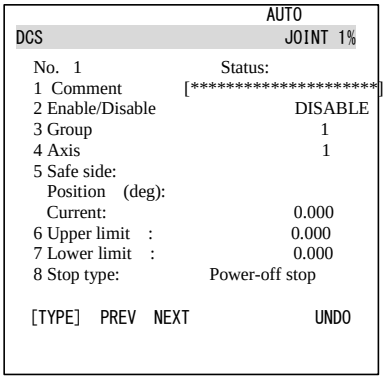
1 Press the [MENU] key to display the screen menu.
2 Press [0 NEXT] and press [6 SYSTEM].
3 Press the F1 ([TYPE]).
4 Select [DCS]. The following screen will be displayed.



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

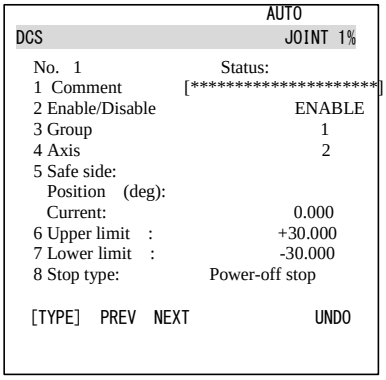


6 Move the cursor to [1], then press the [DETAIL].

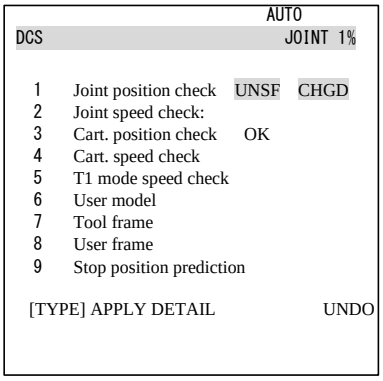


7 Move the cursor to [DISABLE], then press [CHOICE], set the status to [ENABLE].
8 Move the cursor to [Group], then input the robot group number, then press the [ENTER] key.
9 Move the cursor to [Axis], then input “2”, then press the [ENTER] key.
10 Move the cursor to [Upper limit] right side, then input “30”, then press the [ENTER] key.
11 Move the cursor to [Lower limit] right side, then input “-30”, then press the [ENTER] key.

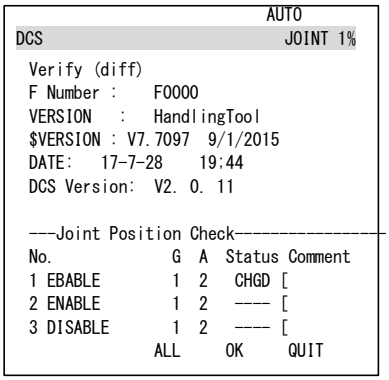
> ⚠ **WARNING**
> If only the operating space is set using Joint Position Check, the robot stops after it goes beyond the workspace. When the motor power is shut down, the robot’s momentum causes it to move some distance before it completely stops. The actual "Robot Stop Position" will be beyond the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



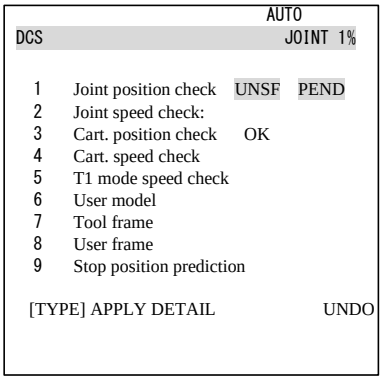
12 Press the [PREV] key two times, back to the first screen.



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.

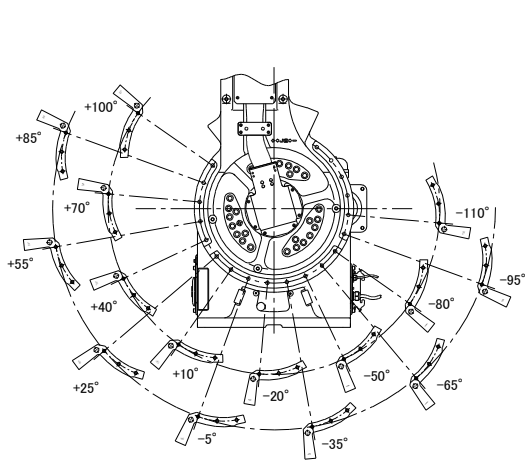
> ⚠ **WARNING**
> You must cycle the power of the controller to enable the new setting. If you fail to do so, the robot does not work normally and it may injure personnel or damage the equipment.

5.1.3 Adjustable Mechanical Stopper and Limit Switch Setting

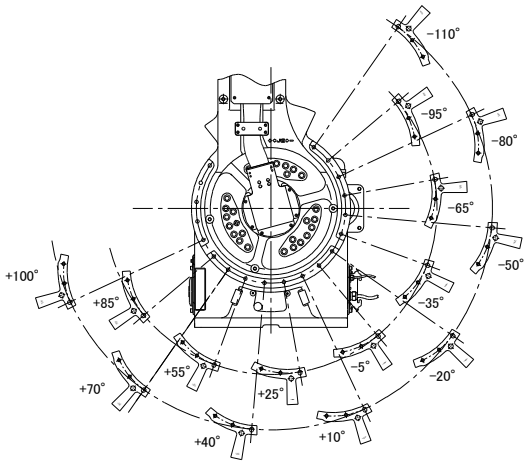
For the J2, and J3 axes, Adjustable mechanical stopper (option) can be installed in addition to standard mechanical stopper. It is possible to re-position adjustable mechanical stoppers. The limit switch-based adjustable range can be changed by changing the dog positions. Contact FANUC for the setting of the mechanical stopper.

Item		
J2 axis mechanical stopper	Upper limit	Settable in steps of 15° in the range of -110° to +100°. A mechanical stopper is also provided at the upper limit +115° of the standard movable range.
	Lower limit	Settable in steps of 15° in the range of -110° to +100°. A mechanical stopper is also provided at the lower limit -130° of the standard movable range.
	Space between the upper and lower limits	A space of 15° or more is required.
J2 axis limit switch	Upper limit	Settable in steps of 15° in the range of -110° to +100°. Also settable to the upper limit +115° of the standard movable range.
	Lower limit	Settable in steps of 15° in the range of -125° to +100°. Also settable to the lower limit -130° of the standard movable range.
	Space between the upper and lower limits	A space of 15° or more is required.
J3 axis (J2+J3) mechanical stopper	Upper limit	Settable in steps of 15° in the range of -45° to +180°. A mechanical stopper is also provided at the upper limit +195° of the standard movable range.
	Lower limit	Settable in steps of 15° in the range of -60° to +150°. A mechanical stopper is also provided at the lower limit -74.5° of the standard movable range.
	Space between the upper and lower limits	A space of 30° or more is required.
J3 axis (J2+J3) limit switch	Upper limit	Settable in steps of 15° in the range of -45° to +180°. Also settable to the upper limit +195° of the standard movable range.
	Lower limit	Settable in steps of 15° in the range of -60° to +165°. Also settable to the lower limit -74.5° of the standard movable range.
	Space between the upper and lower limits	A space of 30° or more is required.

NOTE
1 If the newly set operation range does not include 0°, you must change it zero degree mastering so that 0° is included.
2 When adjustable mechanical stopper (option) is ordered, mounting bolt is attached.
3 When motion range is changed by movable mechanical stopper, be sure to set the motion range of soft same refer to Subsection 5.1.4.



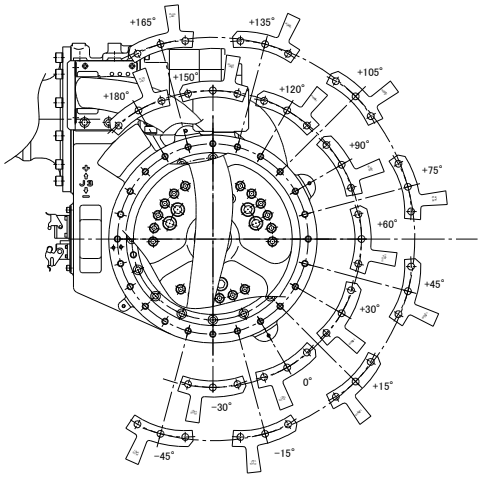
Mounting position of plus side stopper



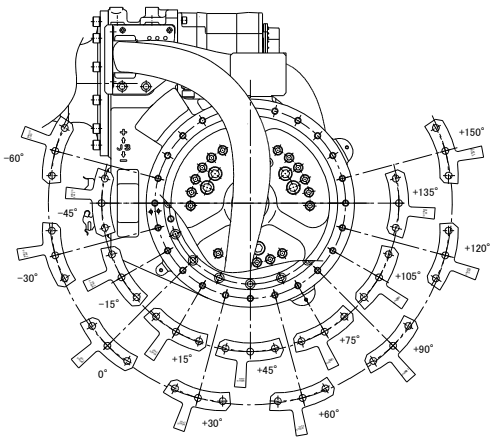
Mounting position of minus side stopper

(NOTE) J2−axis right view
A minimum space of 15° is required between plus side and minus side stopper.

Fig. 5.1.3 (a) Mounting of J2-axis mechanical stopper (option)



Mounting position of plus side stopper



Mounting position of minus side stopper

(NOTE) J3−axis left view
A minimum space of 30° is required between plus side and minus side stopper.

Fig. 5.1.3 (b) Mounting of J3-axis mechanical stopper (option)

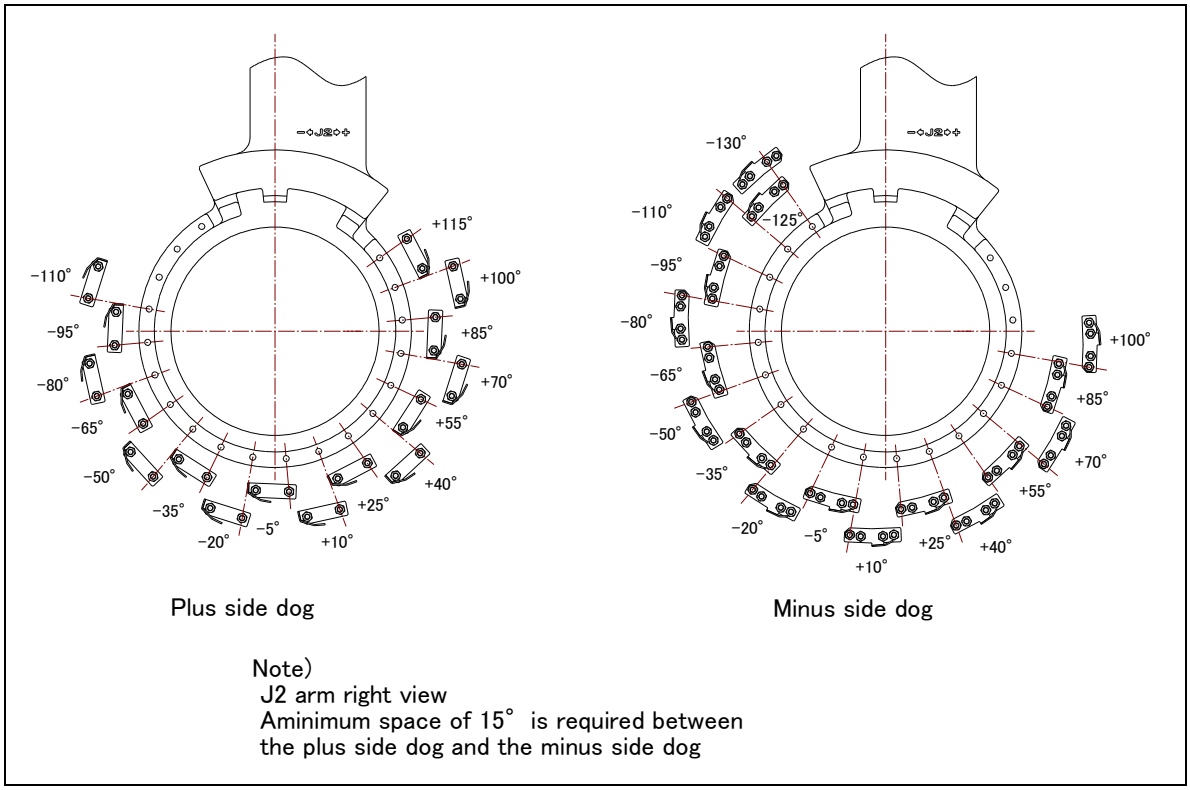


Fig. 5.1.3 (c) J2-axis dog (option) location

NOTE
When the J2-axis adjustable mechanical stoppers are used, the rear parts of the mechanical stoppers also function as the dogs for limit switches, so dogs need not be prepared separately.

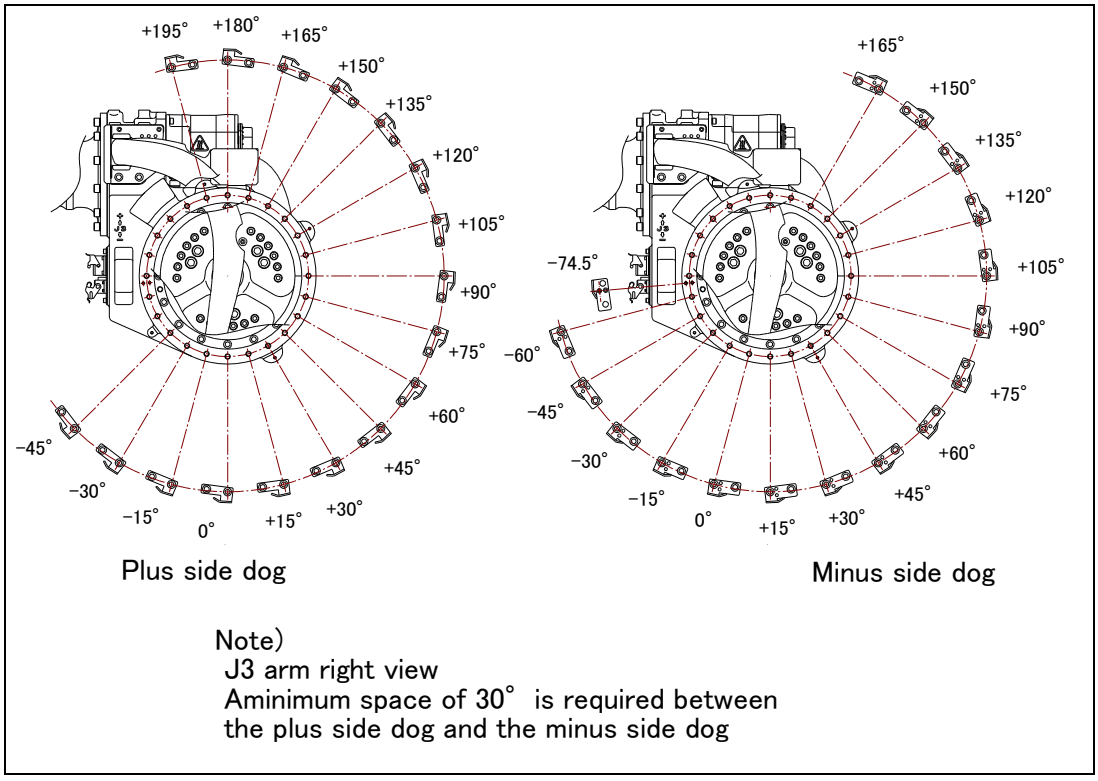
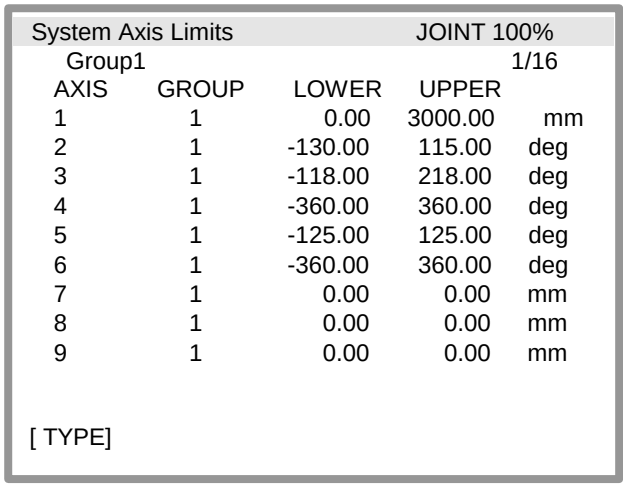


Fig. 5.1.3 (d) J3-axis dog (option) location

5.1.4 Changing the parameter setting

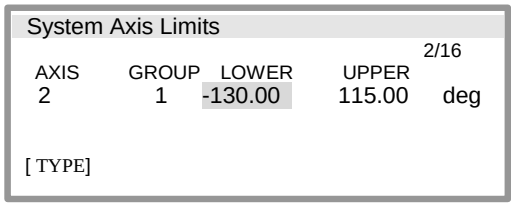
Setting procedure

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



NOTE
0.00 indicates the robot does not have these axes.

5 Move the cursor to the axis limit to be set. Type the new value using the numeric keys on the teach pendant. In this time, set the axial upper limit and the lower limit at the position same as adjustable mechanical stoppers are attached.



6 Turn off the controller and then turn it back on again in the cold start mode so the new information can be used.

⚠ WARNING
1 You must turn off the controller and then turn it back on to use the new information; otherwise, the old settings remain valid and could cause personnel injury or equipment damage.
2 After changing system variables, be sure to run the robot at a low speed and make sure that the robot stops at the ends of the stroke.
3 If a collision should occur, the adjustable mechanical stopper becomes deformed to absorb energy, so that the robot can stop safely. If the stopper is deformed by mistake, replace it.
4 Do not depend on parameter settings to control the motion range of your robot.

NOTE
For the stroke and mechanical stopper of the J1-axis traveling unit, contact the manufacturer of the traveling unit.

5.2 ADJUSTING LIMIT SWITCH (OPTION)

Axis limit switches are overtravel switches that, when tripped, cut power to the servo motors and an operation is stopped. Overtravel switches for J2-axis and J3-axis are optional.

ADJUSTING PROCEDURE

1 Set the $MOR_GRP.$CAL_DONE system parameter to FALSE. This disables the motion limit specified by the software. As a result, the operator can rotate the robot by a jog feed which goes beyond the motion limit.
2 Loosen the following bolts.
Bolts secure the J2-axis : two M6 x 10, two M4 x 25
Bolts secure the J3-axis : two M6 x 10, two M4 x 25
3 Move the limit switch so that the robot activates it at about 0.5 degrees before the stroke end. Step on the dog, and position the limit switch in such a place that only one of the step-on allowance indication lines at the tip of the switch is hidden.
4 When the limit switch operates and detects over travel (OT), the robot stops, and an error message, "OVERTRAVEL", is displayed. To restart the robot, hold on the [SHIFT] key and press the [RESET] key. Then, while holding on the [SHIFT] key, move the adjusting axis off the OT limit switch by jogging in joint mode.
5 Check that the robot also activates the limit switch when the robot is approx. 0.5 degrees from the opposite stroke end in the same way as above. If the limit switch does not operate at the position, adjust the position of the switch again.
6 Set the $MOR_GRP.$CAL_DONE system parameter to TRUE.
7 Turn off the controller power, then turn it on again to restart the controller.

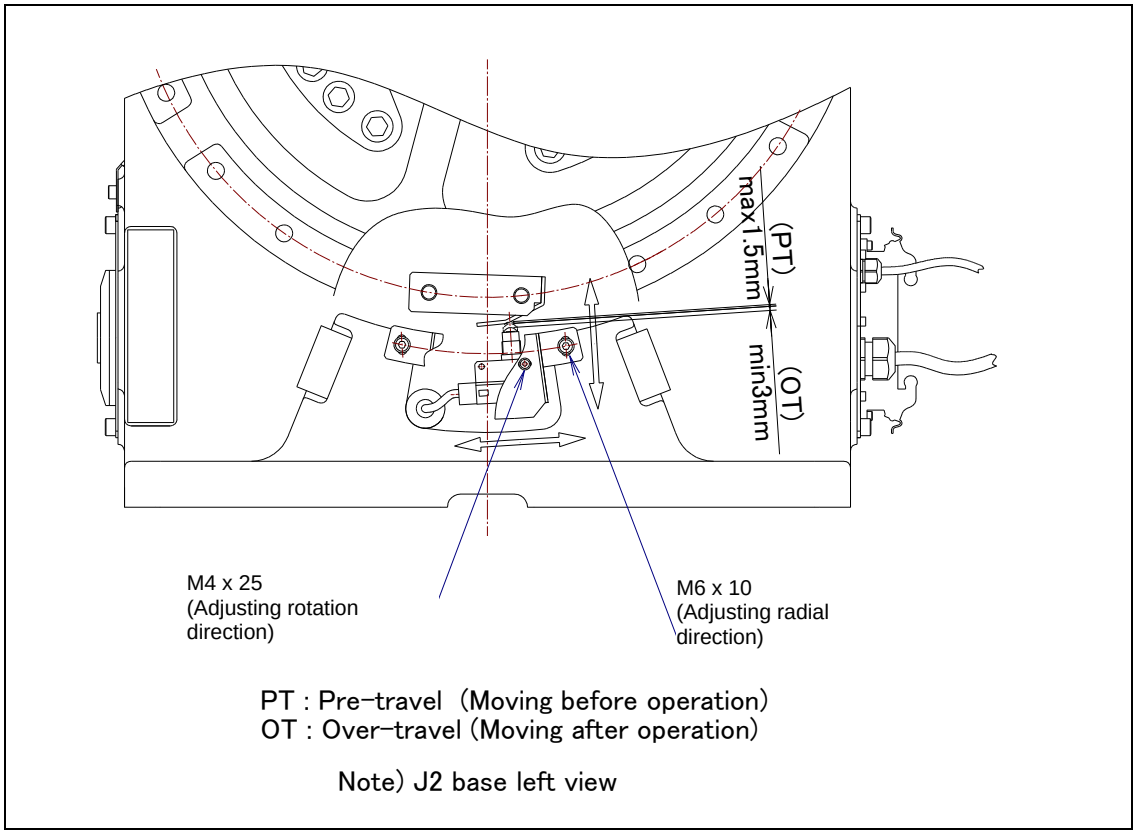


Fig. 5.2 (a) Adjusting J2-axis limit switch (option)

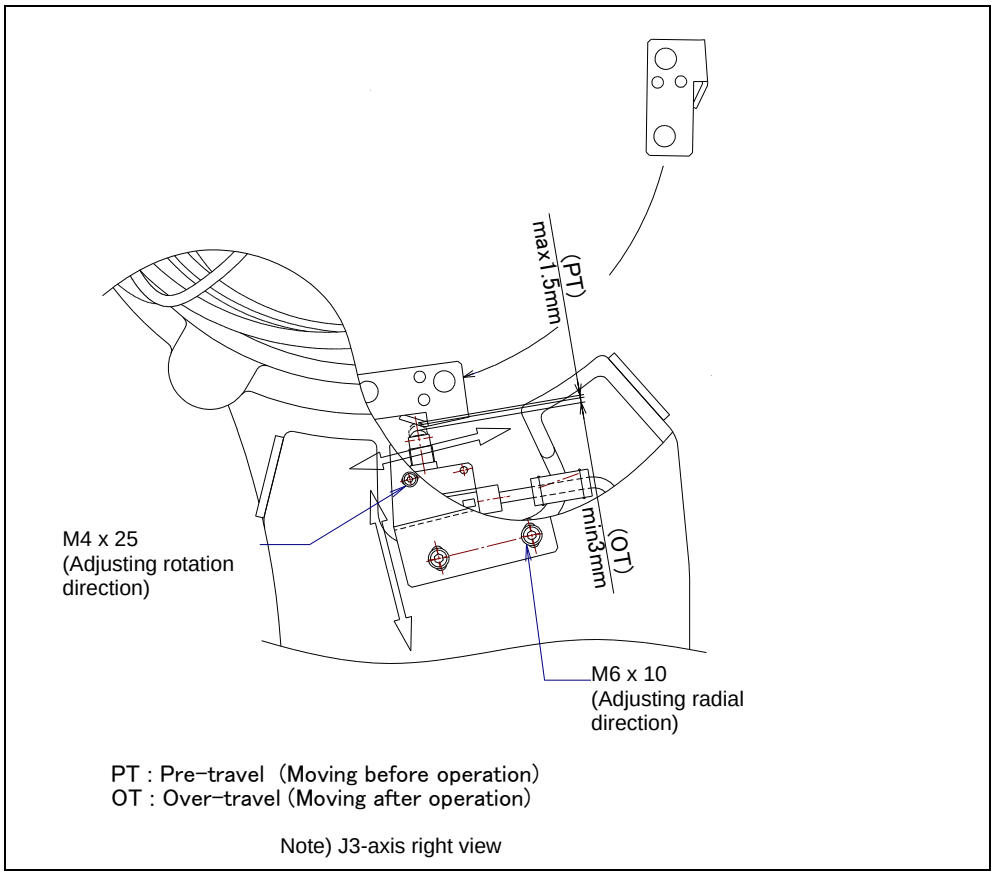


Fig. 5.2 (b) Adjusting J3-axis limit switch (option)

5.3 MASTERING

Mastering is an operation performed to associate 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 is enabled, if load setting (See Section 9.5 in CONNECTION) is not correct, it will influence the precision of the mastering.

5.3.1 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 go dead. Replace the batteries in the control and mechanical units periodically. An alarm will be issued to warn the user of a low battery voltage.

> **NOTE**
> For the mastering and adjustment method of the J1-axis traveling unit, contact the manufacturer of the traveling unit.

Mastering method

Table 5.3.1 (a) describes the following mastering methods. Note that "Quick Mastering for Single Axis" is not supported in R-2000*i*A/200T and R-2000*i*B/200T which software version 7DC2 (V8.20P) or earlier.

Table 5.3.1 (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 has been performed, positioning (calibration) is necessary. Positioning is an operation that recognizes the current robot position based on the newly mastered robot pulse counts.

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

> ⚠ **CAUTION**
> 1 The J1-axis motor is shipped as an accessory. Therefore, after installing the motor in the J1-axis traveling unit, be sure to perform single-axis mastering for the J1 axis.
> 2 If mastering is performed incorrectly, the robot may behave unexpectedly. This is very dangerous. For that reason, the Master/Cal screen is designed to appear only when the $MASTER_ENB system variable is set to 1 or 2. After performing positioning, press the F5 ([DONE]) on the Master/Cal screen. The $MASTER_ENB system variable is reset to 0 automatically. And the Master/Cal screen will disappear.
> 3 It is recommended that you back up the current mastering data before performing mastering.

5.3.2 Resetting Alarms and Preparing for Mastering

Before performing mastering because a motor has been replaced, it is necessary to reset 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.

If "SRVO-062 BZAL" alarm or "SRVO-068 DTERR" alarm occurred, and you cannot release the alarm, Please check there is no faulty wiring or disconnected part.

5.3.3 Zero Position Mastering

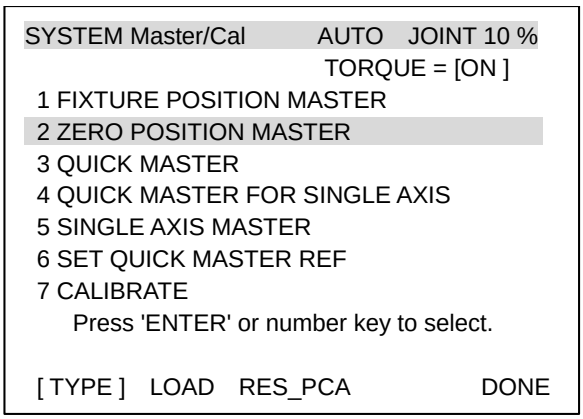
Zero position mastering (witness mark mastering) is performed with all axes set at the 0-degree position. A zero-position mark (witness mark) is attached to J2 to J6-axis. This mastering is performed with J2 to J6-axis set at the 0-degree position using their respective witness marks.
For the 0-degree position of the J1-axis, contact the manufacturer of the J1-axis traveling unit.
Zero position mastering involves a visual check. It cannot be so accurate.
It should be used only as a quick-fix method.

Procedure Mastering to Zero Positions

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 (disabled) or TRUE (enabled)
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 done without the gravity compensation. However, it will affect the accuracy.)

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.



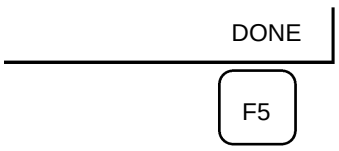
9 Jog the robot into a posture for mastering.
10 Select [2 ZERO POSITION MASTER]. Press F4 [YES].

```
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.

```
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 the original setting, and cycle power of the controller.

Table 5.3.3 (a) Posture with position marks aligned

Axis	Position
J2-axis	0 deg
J3-axis	0 deg (* When J2=0 deg)
J4-axis	0 deg
J5-axis	0 deg
J6-axis	0 deg

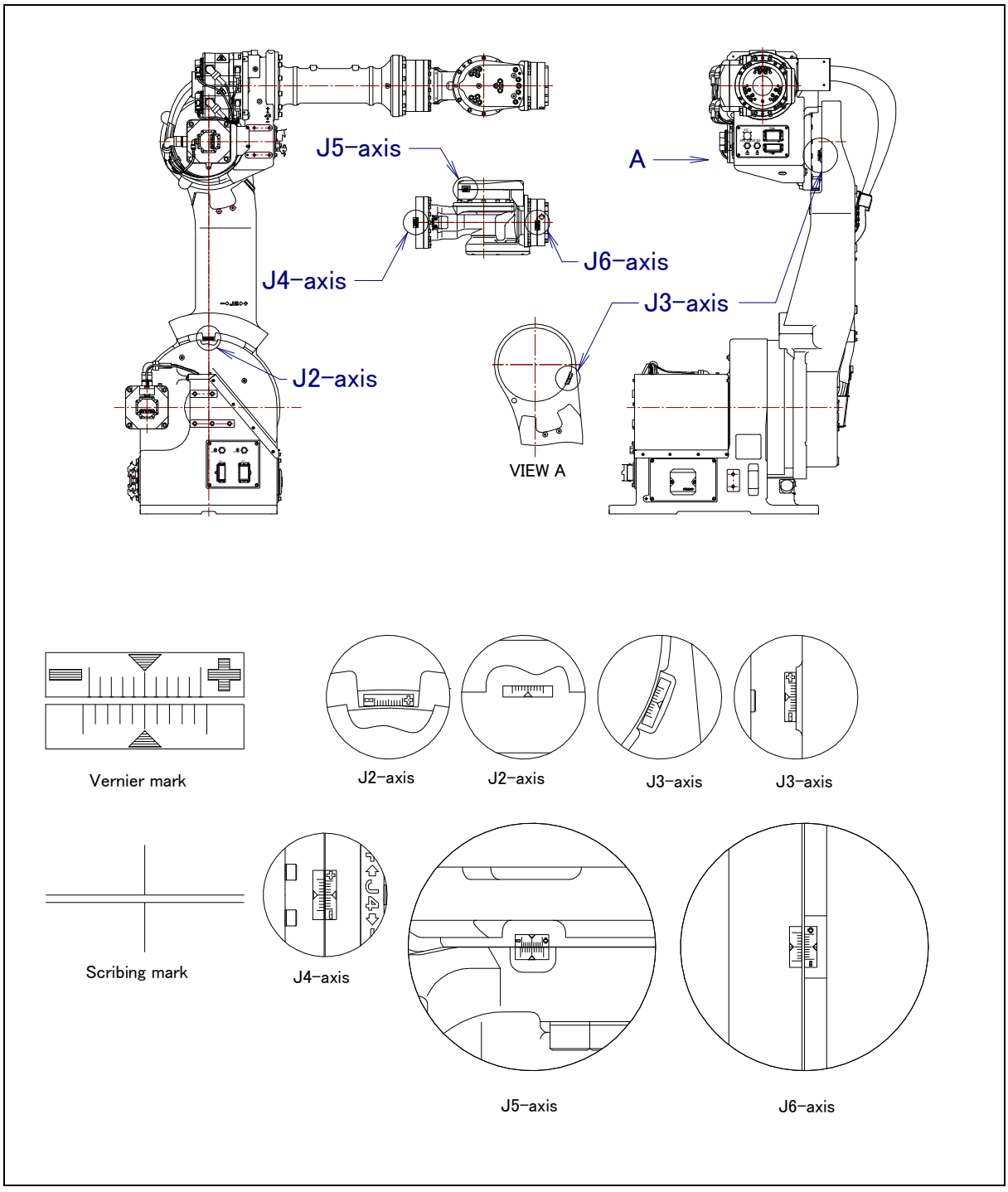


Fig.5.3.3 (a) Zero degree position arrow mark for each axis

5.3.4 Quick Mastering

Quick mastering is performed at a user-specified position. The corresponding count value is obtained from the rotation speed 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 5.3.3 (a). Do not change the setting unless there is any problem.
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.)

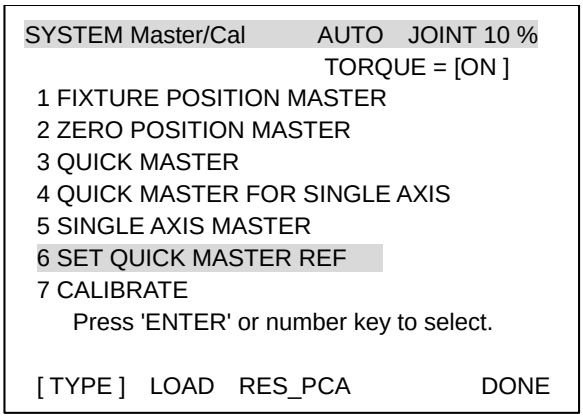
⚠ CAUTION
1 Quick mastering can be used, if the pulse count value is lost, for example, because a low voltage has been detected on the backup battery for the pulse counter.
2 Quick mastering cannot be used, after the motor is replaced or after the mastering data is lost from the robot controller.

Procedure Recording the Quick Master Reference Position

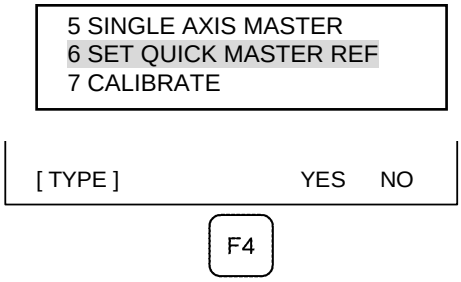
1 Press the [MENU] key to display the screen menu.
2 Select [0 NEXT] and press [6 SYSTEM].
3 Press F1 [TYPE]. Then select [Variables] from the menu.
4 If $DMR_GRP [group]. $GRAV_MAST=1, set the gravity compensation to enabled, if it is 0, set the gravity compensation to disabled. In addition release 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 (disabled) or TRUE (enabled)
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 done without the gravity compensation. However, it will affect the accuracy.)

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 the 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.

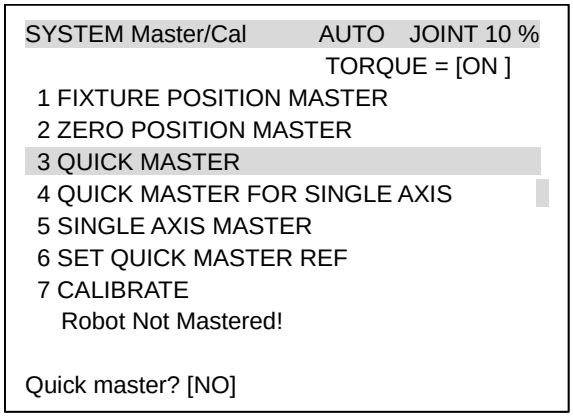
Procedure of Quick Mastering

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.

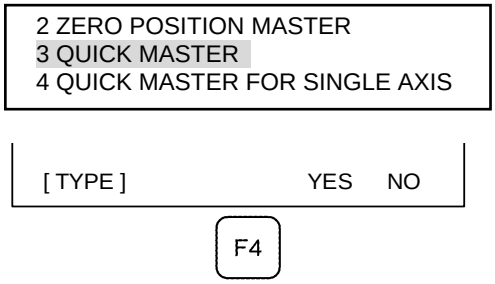
NOTE

Gravity compensation can be set to enabled/disabled by setting the system variables as follows:
$PARAM_GROUP[group].$SV_DMY_LNK[8] : FALSE (disabled) or TRUE (enabled)
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 done without the gravity compensation. However, it will affect the accuracy.)

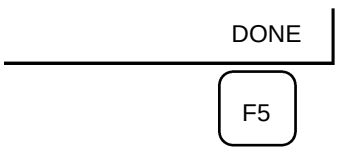
5 Display the Master/Cal screen.



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 saved.



8 Select [7 CALIBRATE] and press [ENTER] key. Calibration is executed. Calibration is 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 the original setting, and cycle power of the controller.

5.3.5 QUICK MASTERING FOR SINGLE AXIS

Quick mastering 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 character 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 5.3.3 (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.)

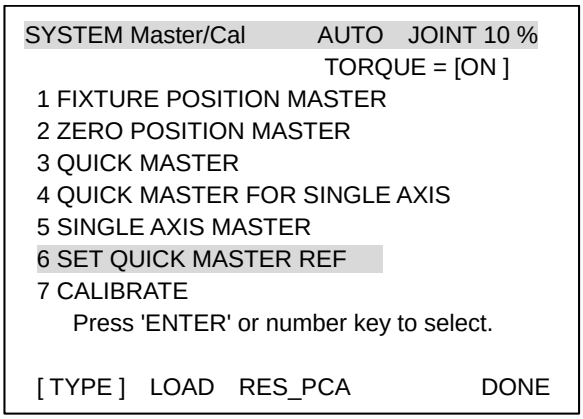
⚠ CAUTION
1 Quick mastering can be used, if the pulse count value is lost, for example, because a low voltage has been detected on the backup battery for the pulse counter.
2 Quick mastering cannot be used, after the motor is replaced or after the mastering data is lost from the robot controller.

Procedure Recording the Quick Mastering Reference Position

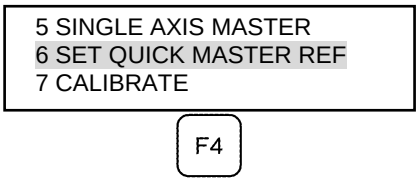
1 Press the [MENU] key to display the screen menu.
2 Select [0 NEXT] and press [6 SYSTEM].
3 Press F1 [TYPE]. Then select [Variables] from the menu.
4 If $DMR_GRP[group].$GRAV_MAST=1, set the gravity compensation to enabled, if it is 0, set the gravity compensation to disabled. In addition release the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



7 Release brake control, and 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.

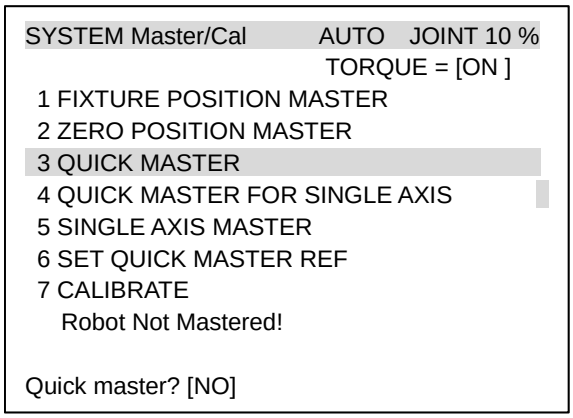
> ⚠ **CAUTION**
> If the robot has lost mastering data due to mechanical disassembly or repair, you cannot perform this procedure. In this case, perform Fixture position mastering or Zero position mastering to restore mastering data.

Procedure of Quick Mastering for single axis

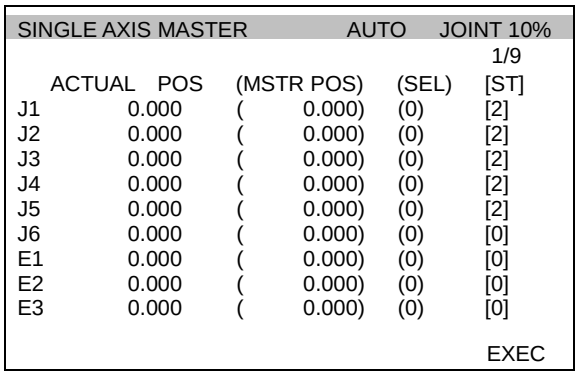
1 Press the [MENU] key to display the screen menu.
2 Select [0 NEXT] and press [6 SYSTEM].
3 Press F1 [TYPE]. Then select [Variables] from the menu.
4 If $DMR_GRP[group].$GRAV_MAST=1, set the gravity compensation to enabled, if it is 0, set the gravity compensation to disabled. In addition release the 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(disabled) or TRUE (enabled)
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 Select [4 QUICK MASTER FOR SINGLE AXIS]. You will see the quick master for single axis screen.

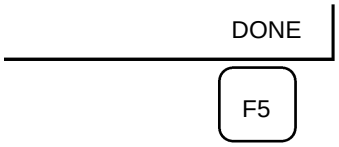


7 Move the cursor to the [SEL] column for the unmastered axis and press the numeric key [1]. Setting of [SEL] is available for one or more axes.

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

                                                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 Select [7 CALIBRATE] and press [ENTER] key. Calibration is executed. Calibration is 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.

5.3.6 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.

```
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
```

Table 5.3.6 (a) Items Set in Single Axis Mastering

Item	Description
Current position (ACTUAL POS)	The current position of the robot is displayed for each axis in degree units. (J1 : mm J2 to J6 : deg)
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.

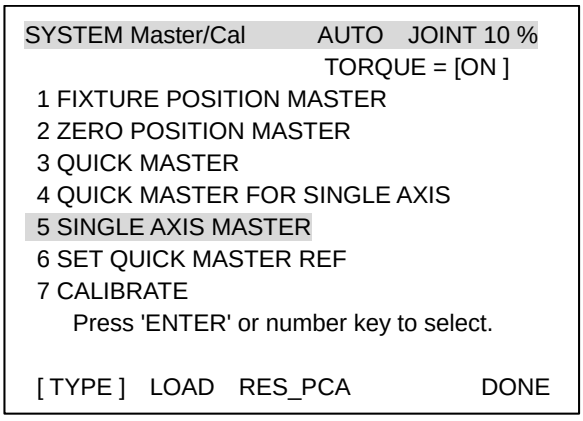
Item	Description
ST	This item indicates whether single axis mastering has been completed for the corresponding axis. It cannot be changed directly by the user. The value of the item is reflected in $EACHMST_DON (1 to 9). 0 : Mastering data has been lost. Single axis mastering is necessary. 1 : Mastering 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 Mastering a Single Axis

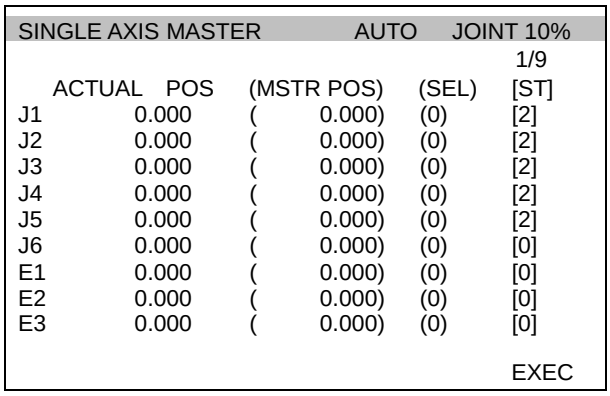
1 Press the [MENU] key to display the screen menu.
2 Select [0 NEXT] and press [6 SYSTEM].
3 Press F1 [TYPE]. Then select [Variables] from the menu.
4 If $DMR_GRP [group].$GRAV_MAST=1, set the gravity compensation to enabled, if it is 0, set the gravity compensation to disabled. In addition release the 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 (disabled) or TRUE (enabled)
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 done without the gravity compensation. However, it will affect the accuracy.)

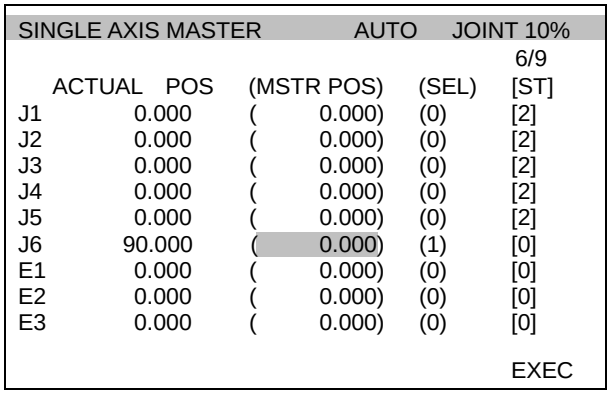
5 Select [6 SYSTEM].
6 Select [Master/Cal]. The positioning screen will be displayed.



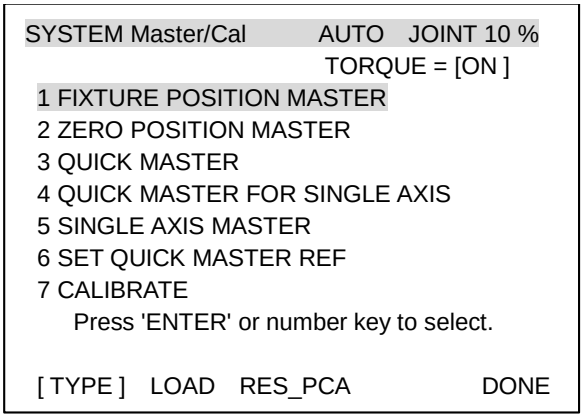
7 Select [5 SINGLE AXIS MASTER]. The following screen will be displayed.



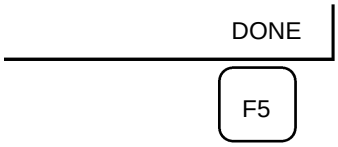
8 Move the cursor to the [SEL] column for the unmastered axis and press the numeric key [1]. Setting of [SEL] is available for one or more axes.
9 Turn off brake control, then jog the robot to the mastering position.
10 Enter axis data for the mastering position.
11 Press F5 [EXEC]. Mastering is performed.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



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



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].



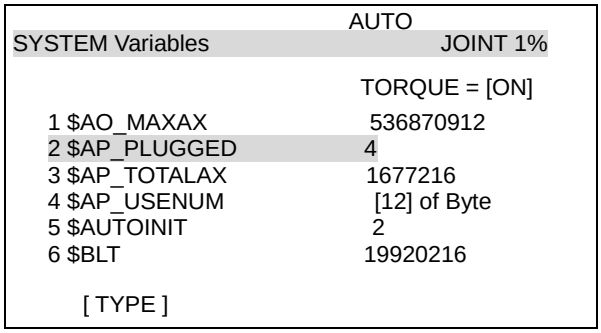
15 Return the setting of the gravity compensation.
16 Return brake control to the original setting, and cycle power of the controller.

5.3.7 Mastering Data Entry

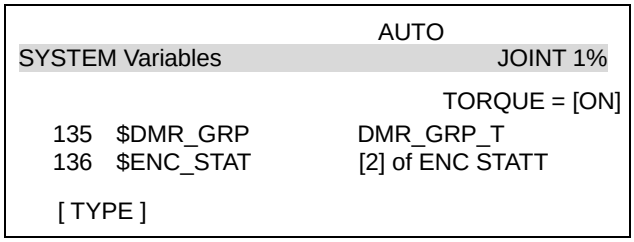
This function enables mastering data values to be assigned directly to a system variable. It can be used if mastering data has been lost but the pulse count is preserved.

Mastering data entry method

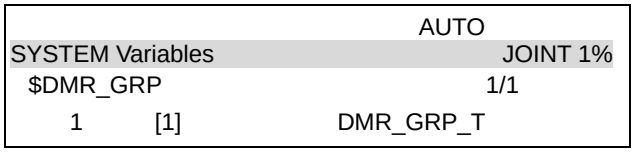
1 Press the [MENU] key, then press [0 NEXT] and select [6 SYSTEM].
2 Press F1 [TYPE]. Select [Variables]. The system variable screen appears.

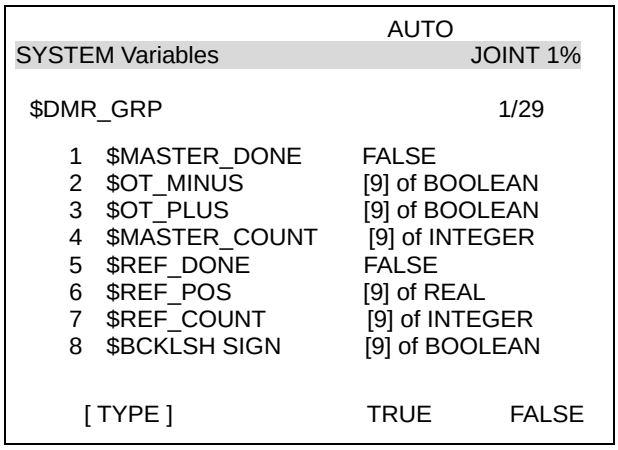


3 Change the mastering data.
The mastering data is saved to the $DMR_GRP.$MASTER_COUN system variable.

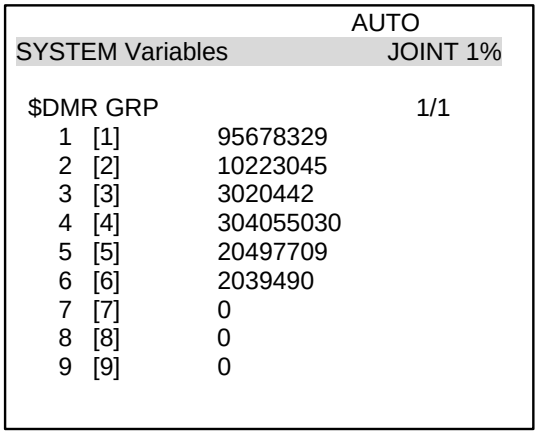


4 Select $DMR_GRP.

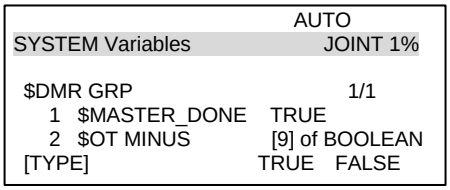




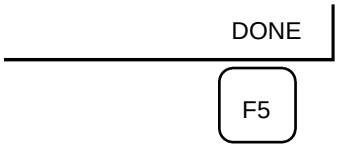
5 Select $MASTER_COUN, and enter the mastering data you have recorded.



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].



5.4 VERIFYING MASTERING

1 How to verify that the robot is mastered properly:
Usually, positioning is performed automatically at power-on. To check whether mastering has been made correctly, note whether the displayed current position agrees with the actual robot position. Use the procedure 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 Subsection 5.3.3 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 in 2 in this Section. 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 Alarms that may be output during mastering and remedy for it

(1) BZAL alarm
This alarm is output if the voltage of the Pulsecoder's backup battery falls to 0 V while the power to the controller is disconnected. Also, if Pulsecoder connector is removed for replacing cables etc. this alarm is output because voltage becomes to 0. To clear the alarm, fit a new battery, execute the pulse reset (See Subsection 5.3.2.), then turn the power off then on again and confirm alarm is not output.
Battery might be weak if you can’t reset alarm, then replace battery to new one , perform pulse reset , turn off and on the controller power. Note that, if this alarm occurs, all data originally held by the Pulsecoder will have been lost. Mastering must be performed again.

(2) BLAL alarm
This alarm is output if the voltage of the Pulsecoder's backup battery has fallen to a level where backup is no longer possible. If this alarm is output, fit a new battery immediately while keeping the power turned on. Check whether the current position data is valid, using the procedure described in 1 in this Section.

(3) CKAL, RCAL, PHAL, CSAL, DTERR, CRCERR, STBERR, and SPHAL, alarms
Contact the FANUC because the Pulsecoder may be defective.

6 WIRING

6.1 WIRING DIAGRAM

Fig. 6.1 (a), (b) shows the wiring diagram of the mechanical unit. Refer to Section 9.6 about piping.

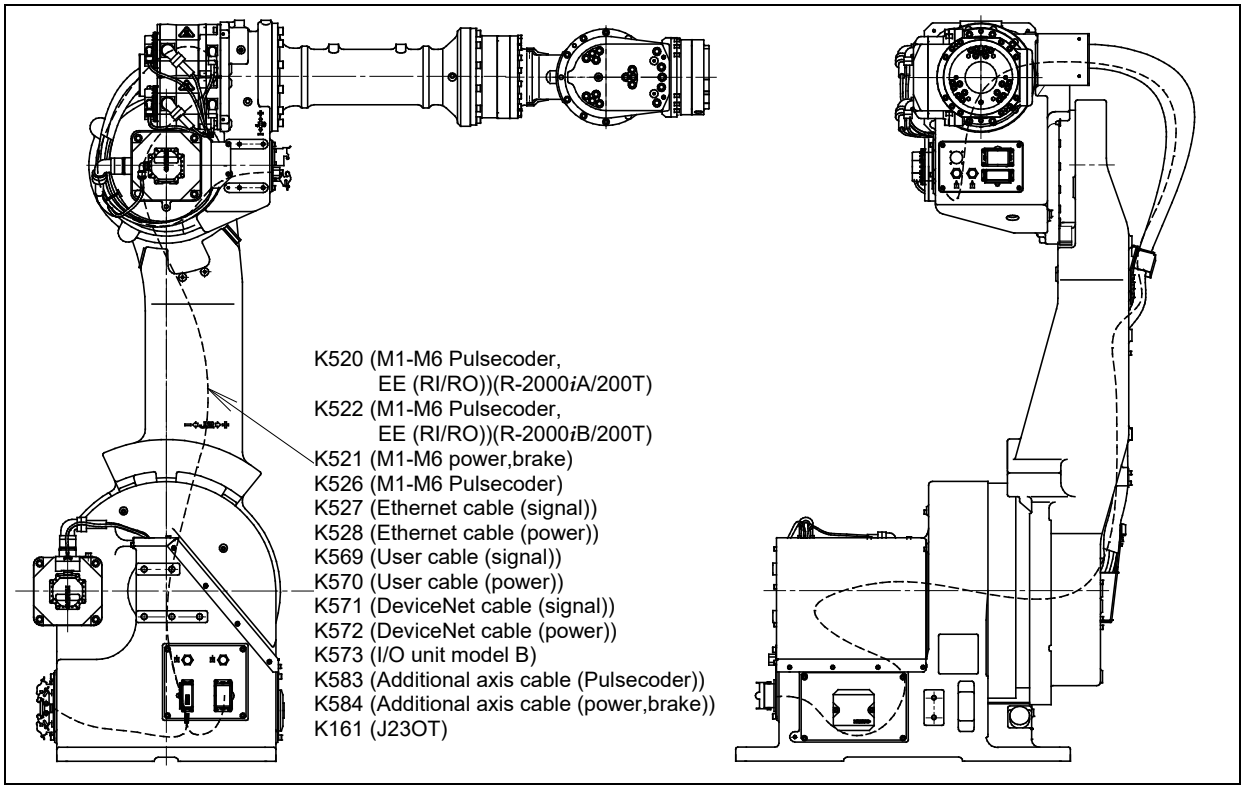


Fig. 6.1 (a) Wiring diagram

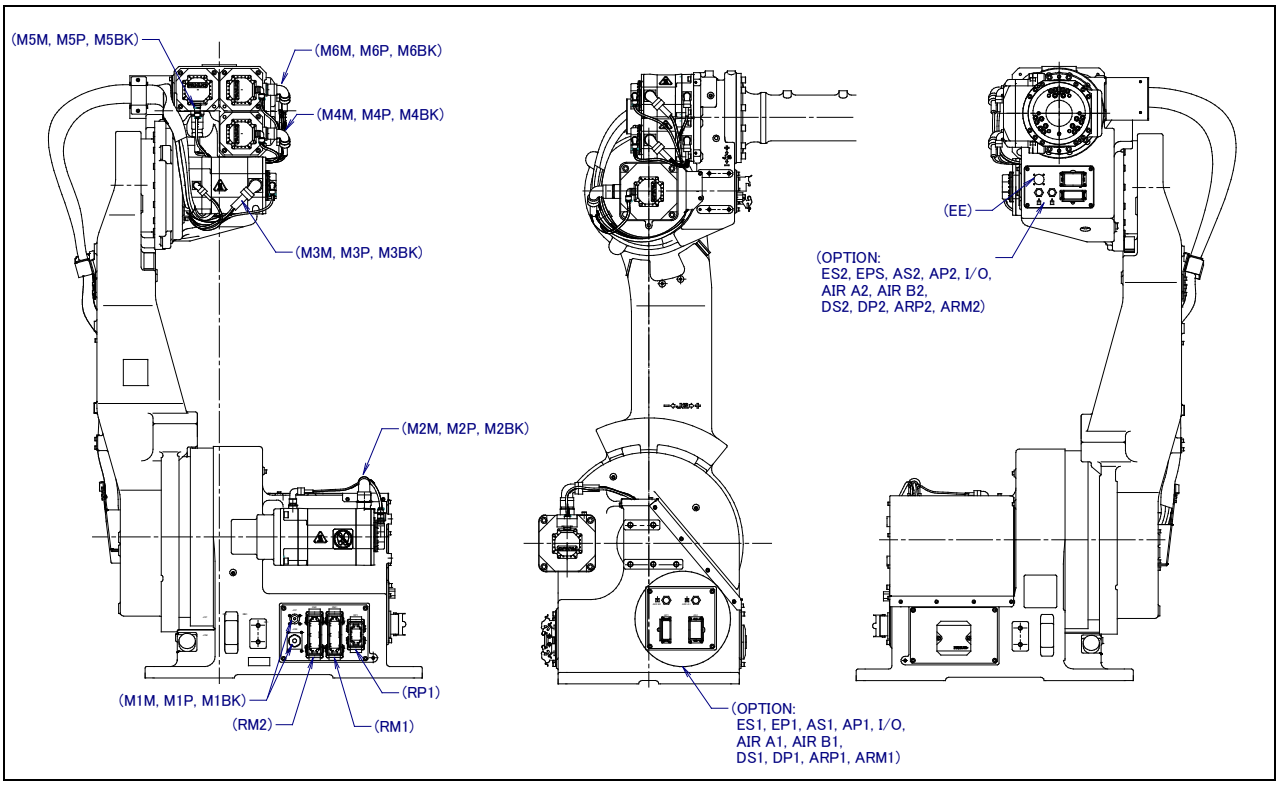


Fig. 6.1 (b) Connector locations

7 SEVERE DUST/LIQUID PROTECTION PACKAGE

7.1 SEVERE DUST/LIQUID PROTECTION PACKAGE(OPTION)

The package is intended to improve the dustproof and waterproof characteristics of the robot so that it can be used in a severe environment.

NOTE
Contact your FANUC representative for confirmation that the Severe Dust/liquid protection package is suitable for your environment.

Model	Severe dust/liquid protection specification
R-2000*i*A/200T, R-2000*i*B/200T	A05B-1324-J805

7.2 DUSTPROOF AND WATERPROOF CHARACTERISTICS

The following table lists the IEC60529-based dustproof and waterproof characteristics.

Standard	Standard	Severe dust/ liquid protection package
J3 arm and wrist section	IP67	IP67
Driving unit of the body	IP66	IP66
Main body	IP54	IP56

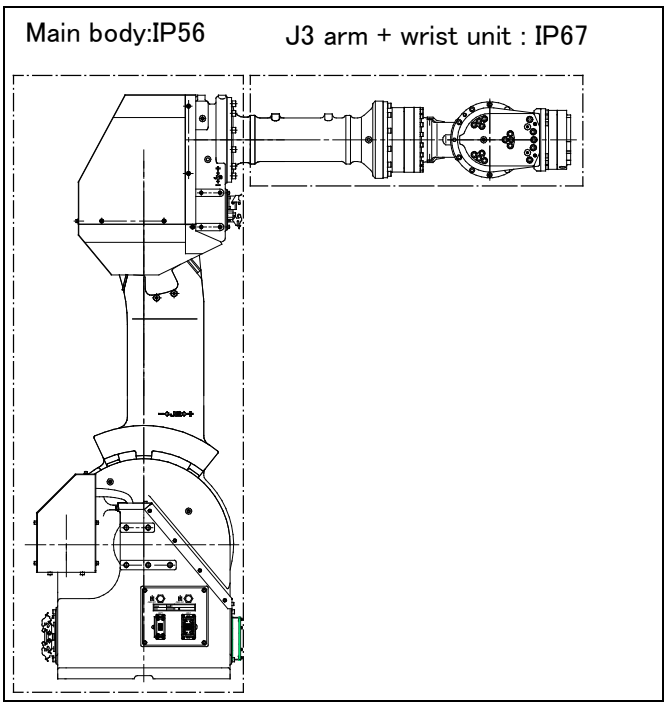


Fig. 7.2 (a) Dustproof and waterproof characteristics

7.3 CONFIGURATION OF THE SEVERE DUST/LIQUID PROTECTION PACKAGE

The following table lists the major differences between the R-2000*i*A/200T and R-2000*i*B/200T standard specification and severe dust/liquid protection package.

	Standard specifications	Severe dust/liquid protection option	
	Entire mechanical unit	Main unit	J3 arm and wrist
Bolts	Black oxide finish steel bolt Black oxide finish washer	FR coating bolt Black chromate washer Stainless steel bolt Black oxide finish steel bolt	FR coating bolt Stainless steel bolt Black chromate washer
Covers		J2-axis motor cover J3 -axis motor cover Battery box cover Cable cover in mechanical unit (for all exposed cables)	

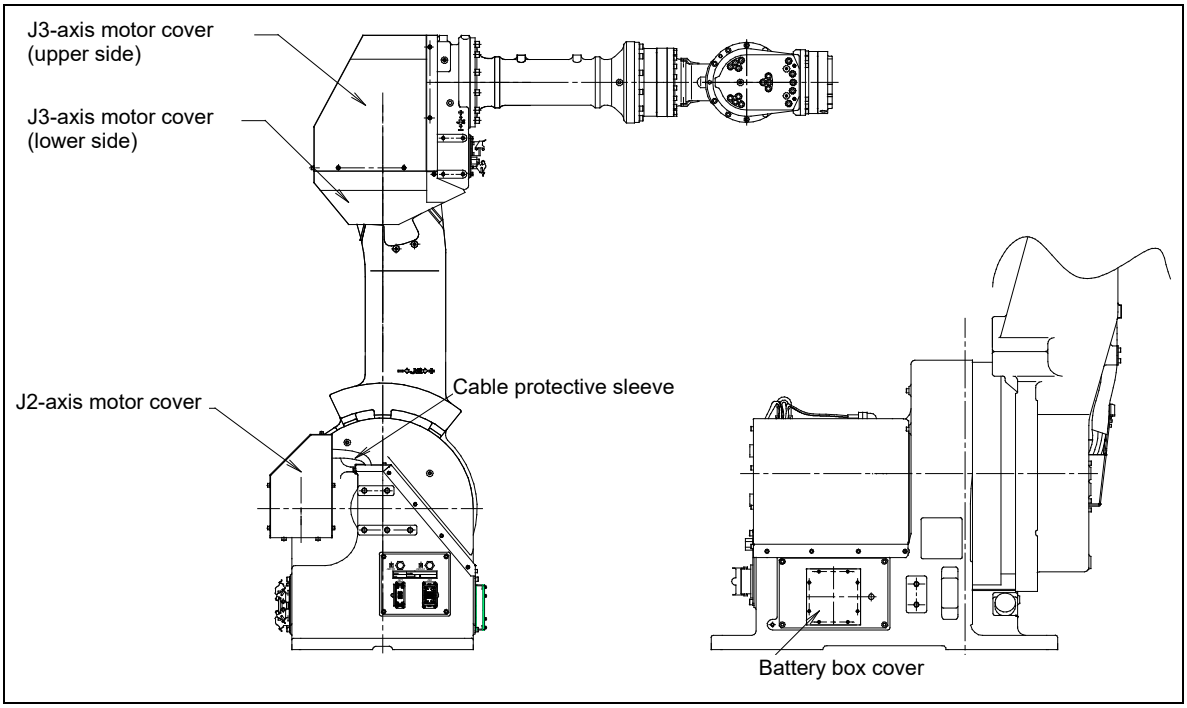


Fig. 7.3 (a) Configuration of the severe dust/liquid protection package

7.4 NOTES ON SPECIFYING SEVERE DUST/LIQUID PROTECTION PACKAGE

1. The liquids below cannot be applied because they may cause deterioration or corrosion of the rubber parts (such as gasket, oil seals, and O-rings) used in the robot. (As exception to this only liquids tested and approved by FANUC can be used with the robot.)
   (a) Organic solvent
   (b) Cutting fluid or detergent including chlorine / gasoline
   (c) Amine type cutting fluid or detergent
   (d) Liquid or solution that includes a corrosive such as an acid or alkali or causes rust
   (e) Other liquids or solutions, that will harm NBR or CR rubber

8 ROBOT INTERFERENCE AREA

Fig. 8 (a) and (b) show the external dimensions of the robot. When installing peripheral equipment, be careful to clear away any objects that are in the robot's motion path in normal operation. Fig. 8 (c) to (f) show the operation range of the robot.

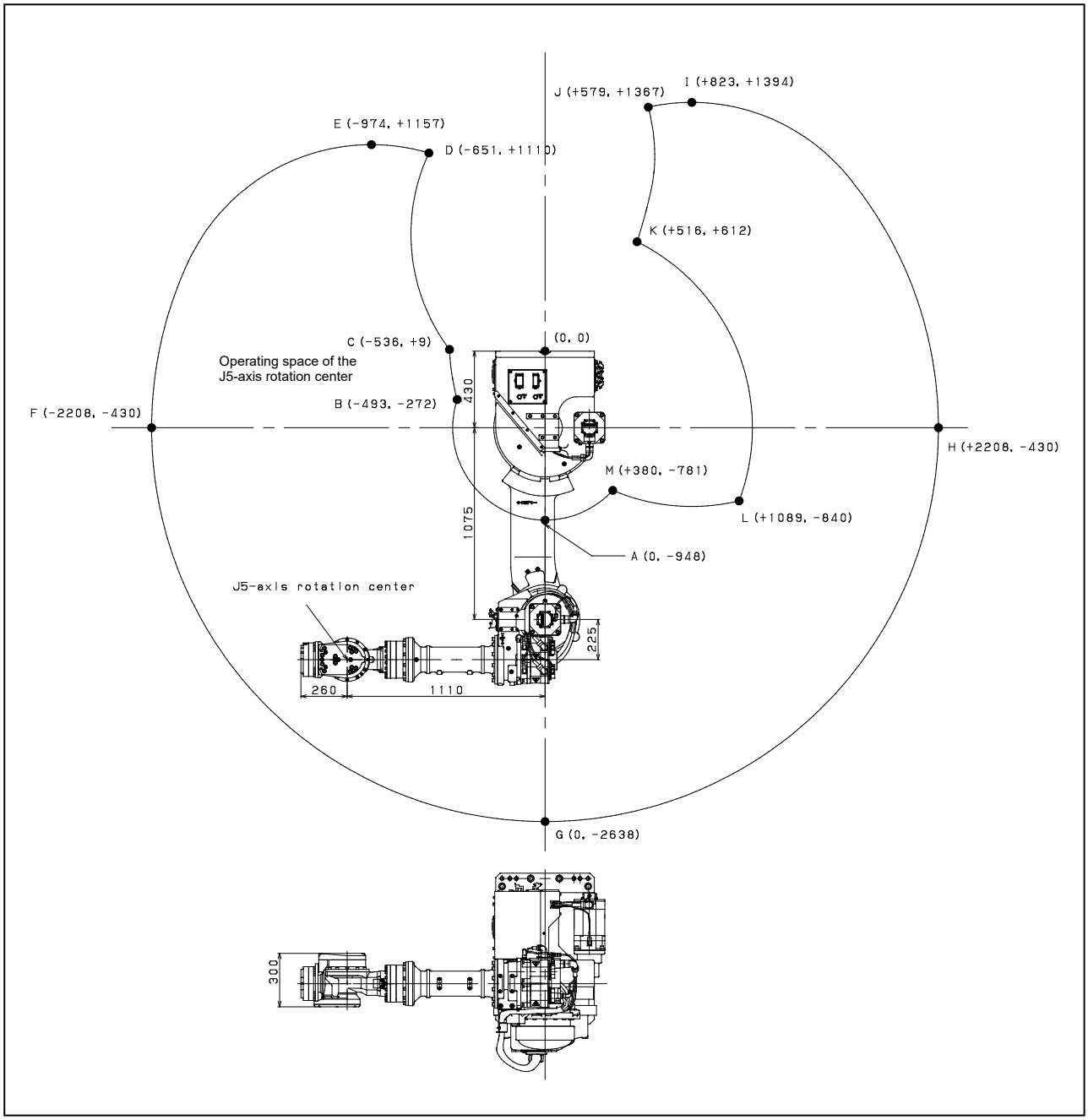


Fig. 8 (a) Mechanical unit operating space (on ceiling mount)

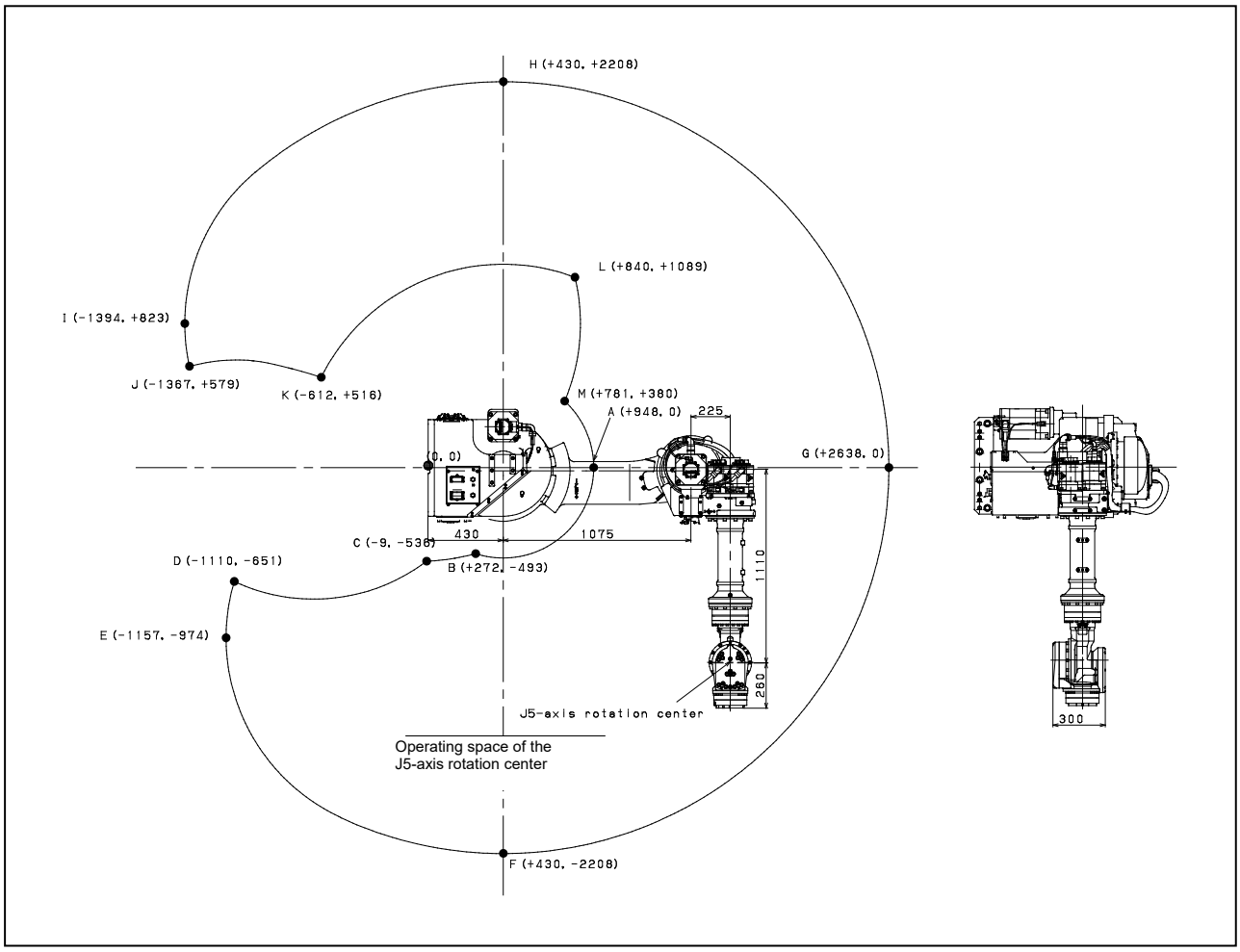
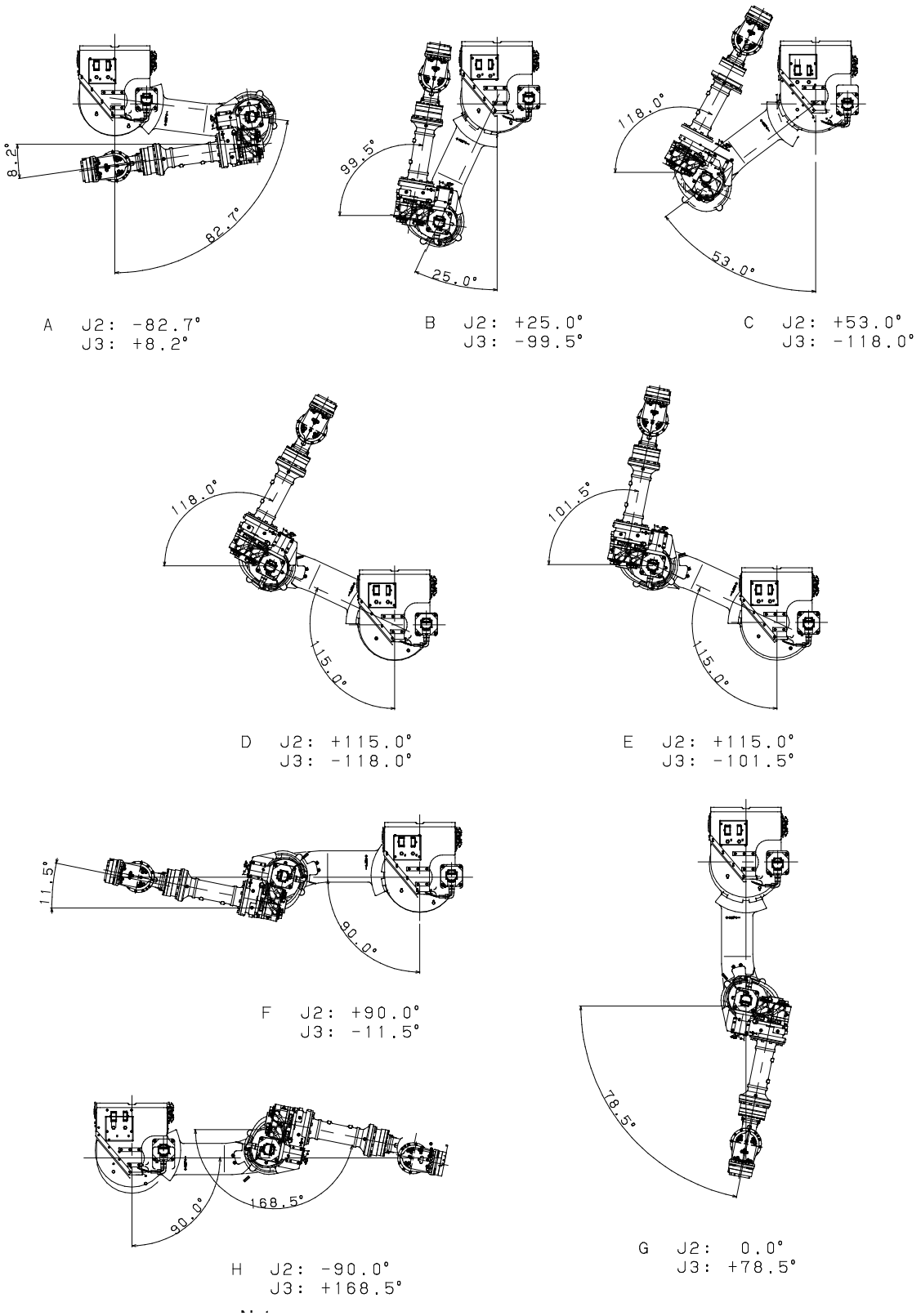
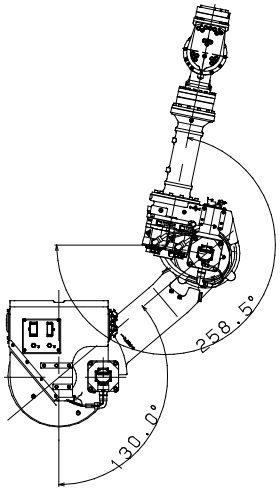


Fig. 8 (b) Mechanical unit operating space (on wall mount)

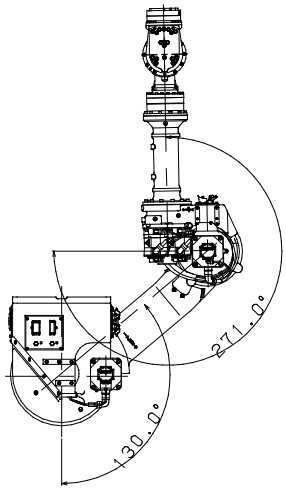


Note
A to H are equivalent to the point A to H of Fig. 8 (a).

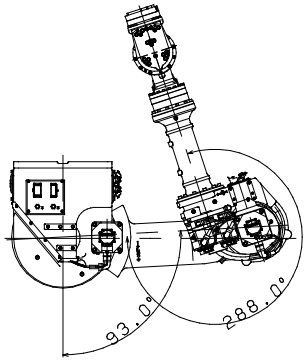
Fig. 8 (c) Mechanical unit operation area (on ceiling mount) (1/2)



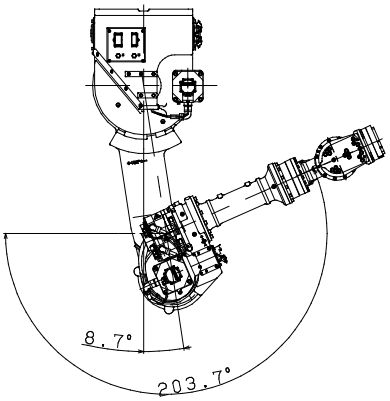
I J2: −130.0°
J3: +258.5°



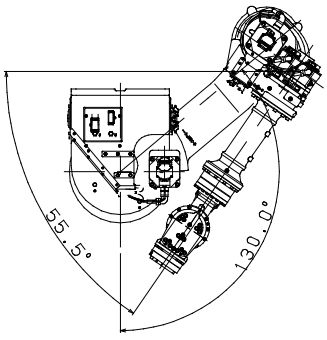
J J2: −130.0°
J3: +271.0°



K J2: −93.0°
J3: +288.0°



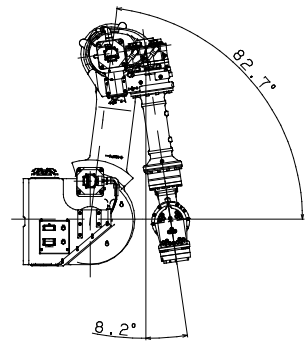
L J2: −8.7°
J3: +203.7°



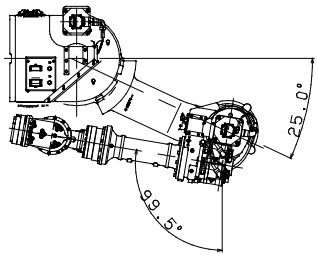
M J2: −130.0°
J3: +55.5°

Note
I to M are equivalent to the point I to M of Fig. 8 (a).

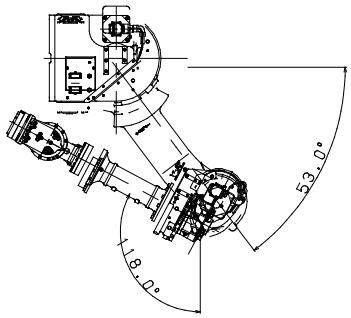
Fig. 8 (d) Mechanical unit operation area (on ceiling mount) (2/2)



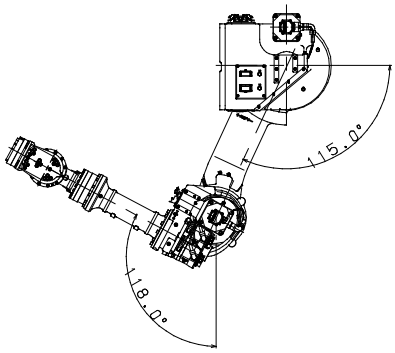
A J2: -82.7°
J3: +8.2°



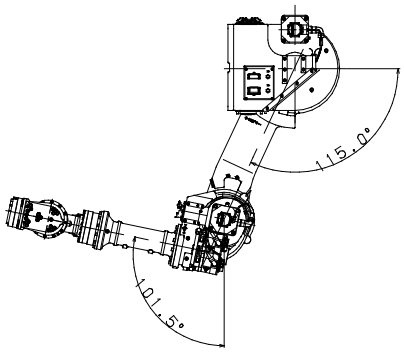
B J2: +25.0°
J3: -99.5°



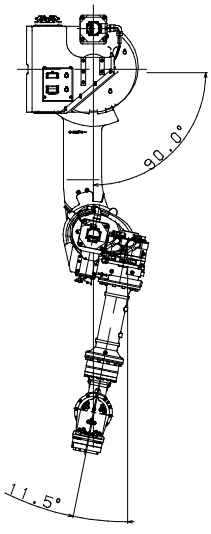
C J2: +53.0°
J3: -118.0°



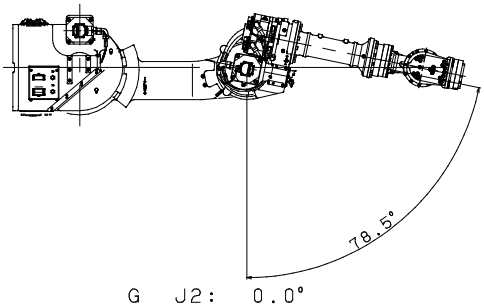
D J2: +115.0°
J3: -118.0°



E J2: +115.0°
J3: -101.5°



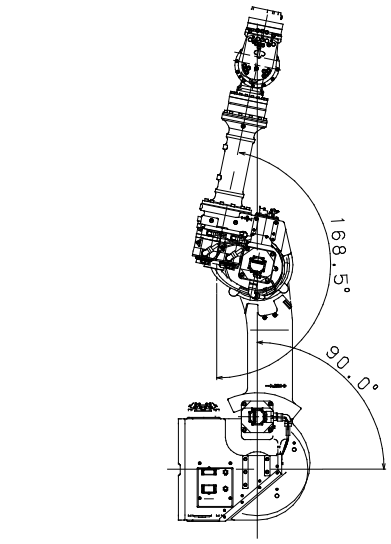
F J2: +90.0°
J3: -11.5°



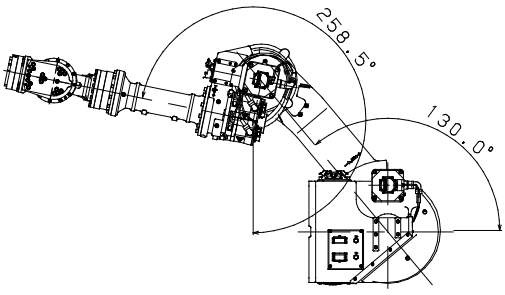
G J2: 0.0°
J3: +78.5°

Note
A to G are equivalent to the point A to G of Fig. 8 (b).

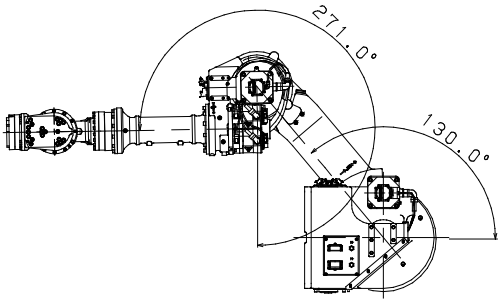
Fig. 8 (e) Mechanical unit operation area (on wall mount) (1/2)



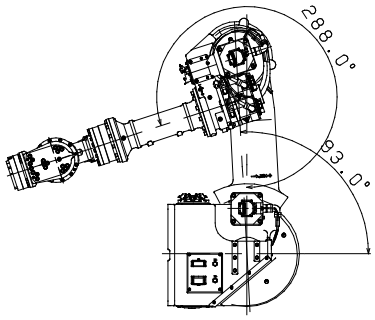
H J2: -90.0°
J3: +168.5°



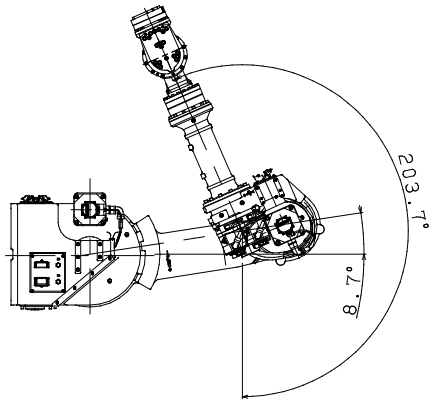
I J2: -130.0°
J3: +258.5°



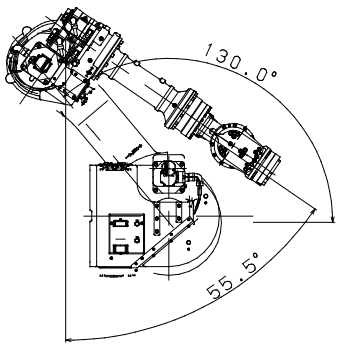
J J2: -130.0°
J3: +271.0°



K J2: -93.0°
J3: +288.0°



L J2: -8.7°
J3: +203.7°



M J2: -130.0°
J3: +55.5°

Note

Note
H to M are equivalent to the point H to M of Fig. 8 (b).

Fig. 8 (f) Mechanical unit operation area (wall mount) (2/2)

9 EQUIPMENT INSTALLATION TO THE ROBOT

9.1 WRIST LOAD CONDITIONS

Fig. 9.1 (a) is a diagram showing the allowable load that can be applied to the wrist section. Apply a load within the region indicated in the graph. Apply the conditions of the allowable load moment and the allowable load inertia. Refer to specification table of “PREFACE” about allowable inertia and moment.

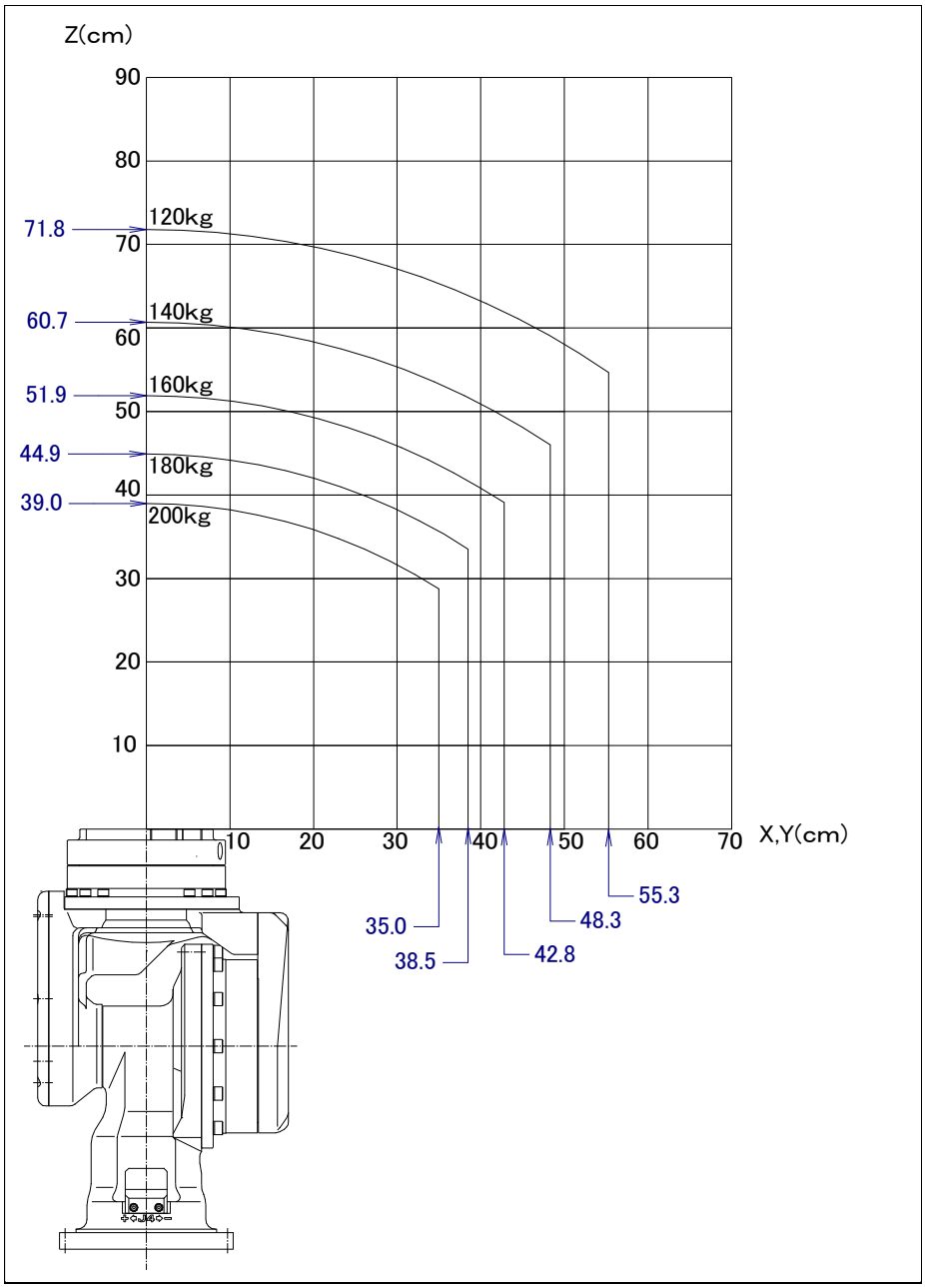


Fig. 9.1 (a) Wrist load diagram (ISO Flange and FANUC/Special Flange)

9.2 LOAD CONDITIONS ON J2 BASE AND J3 ARM

Table 9.2(a) shows J2 base and J3 arm load conditions.

Table 9.2 (a) Load condition on J2 base and J3 arm

	Additional mass	Condition
J2 base	Up to 550 kg. Depending on the load-carrying capacity of the J1-axis traveling unit, however, the mass may be limited.	For details, contact the manufacturer of the J1-axis traveling unit.
J3 arm	If any additional mass is present, the additional mass of the wrist is limited.	For details, contact FANUC.

9.3 END EFFECTOR INSTALLATION TO WRIST

Fig. 9.3 (a) to (c) are the diagrams for installing end effectors on the wrist. To fasten the end effector, first position it with two pin holes at G using fitting A or B, then lock it using screws at D. Select screws and positioning pins of a length that matches the depth of the tapped and pin holes. Fasten the bolt for fixing the end effector with following torque. 73.5±3.4 Nm (750±35kg fcm)

> **⚠ CAUTION**
> Notice the tooling coupling depth to wrist flange should be shorter than the flange coupling length.

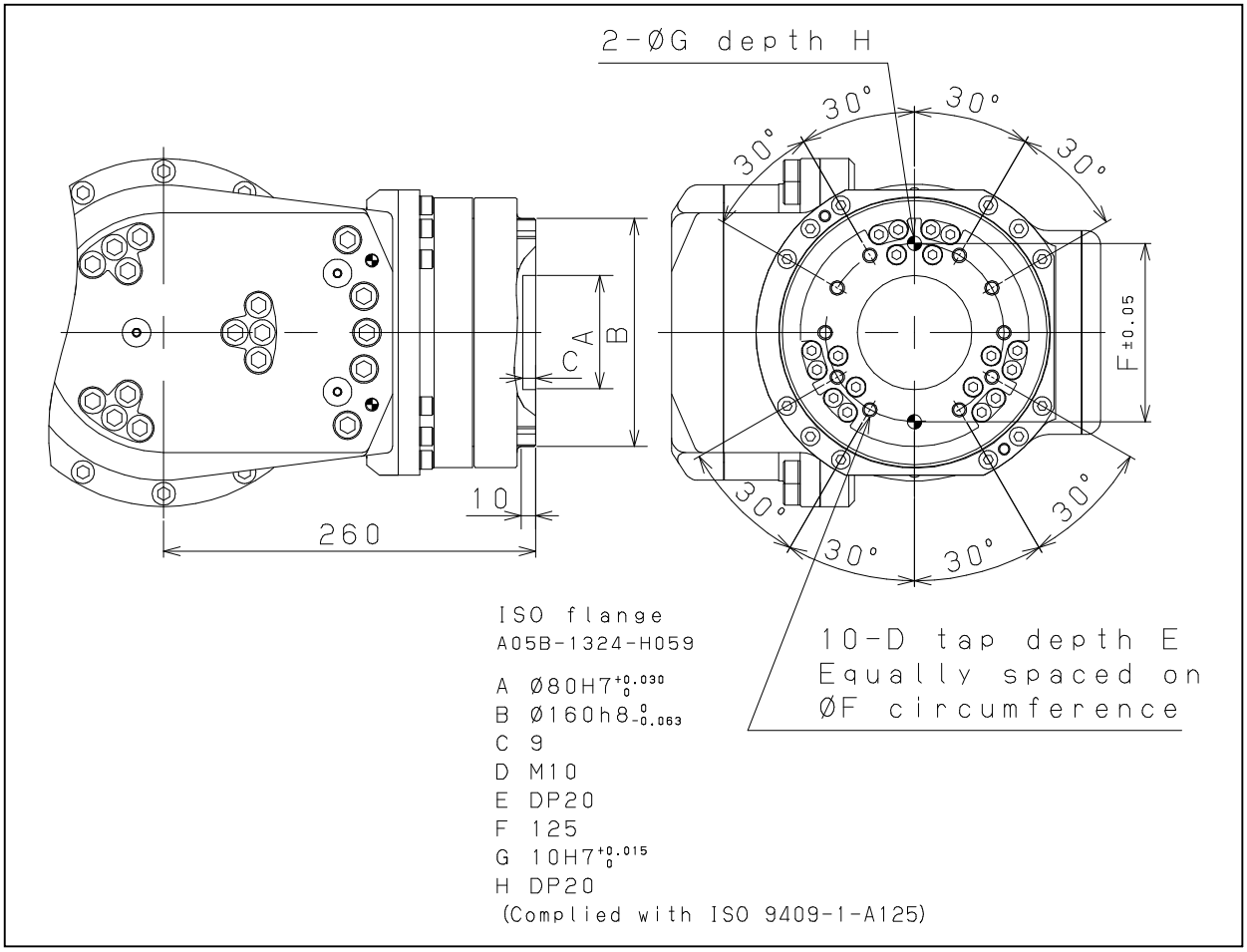


Fig. 9.3 (a) End effector mounting face (ISO flange)

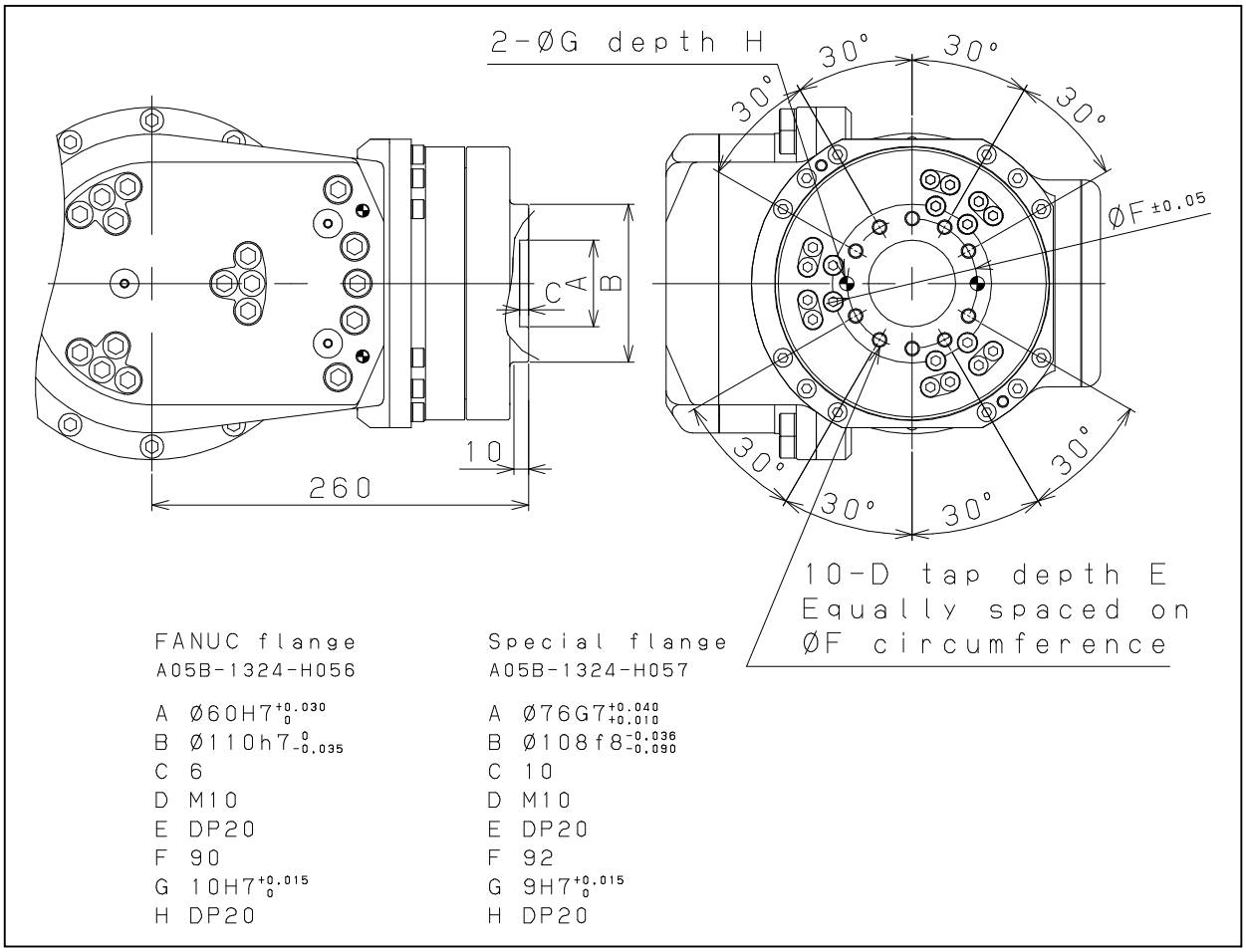


Fig. 9.3 (b) End effector mounting face (FANUC/Special flange)

> ⚠ **CAUTION**
> When a FANUC flange or special flange is used, use ten bolts to install an end effector.

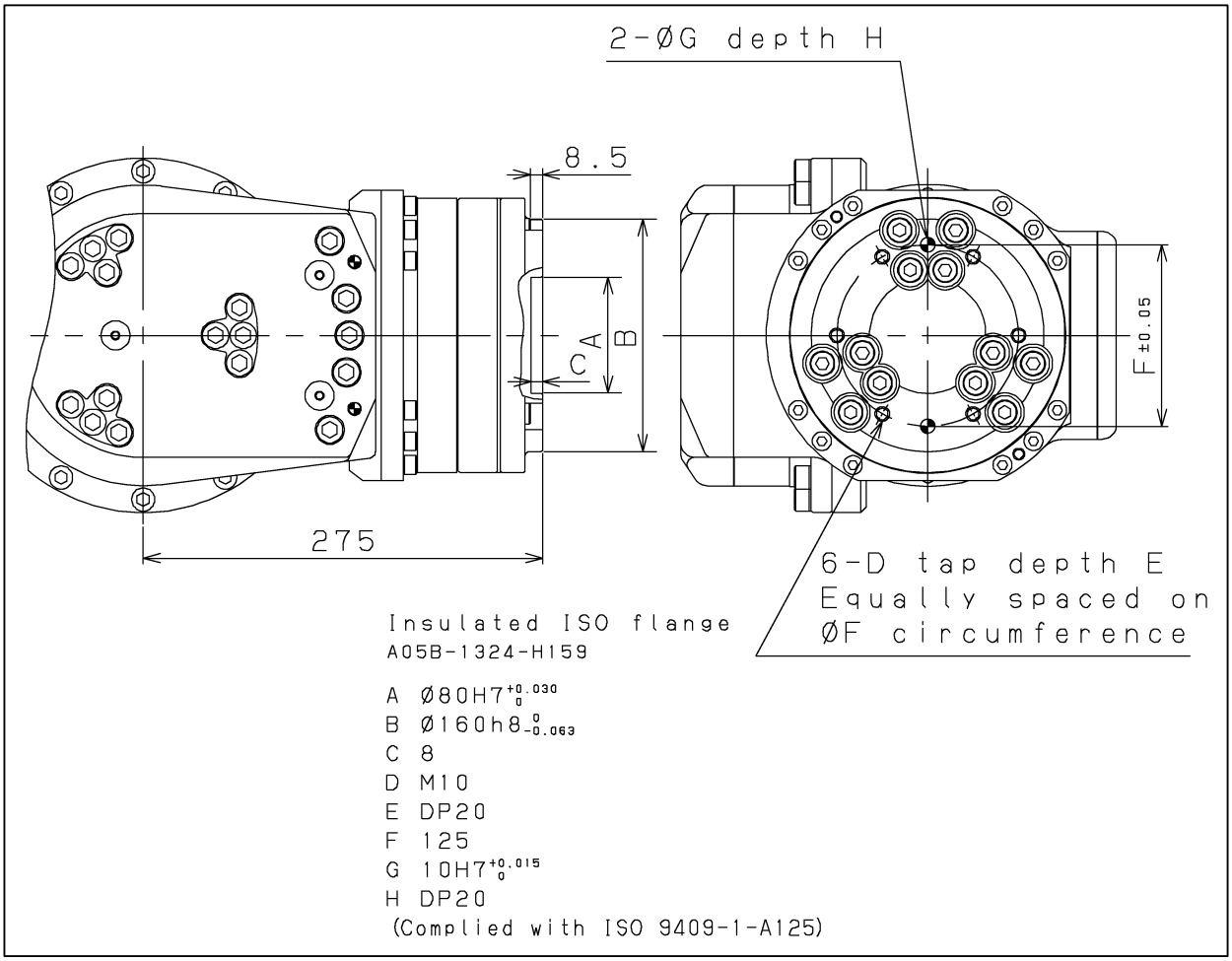


Fig. 9.3 (c) End effector mounting face (Insulated flange)

9.4 EQUIPMENT MOUNTING FACE

As shown in Fig. 9.4 (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 can 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 tighten both with the tightening bolts used for mechanical unit.
3 Equipment should be installed so that mechanical unit cable is not pinched or damaged. If equipment installation restricts or damages the mechanical unit cable, it might become disconnected, and unexpected conditions might occur.

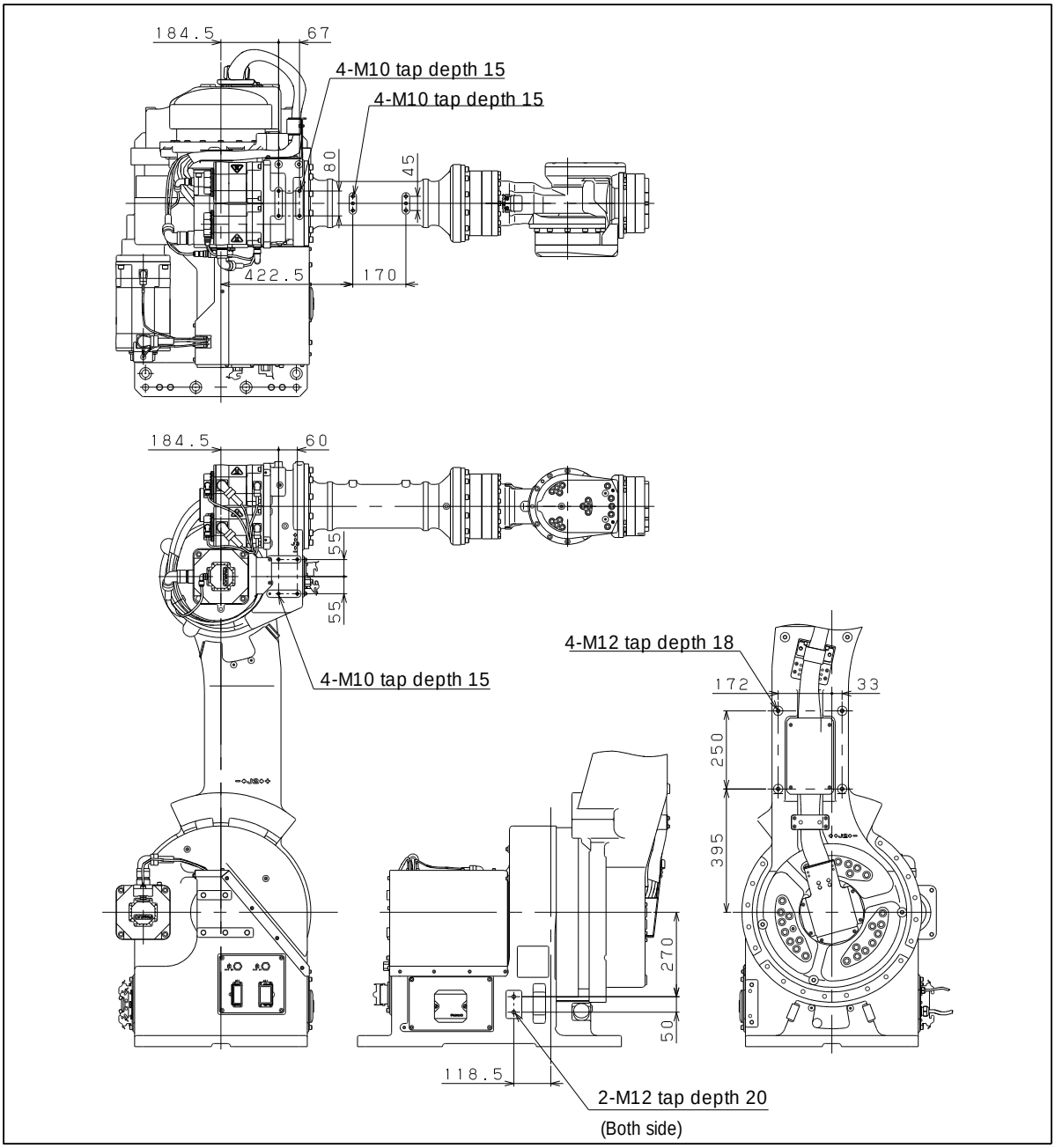


Fig. 9.4 (a) Equipment mounting surfaces

9.5 LOAD SETTING

> ⚠ **CAUTION**
> Set the correct load condition parameter before the robot runs. Do not operate the robot in over when its payload is exceeded or incorrect. Do not exceed the allowable payload including connection cables and its swing. Operation in with the robot over payload may result in troubles such as reducer life reduction.

Motion performance screens

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          200.00   [                    ]
 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  SETING >
         IDENT                          >
```

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 press F3 [DETAIL]. The MOTION PAYLOAD SET screen will be displayed.

```
MOTION PAYLOAD SET              JOINT   100%

  Group 1
  Schedule No[   1]:[*******          ]
1 PAYLOAD              [kg]        200.00
2 PAYLOAD CENTER  X    [cm]        -34.86
3 PAYLOAD CENTER  Y    [cm]          0.00
4 PAYLOAD CENTER  Z    [cm]         28.45
5 PAYLOAD INERTIA X    [kgfcms^2]   72.94
6 PAYLOAD INERTIA Y    [kgfcms^2]   83.31
7 PAYLOAD INERTIA Z    [kgfcms^2]   24.39

 [TYPE]  GROUP  NUMBER  DEFAULT  HELP
```

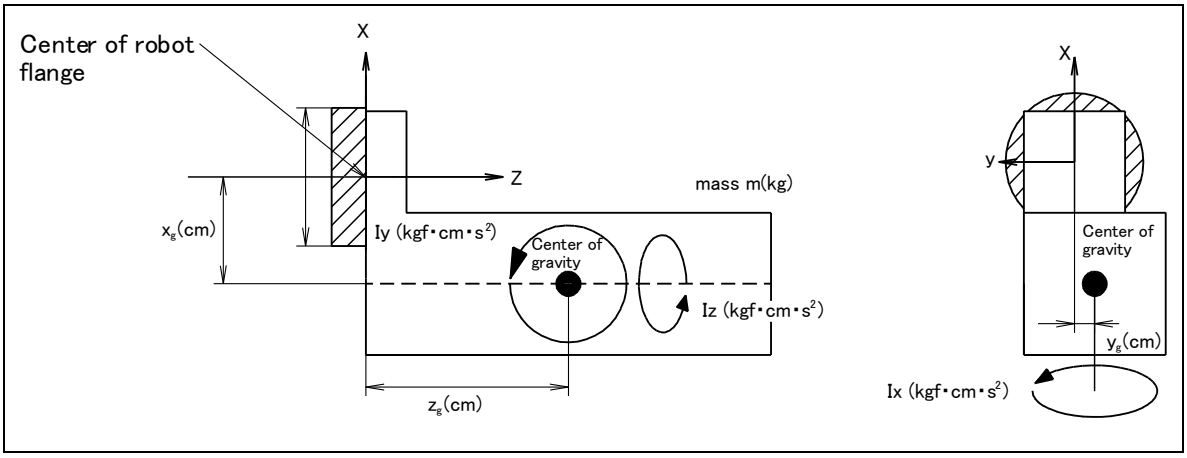


Fig. 9.5 (a) Standard tool coordinate

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 Press F3 ([NUMBER]) will bring you to the MOTION PAYLOAD SET screen for another condition number. For a multigroup system, pressing 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 MOTION PERFORMANCE screen, press F4 ([ARMLOAD]) to display the MOTION ARMLOAD SET screen.

```
MOTION ARMLOAD SET              JOINT   100%

   Group 1
 1 ARM LOAD AXIS #1 [kg]              550.00
 2 ARM LOAD AXIS #3 [kg]                0.00

[ TYPE ]    GROUP          DEFAULT   HELP
```

10 Specify the weight of the load on the J2 base and J3 arm as follows:
ARMLOAD AXIS #1[kg]: Weight of the load on the J2 base
ARMLOAD AXIS #3[kg]: Weight of the load on the J3 arm
The following message appears: “Path and Cycletime will change. Set it?” Respond to the message with F4 ([YES]) or F5 ([NO]). Once the arm payload is set up, the settings are completed by cycling power of controller.

9.6 AIR SUPPLY (OPTION)

There are air inlet and air outlet supply opening on the side of the J2 base and the front of J3 casting as the following Fig.9.6(a). The connector is a Rc1/2 female (ISO). As coupling are not supplied, it will be necessary to prepare couplings which suit to the tube size.

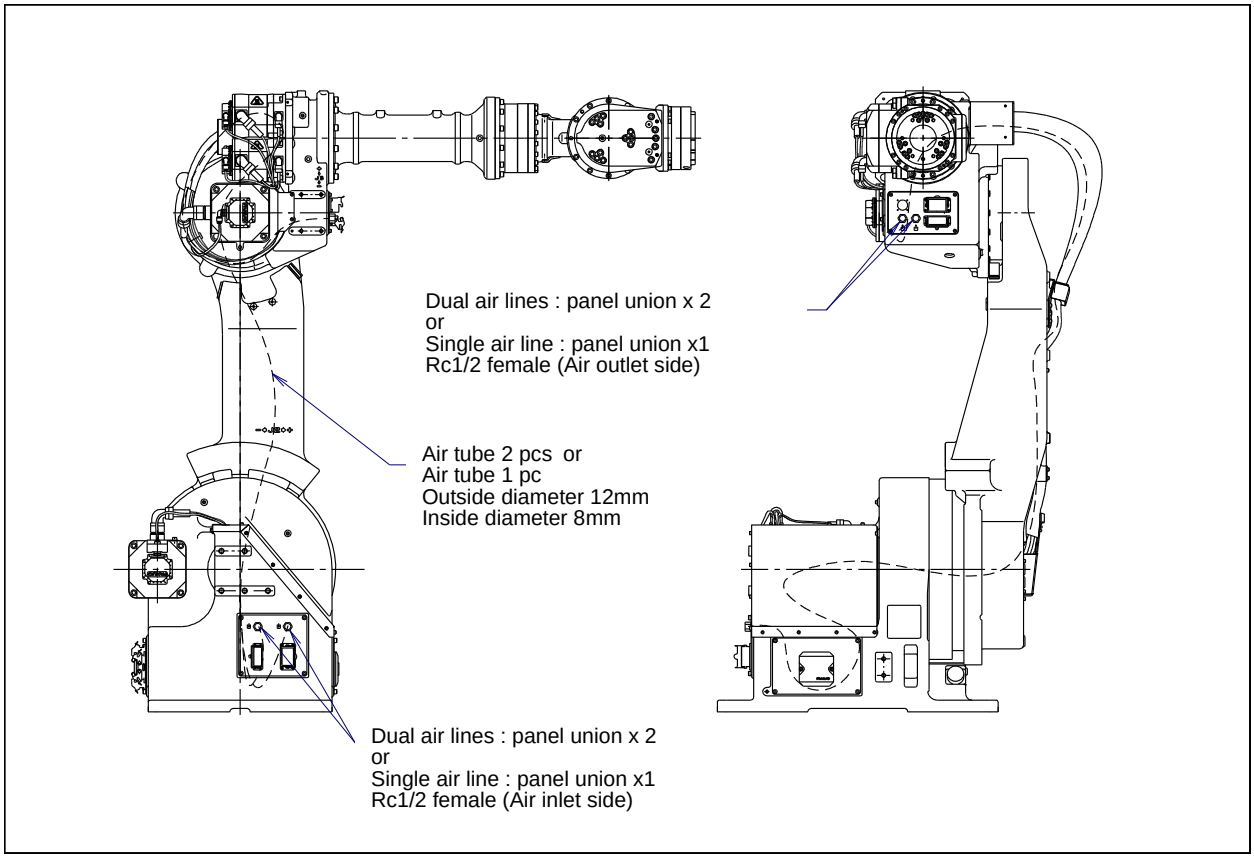


Fig. 9.6 (a) Air-pressure supply connection (option)

9.7 INTERFACE FOR OPTION CABLE (OPTION)

⚠ WARNING

- Use mechanical unit cables that have required user interface.
- Don't add user cable or hose to inside of mechanical unit.
- Please do not obstruct the movement of the mechanical unit cable when cables are added to outside of mechanical unit.
- Please do not perform remodeling (Adding a protective cover and fix an outside cable more) obstructing the behavior of the outcrop of the cable.
- Please do not interfere with the other parts of mechanical unit when equipment is installed in the robot.
- Cut unnecessary length of wire rod. Make insulation processing like winding acetate tape. (See Fig. 9.7 (a))
- If you can not prevent electrostatic charge of work and end effector, keep away an end effector (a hand) cable from an end effector and a work as much as possible, when wiring it. When they come to close unavoidable, make insulation processing between them.
- Be sure to seal connectors of hand side and robot side and terminal parts of cables, to prevent water from entering the mechanical unit Also, attach cover to unused connector.
- Check looseness of connector and wound of coating of cables routinely.
- When these attentions are not kept, unexpected troubles might occur.

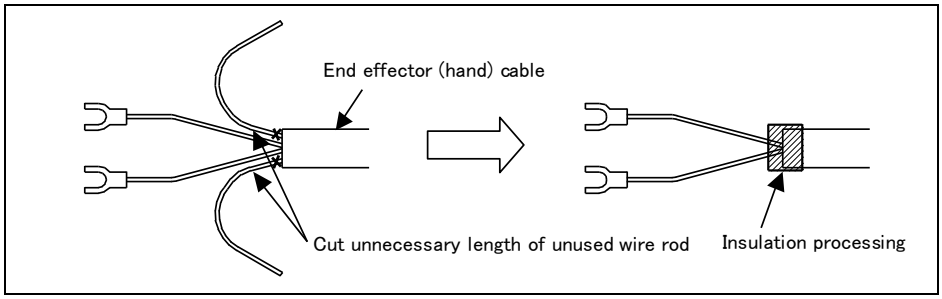


Fig. 9.7 (a) Treatment method of end effector (hand) cable

Fig. 9.7 (b) to (e) show the position of the end effecter interface. EE interface (RI/RO), I/O Unit-MODEL B interface and user cable (signal lines, power lines), DeviceNet cable (signal lines, power lines) and Additional axis motor cable (power, brake/Pulsecoder) and Ethernet cable (signal line/power line) are prepared as options.

NOTE

Each option cable is written like below on connector panel

EE(RI/RO) interface	: EE
I/O Unit Model B	: I/O
User cable (signal)	: AS
User cable (power)	: AP
DeviceNet cable (signal)	: DS
DeviceNet cable (power)	: DP
Additional axis motor cable (Pulsecoder)	: ARP
Additional axis motor cable (power,brake)	: ARM
Ethernet cable (signal)	: ES
Ethernet cable (power)	: EP

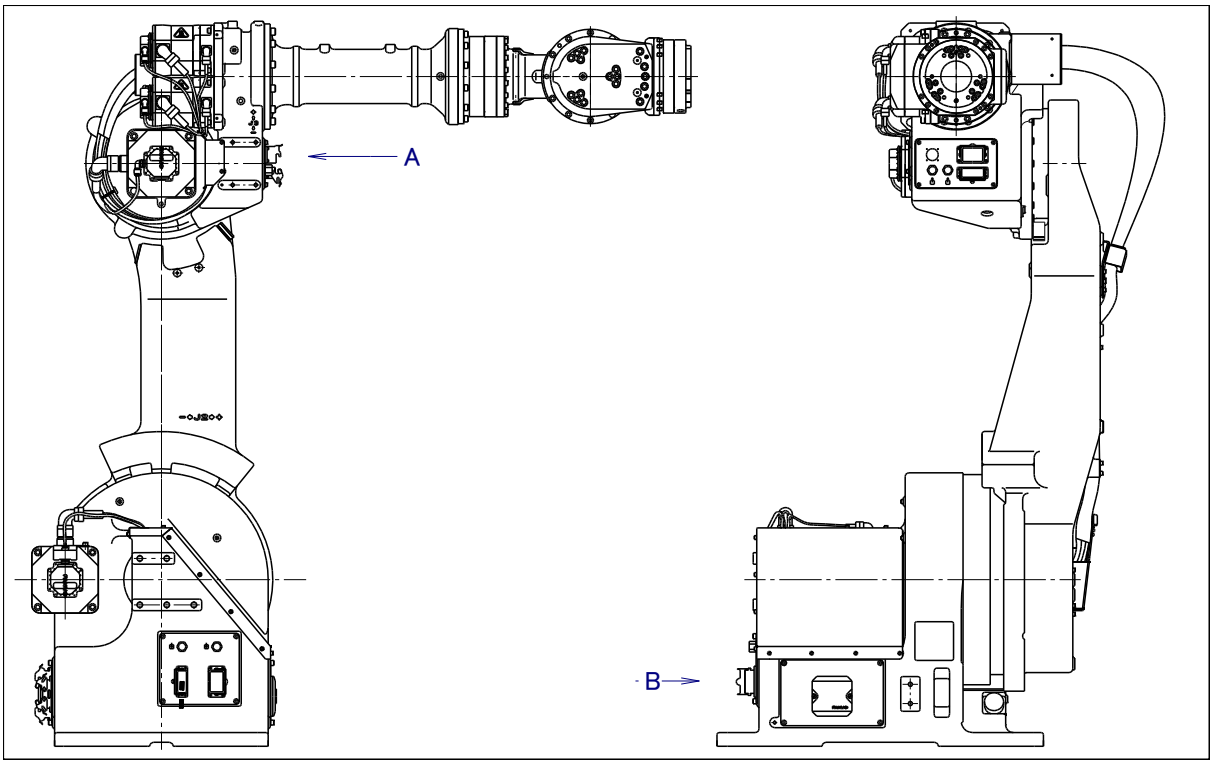
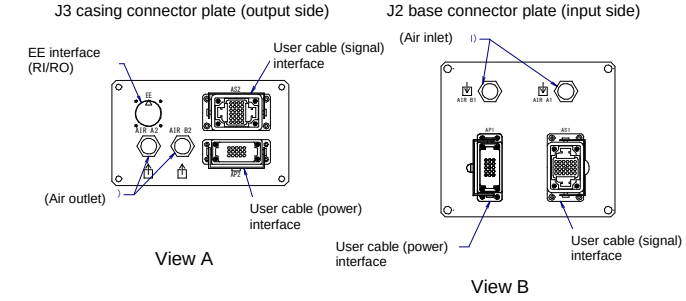
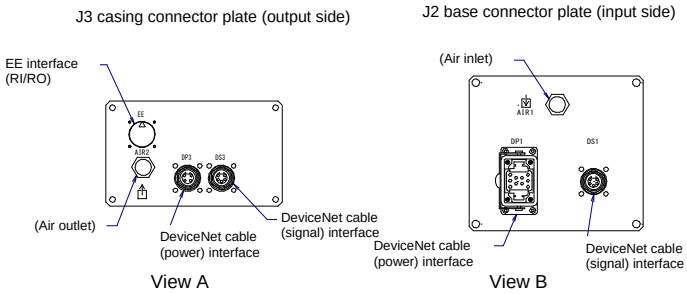


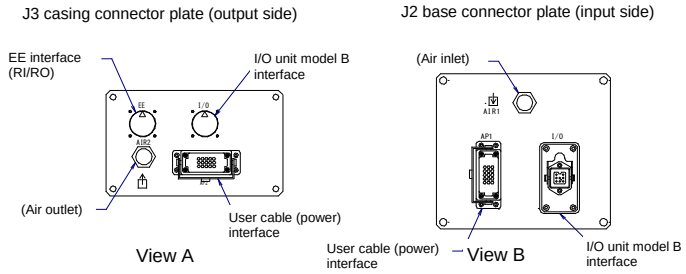
Fig. 9.7 (b) Interface for option cable (Option)



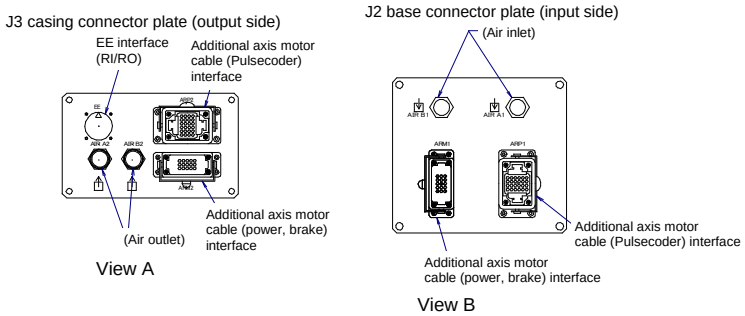
With user cable (signal/power)
Cable spec. :
A05B-1324-H801 (R-2000*i*A/200T)
A05B-1324-H871 (R-2000*i*B/200T)



With DeviceNet cable (signal/power)
Cable spec. :
A05B-1324-H802 (R-2000*i*A/200T)
A05B-1324-H872 (R-2000*i*B/200T)



With I/O unit MODEL B and user cable (power)
Cable spec. :
A05B-1324-H803 (R-2000*i*A/200T)
A05B-1324-H873 (R-2000*i*B/200T)



With additional axis motor cable (power, brake/Pulsecoder)
Cable spec. :
A05B-1324-H804 (R-2000*i*A/200T)
A05B-1324-H874 (R-2000*i*B/200T)

Fig. 9.7 (c) Layout of interface for option cable

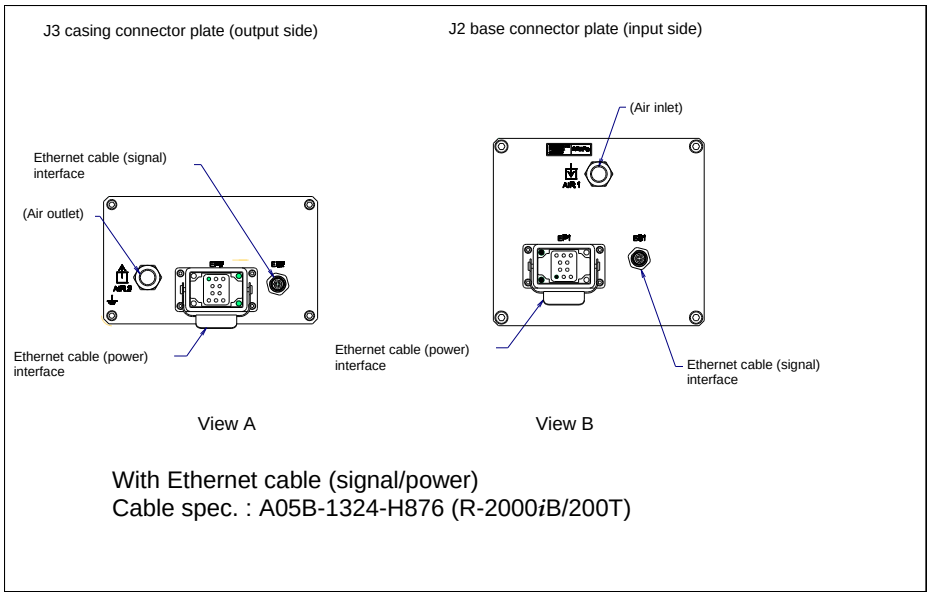
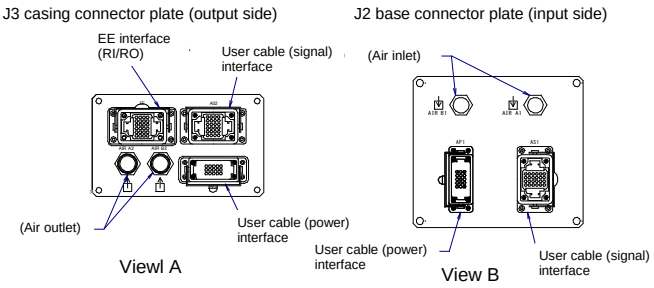
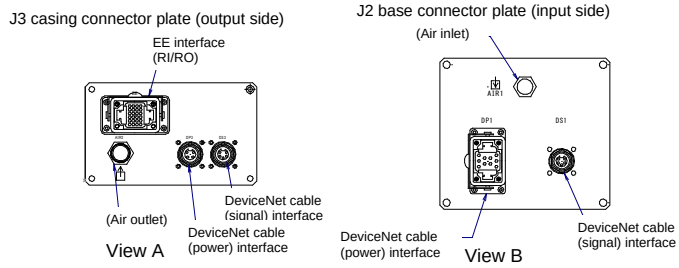


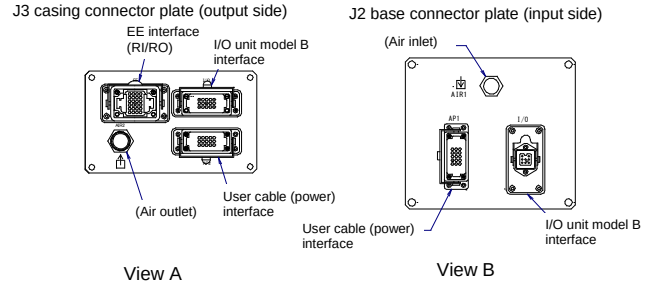
Fig. 9.7 (d) Layout of interface for option cable



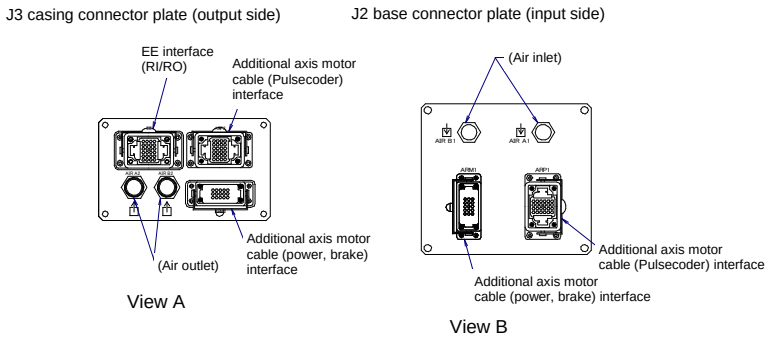
With user cable (signal/power)
Cable spec. :
A05B-1324-H801 (R-2000*i*A/200T)
A05B-1324-H871 (R-2000*i*B/200T)



With DeviceNet cable (signal/power)
Cable spec. :
A05B-1324-H802 (R-2000*i*A/200T)
A05B-1324-H872 (R-2000*i*B/200T)



With I/O unit MODEL B and user cable (power)
Cable spec. :
A05B-1324-H803 (R-2000*i*A/200T)
A05B-1324-H873 (R-2000*i*B/200T)



With additional axis motor cable (power, brake/Pulsecoder)
Cable spec. :
A05B-1324-H804 (R-2000*i*A/200T)
A05B-1324-H874 (R-2000*i*B/200T)

Fig. 9.7 (e) Layout of interface for option cable
(When severe dust/liquid protection option is specified)

1 EE interface (RI/RO) (Option)

Fig. 9.7 (f) to (i) show pin layout for EE interface (RI/RO). When severe dust/liquid protection package is specified, the connector has guide pins and bushes for preventing improper insertion. For cables prepared by the user, use these guide pins and bushes.

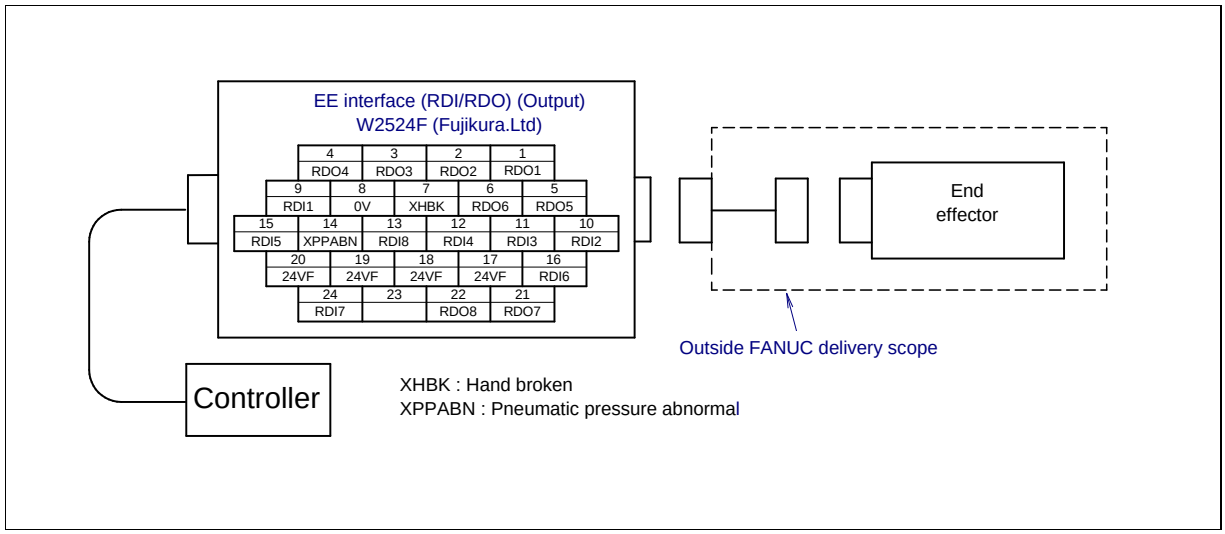


Fig. 9.7 (f) Pin layout for EE interface (RDI/RDO) (option)
(R-2000*i*A/200T)

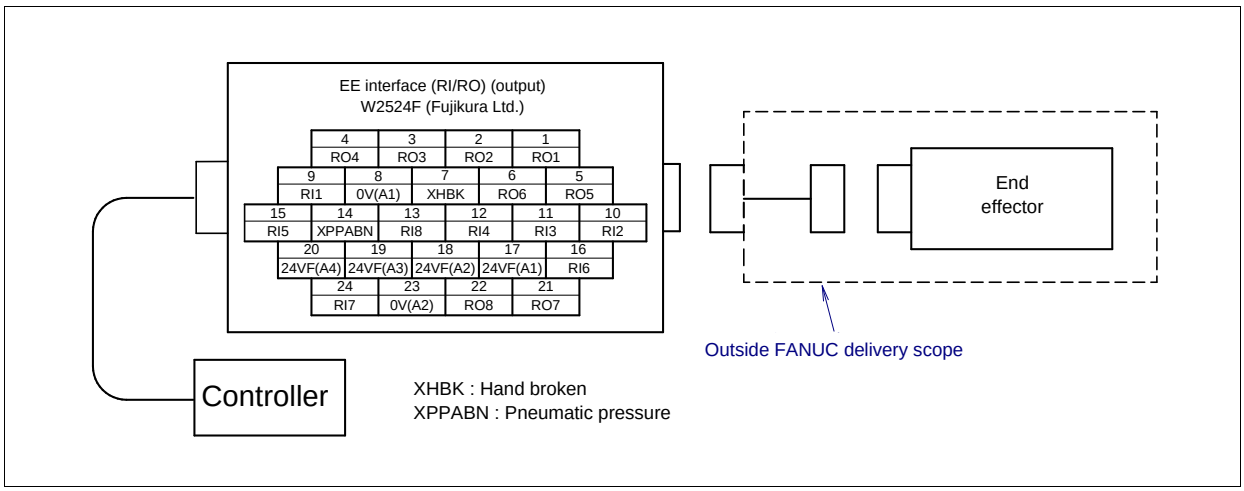


Fig. 9.7 (g) Pin layout for EE interface (RI/RO) (option)
(R-2000*i*B/200T)

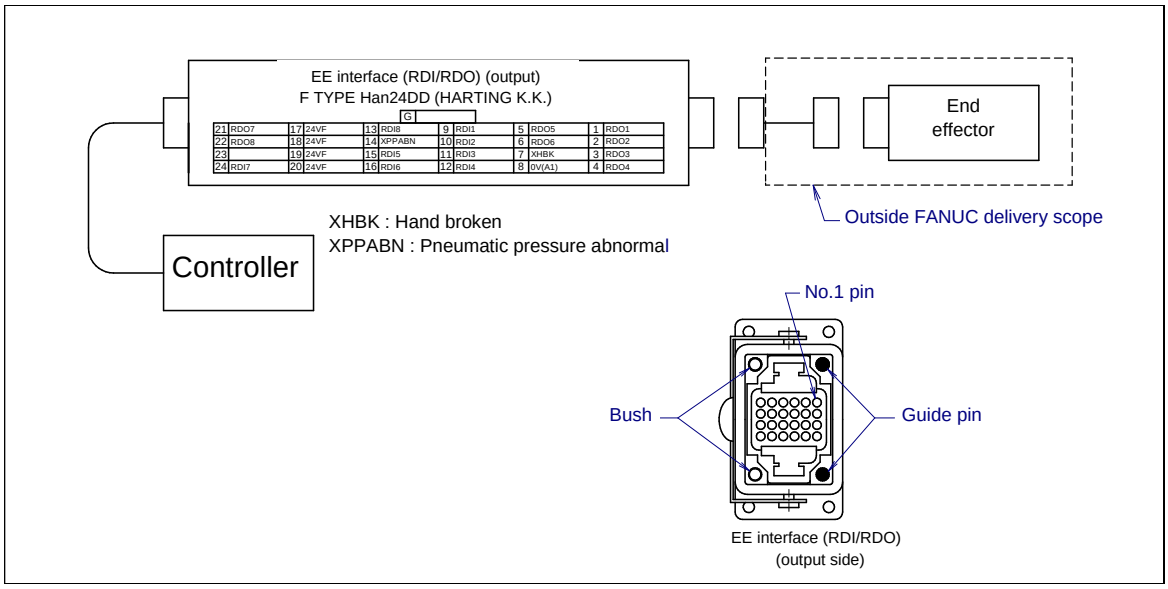


Fig. 9.7 (h) Pin layout for EE interface (RDI/RDO)
(When the severe dust/liquid protection package is selected) (Option) (For R-2000*i*A/200T)

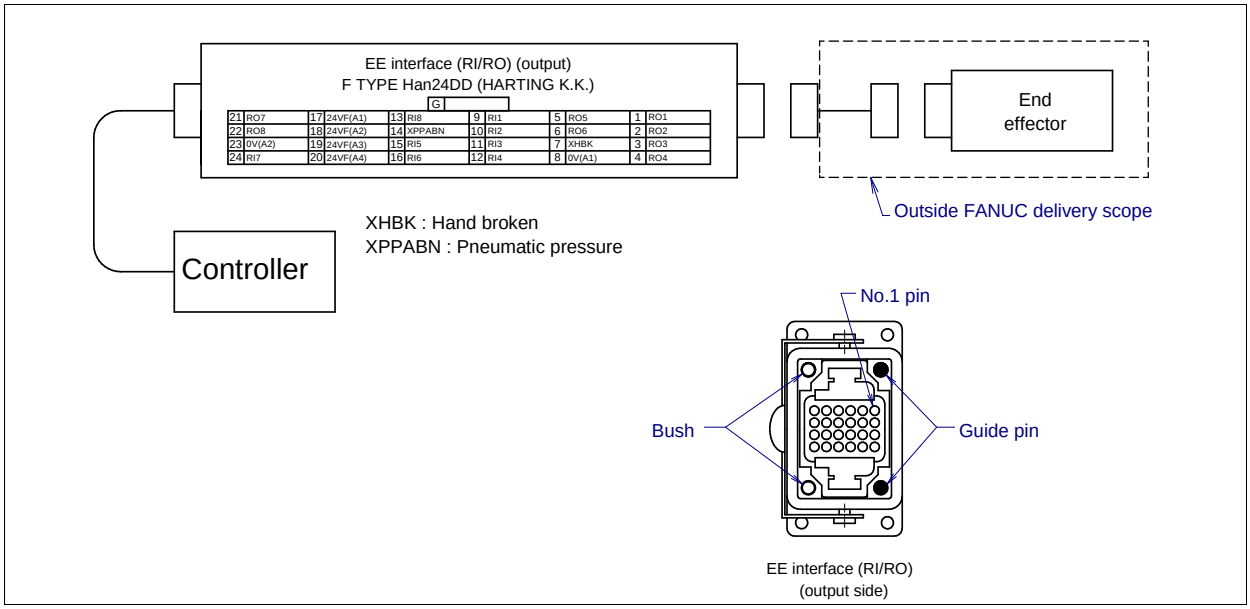


Fig. 9.7 (i) Pin layout for EE interface (RI/RO)
(When the severe dust/liquid protection package is selected) (Option) (For R-2000*i*B/200T)

2 I/O Unit-MODEL B interface (Option)

Fig. 9.7 (j) shows pin layout for I/O Unit-MODEL B interface.

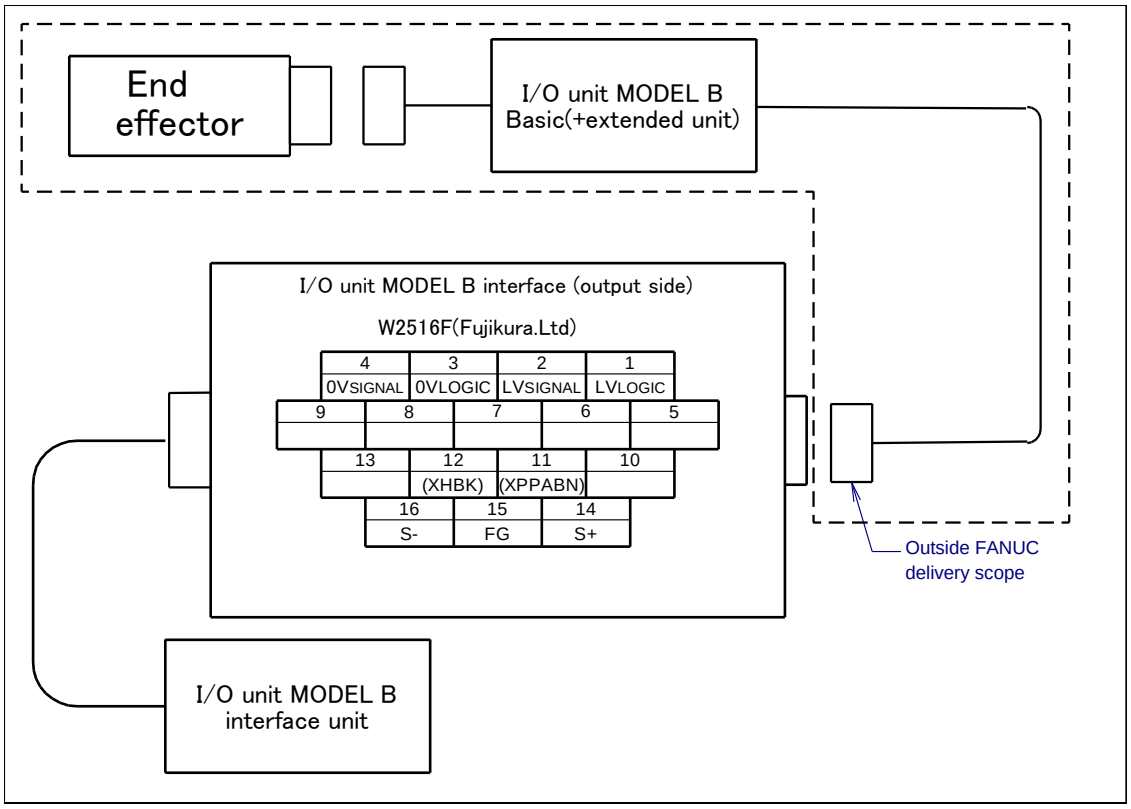


Fig. 9.7 (j) Pin layout for I/O Unit-MODEL B interface (option)

3 User cable (signal line) (AS) Interface (option)
Fig. 9.7 (k) shows pin layout for user cable (signal line) interface. The connector has a code pin for preventing improper insertion. For cables prepared by the user, use this code pin.

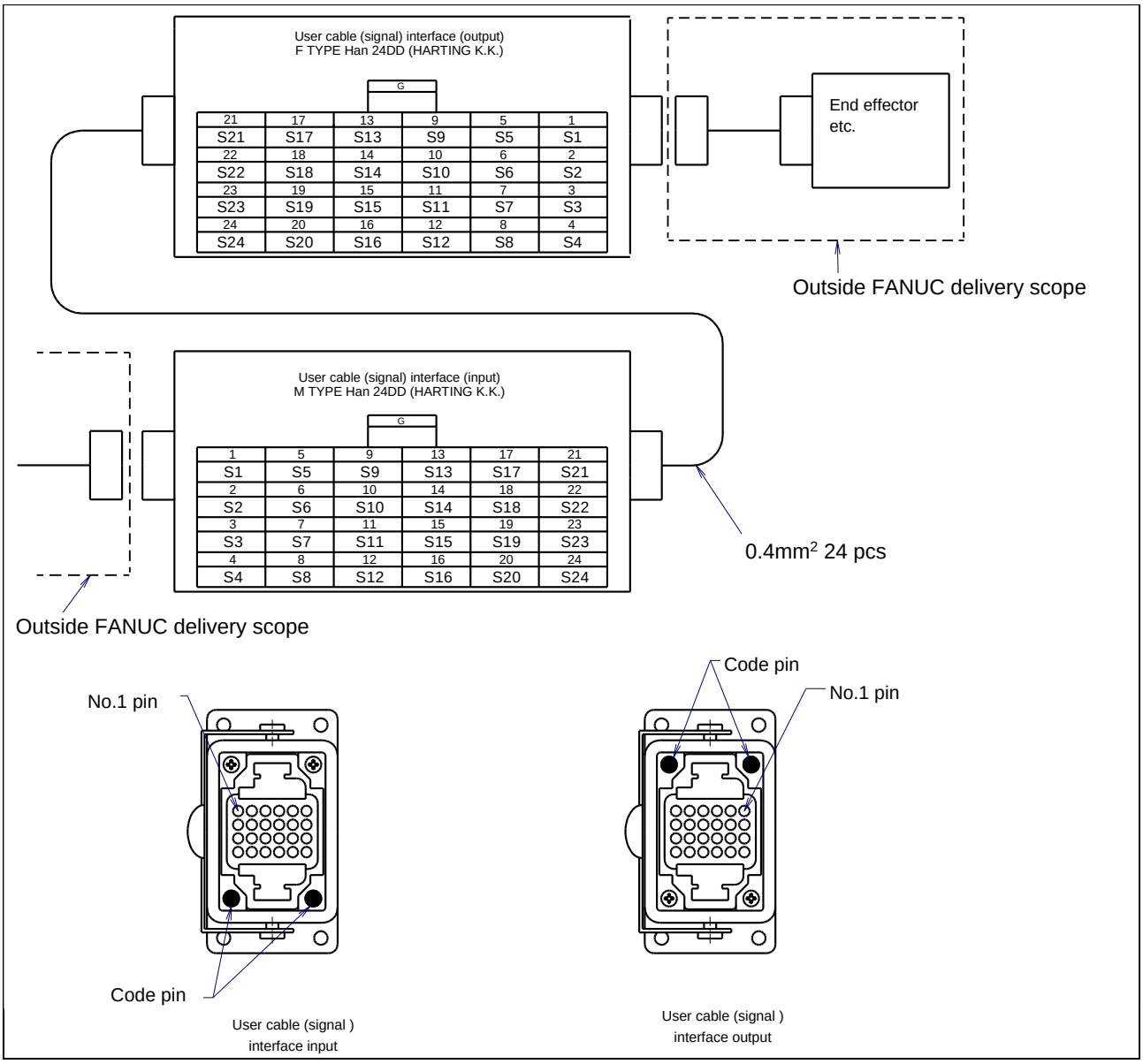


Fig. 9.7 (k) Pin layout for user cable (signal line) (AS) interface and code pin layout (option)

4 User cable (power line) (AP) Interface (option)
Fig. 9.7 (l) shows the pin layout for the user cable (power line) interface. The connector has a code pin for preventing improper insertion. The code pin is required for the cable which is prepared by the user.

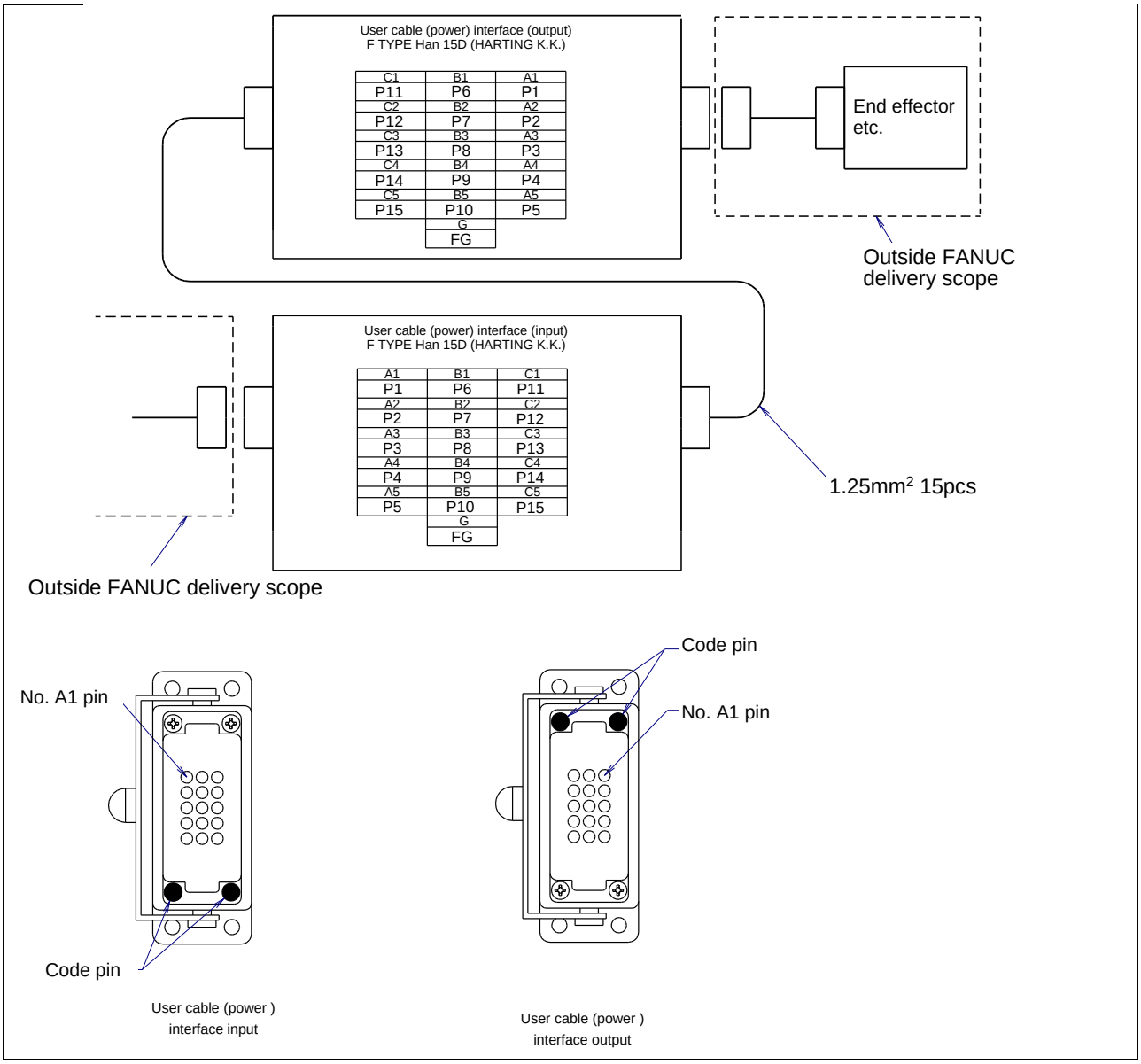


Fig. 9.7 (l) Pin layout for user cable (power line) (AP) interface and code pin layout (option)

5 DeviceNet cable (signal line) (DS) interface (option)
Fig. 9.7 (m) shows pin layout for DeviceNet cable (signal line) interface.

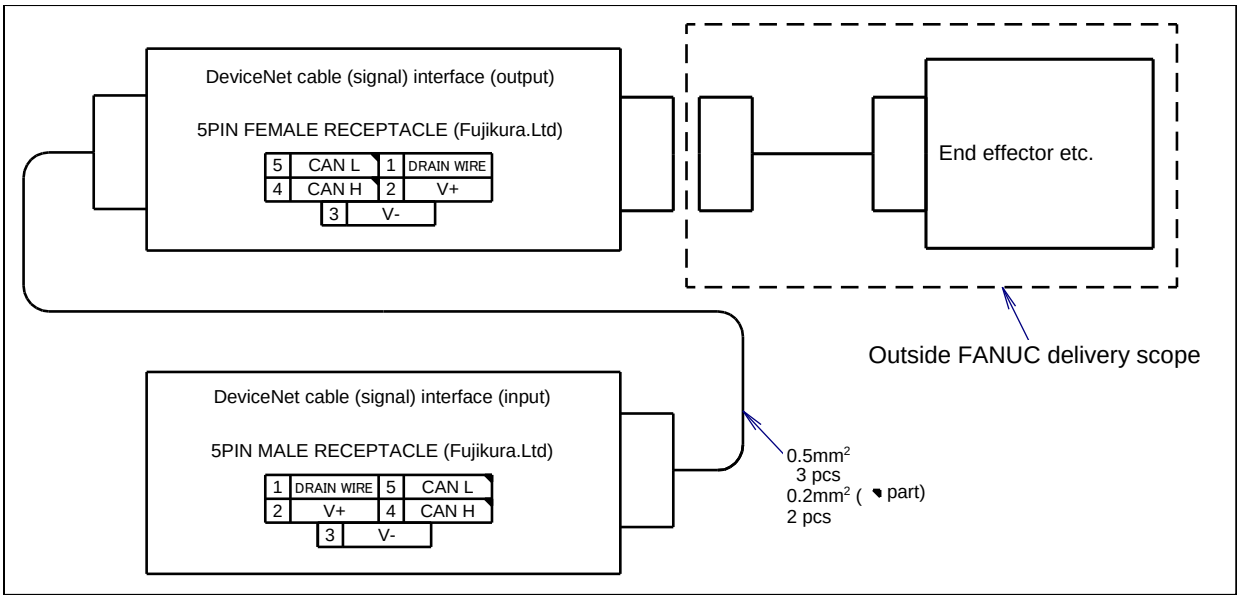


Fig. 9.7 (m) Pin layout for DeviceNet cable (signal line) (DS) interface (option)

6 DeviceNet cable (power line) (DP) interface (option)
Fig. 9.7 (n) shows pin layout for DeviceNet cable (power line) interface.

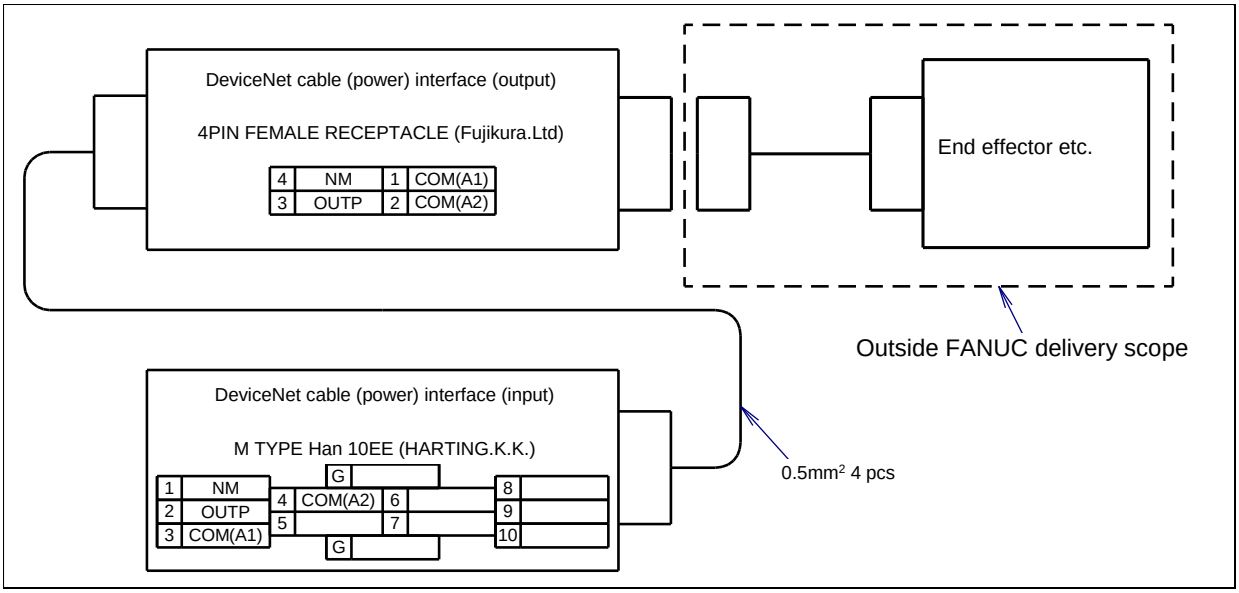


Fig. 9.7 (n) Pin layout for DeviceNet cable (power line) (DP) interface (option)

7 Additional axis motor cable (Pulsecoder line) (ARP) interface (option)
Fig. 9.7 (o) shows pin layout for Additional axis motor cable (Pulsecoder line) interface.
The connector has a code pin for preventing improper insertion.

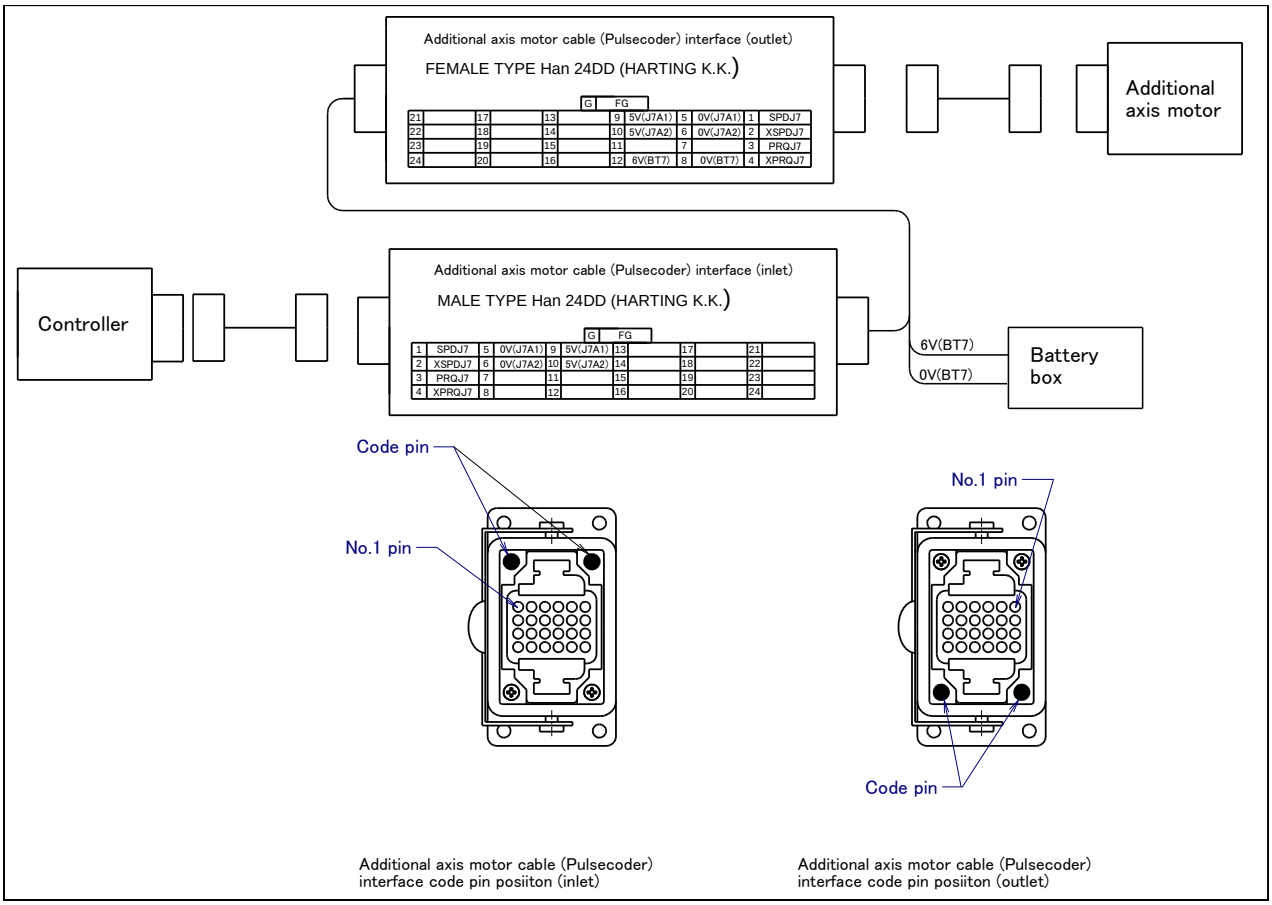


Fig. 9.7 (o) Pin layout for additional axis motor cable (Pulsecoder line) (ARP) interface (option)

Table 9.7 (a) Comparative table of signal name according to the motor

ARP	α motor, β motor	αi, αi –B motor, βi, βi-B motor
SPD	SD	-
XSPD	*SD	-
PRQ	REQ	RD
XPRQ	*REQ	*RD

8 Additional axis motor cable (power and brake cables))(ARM) Interface (option)
Fig.9.7 (p) shows pin layout for Additional axis motor cable (power and brake cables) interface. The connector has a code pin for preventing improper insertion.

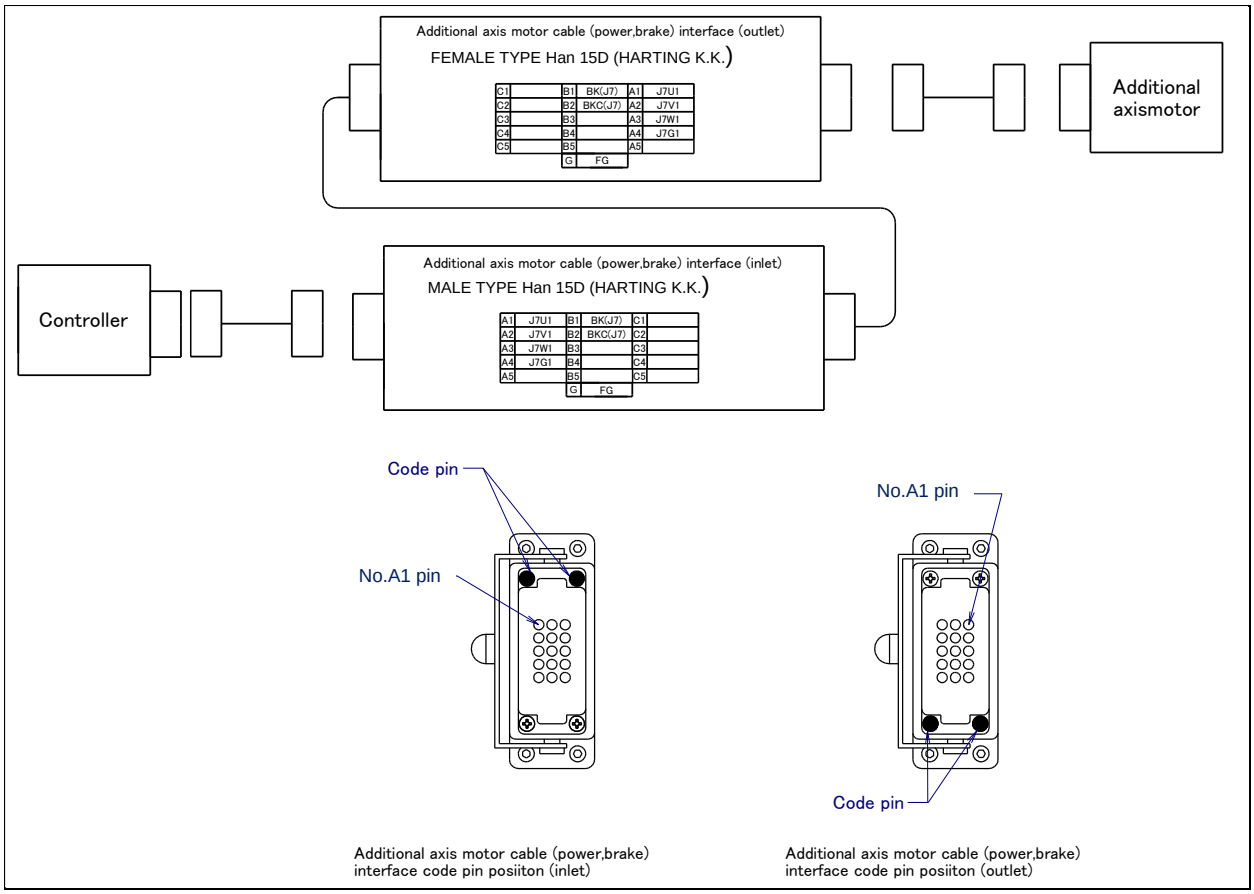


Fig. 9.7 (p) Pin layout for additional axis motor cable (power and brake cables) (ARM) interface (option)

9 Ethernet cable (signal line) (ES) interface (option)
Fig. 9.7 (q) shows the pin layout of the Ethernet cable (signal line) (ES) interface.

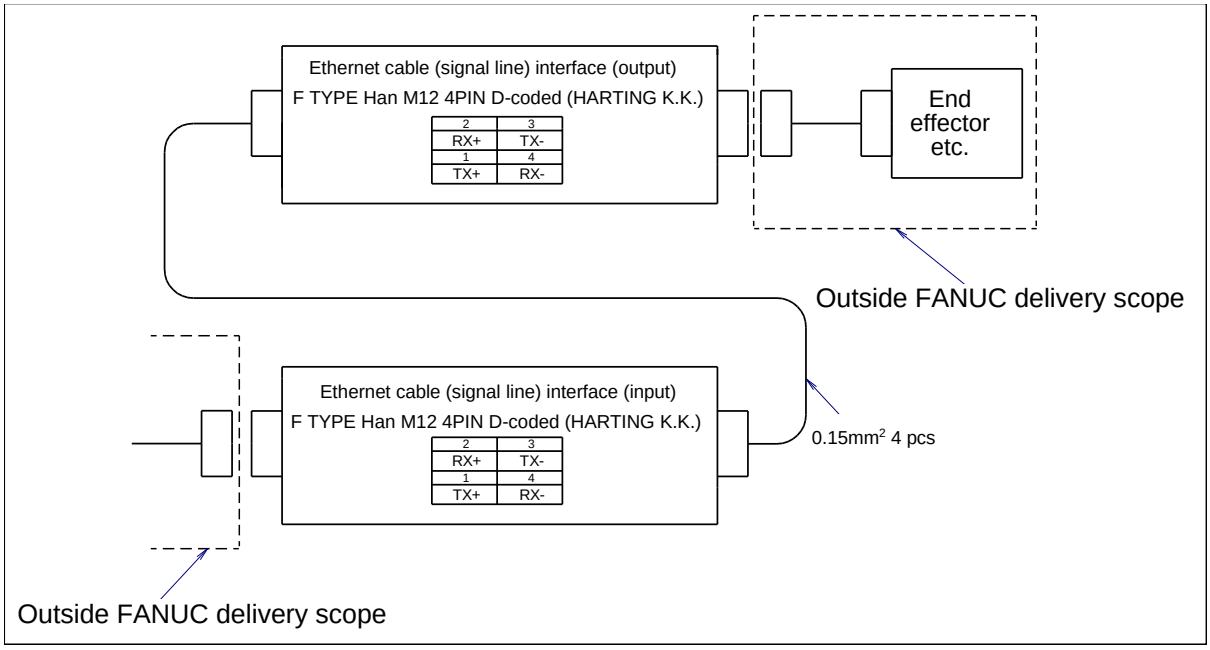


Fig. 9.7 (q) Pin layout for Ethernet cable (signal line) (ES) interface (option)

10 Ethernet cable (power line) (EP) interface (option)
Fig. 9.7 (r) shows the pin layout of the Ethernet cable (power line) (EP) interface. The connector has a code pin for preventing improper insertion.

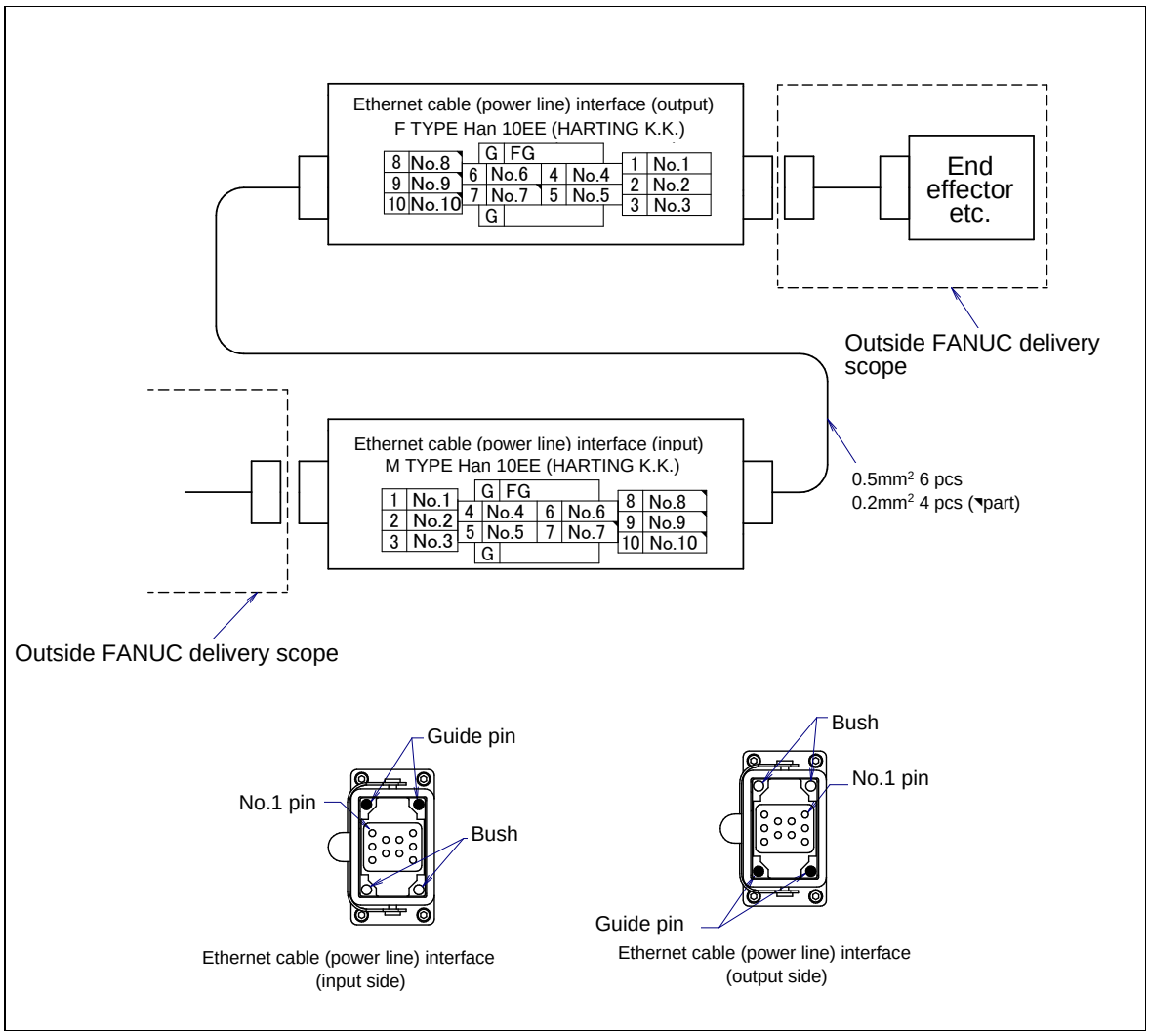


Fig. 9.7 (r) Pin layout for Ethernet cable (power line) (EP) interface (option)

Table 9.7 (b) Connector specifications (Machine side)

Cable	Input side (J1 connector panel)		Maker /dealer	Output side (J3 connector panel)		Maker /dealer
EE (RI/RO)	———		———	JMWR2524F		Fujikura Ltd.
I/O	———		—	JMWR2516F		
EE (RI/RO) (When severe dust/liquid protection package is specified)	———		———	Housing Insert Contact Guide pin Bush	09 30 006 0301 09 16 024 3101 09 15 000 6204 09 33 000 9908 09 33 000 9909	HARTING K.K.
AS	Housing Insert Contact Code pin	09 30 006 0301 09 16 024 3001 09 15 000 6103 09 30 000 9901	HARTING K.K.	Housing Insert Contact Code pin	09 30 006 0301 09 16 024 3101 09 15 000 6203 09 30 000 9901	
AP	Housing Insert Contact Code pin	09 20 010 0301 09 21 015 3001 09 15 000 6101 09 30 000 9901		Housing Insert Contact Code pin	09 20 010 0301 09 21 015 3101 09 15 000 6201 09 30 000 9901	
ARP	Housing Insert Contact Contact Code pin	09 30 006 0301 09 16 024 3001 09 15 000 6103 09 15 000 6104 09 30 000 9901		Housing Insert Contact Contact Code pin	09 30 006 0301 09 16 024 3101 09 15 000 6203 09 15 000 6204 09 30 000 9901	
ARM	Housing Insert Contact Code pin	09 20 010 0301 09 21 015 3001 09 15 000 6101 09 30 000 9901		Housing Insert Contact Code pin	09 20 010 0301 09 21 015 3101 09 15 000 6201 09 30 000 9901	
ES	Connector Contact	21 03 881 2425 09 67 000 7476		Connector Contact	21 03 881 2425 09 67 000 7476	
EP	Housing Insert Contact Contact Guide pin Bush	09 30 006 0301 09 32 010 3001 09 33 000 6105 09 33 000 6121 09 30 000 9908 09 30 000 9909		Housing Insert Contact Contact Guide pin Bush	09 30 006 0301 09 32 010 3101 09 33 000 6205 09 33 000 6220 09 30 000 9908 09 30 000 9909	
DS	84854-9101		MOLEX JAPAN CO., LTD.	84854-9100		MOLEX JAPAN CO., LTD.
DP	Housing Insert Contact	09 30 006 0301 09 32 010 3001 09 33 000 6105	HARTING K.K.	84854-9102		

Table 9.7 (c) Connector specifications (User side) (1/2)

Cable	Input side (J1 connector panel)		Output side (J3 connector panel)		Maker /dealer
EE (RI/RO)	———		JMSP2524M (*1) Straight plug JMLP2524M Angle plug		Fujikura Ltd.
I/O	———		JMSP2516M (*2) Straight plug JMLP2516M Angle plug		
AS	Hood (NOTE 2)	09 30 006 1540 Side entry 1541 ↓ 0542 0543 1440 Top entry 1441 ↓ 0442 0443	Hood	← same as left	HARTING K.K.
	Insert	09 16 024 3101	Insert	09 16 024 3001	
	Contact (NOTE 2)	09 15 000 6204 AWG 26-22 6203 AWG 20 6205 AWG 18 6202 AWG 18 6201 AWG 16 6206 AWG 14	Contact (NOTE 2)	09 15 000 6104 AWG 26-22 6103 AWG 20 6105 AWG 18 6102 AWG 18 6101 AWG 16 6106 AWG 14	
	Clamp (NOTE 2)	09 00 000 5083 5086 5090 5094 etc. Many other types are available	Clamp	← same as left	
	Code pin	09 30 000 9901	Code pin	09 30 000 9901	
AP	Hood (NOTE 2)	09 20 010 1541 Side entry 0540 ↓ 0541 1440 Top entry 0440 ↓ 0441	Hood	← same as left	
	Insert	09 21 015 3101	Insert	09 21 015 3001	
	Contact (NOTE 2)	09 15 000 6204 AWG 26-22 6203 AWG 20 6205 AWG 18 6202 AWG 18 6201 AWG 16 6206 AWG 14	Contact (NOTE 2)	09 15 000 6104 AWG 26-22 6103 AWG 20 6105 AWG 18 6102 AWG 18 6101 AWG 16 6106 AWG 14	
	Clamp (NOTE 2)	09 00 000 5083 5086 5090 5094 etc. Many other types are available	Clamp	← same as left	
	Code pin	09 30 000 9901	Code pin	09 30 000 9901	

Table 9.7 (d) Connector specifications (User side) (2/2)

Cable	Input side (J1 connector panel)		Output side (J3 connector panel)		Maker /dealer
EE (RI/RO) (When severe dust/liquid protection package is specified)	———		Hood (NOTE 2)	09 30 006 1540 Side entry 1541 ↓ 0542 0543 ↓ 1440 (*3) Top entry 1441 ↓ 0442 0443	HARTING K.K.
			Insert	09 16 024 3001 (*4)	
			Contact (24 pcs)	09 15 000 6104 (*5) AWG 26-22 6103 AWG 20 6105 AWG 18 6102 AWG 18 6101 AWG 16 6106 AWG 14	
			Clamp (NOTE 2)	09 00 000 5085 (*6) 5086 5090 5094 Many other types are available	
			Guide pin (2 pcs)	09 33 000 9908 (*7)	
			Bush (2 pcs)	09 33 000 9909 (*8)	
ES	Connector	21 03 881 1415	Connector	←The same	
	Contact (NOTE 2)	09 67 000 7576 AWG 28-24 5576 AWG 26-22 8576 AWG 24-20 3576 AWG 22-18	Contact	←same as left	
EP	Hood (NOTE 2)	09 20 010 1540 Side entry 1541 ↓ 0542 0543 ↓ 1440 Top entry 1441 ↓ 0442 0443	Hood	← same as left	
	Insert	09 32 010 3101	Insert	09 32 010 3001	
	Contact (NOTE 2)	09 33 000 6220 AWG 20 6214 AWG 18 6205 AWG 18 6204 AWG 16 6202 AWG 14 6207 AWG 12	Contact (NOTE 2)	09 33 000 6121 AWG 20 6114 AWG 18 6105 AWG 18 6104 AWG 16 6102 AWG 14 6107 AWG 12	
	Clamp (NOTE 2)	09 00 000 5083 5086 5090 5094 Many other types are available.	Clamp	← same as left	
	Guide pin	09 30 000 9908	Guide pin	← same as left	
	Bush	09 30 000 9909	Bush	← same as left	

NOTE 1

Underlined parts are attached. Below shows spec. to order in our company.
(*1)A63L-0001-0234#S2524M
(*2)A63L-0001-0234#S2516M
(*3)A63L-0001-0453#06B1440
(*4)A63L-0001-0453#24DDM
(*5)A63L-0001-0453#CA6104
(*6)A63L-0001-0453#A-152D
(*7)A63L-0001-0453#A-9908
(*8)A63L-0001-0453#A-9909

NOTE 2

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

Table 9.7 (e) Connector specifications (DeviceNet cable, on the user equipment side)

Cable name	Input side (J2 base)			Maker/ Dealer	Output side (J3 casing)	Maker/ Dealer
DS	MINI connector for use on the device net 5-pin, female CM03-P5S			Fujikura Ltd.	MINI connector for use on the device net 5-pin, male CM03-J5P	Fujikura Ltd.
DP	Hood (NOTE 2)	09 30 006 1540 1541 0542 0543 1440 1441 0442 0443	Side entry ↓ Top entry ↓	HARTING K.K.	MINI connector for use on the device net 4-pin, male CM03-J4P	Fujikura Ltd.
	Insert	09 32 010 3101				
	Contact (NOTE 2)	09 33 000 6220 6214 6205 6204 6202 6207	AWG20 AWG18 AWG18 AWG16 AWG14 AWG12			
	Clamp (NOTE 2)	09 00 000 5083 5086 5090 5094 Many other types are available.				

10 TRANSPORTATION AND INSTALLATION

10.1 TRANSPORTATION

1) Transportation using a crane
The robot can be transported by lifting it. When transporting the robot, mount the transport materials to the robot and change the attitude of the robot to that shown in Fig.10.1 (a) and lift by attaching slings to the four M20 eyebolts.

> ⚠ **CAUTION**
> When lifting the robot, take notice so that the motor, connectors, or cables of the robot are not damaged by slings.

2) Transportation using a forklift
The robots can also be transported using a forklift (Refer to Fig. 10.1 (b)).

> ⚠ **CAUTION**
> When using a forklift to transport the robot, remove the eyebolt (fastened with a nut) from a transport material on the right side of the robot.

> ⚠ **WARNING**
> When a peripherals are installed on a robot, the center of gravity of the robot changes and the robot might become unstable while being transported.
>
> Robot becomes unstable when it is transported with the end effector applied to wrist ,and it is dangerous. Please be sure to remove end effector when robot is transported.
>
> Use the forklift pockets only to transport the robot with a forklift. Do not use the forklift pockets to secure the robot.
> Before moving the robot by using forklift pockets, check and tighten any loose bolts on the forklift pockets.

> ⚠ **CAUTION**
> When hoisting or lowering the robot with a crane or forklift, move it slowly, and with great care. When placing the robot on the floor, exercise care to prevent the installation surface of the robot from striking the floor.

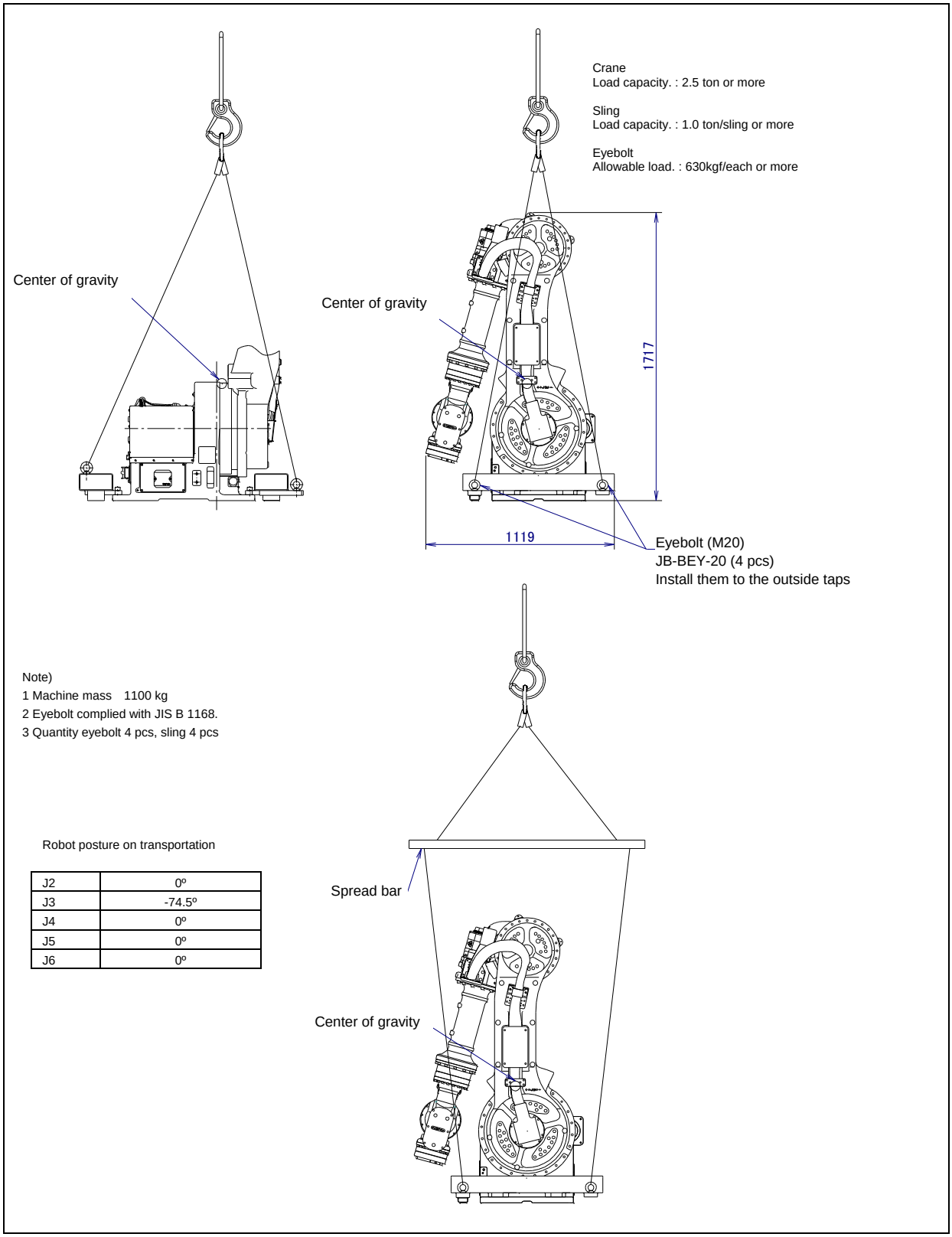


Fig. 10.1 (a) Transportation using a crane

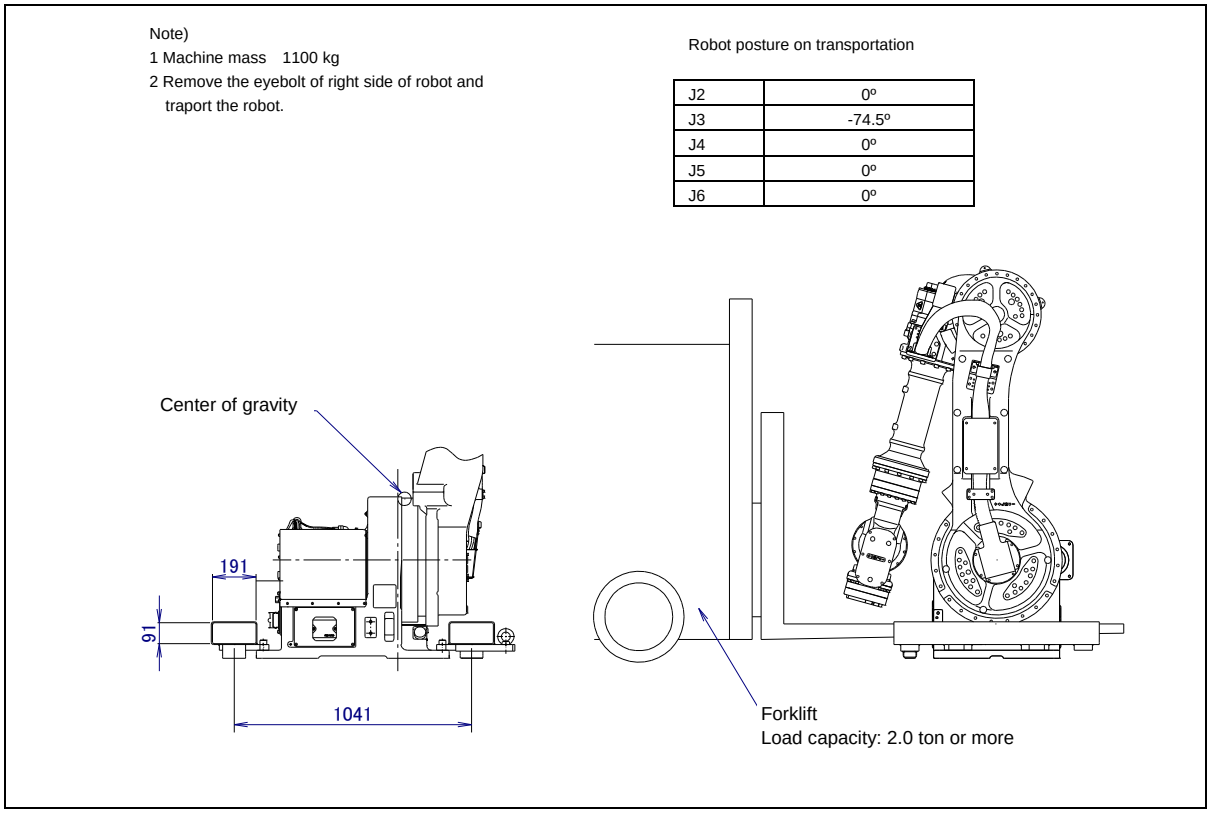


Fig. 10.1 (b) Transportation using a forklift

> ⚠ **CAUTION**
> Be careful not to strike the transport equipment with the forklift forks.

10.2 INSTALLATION

Fig. 10.2 (a) shows the robot base dimensions.

Avoid placing any object in front of the robot on the mounting surface to facilitate the installation of the mastering fixture, as shown in Fig. 10.2 (a) (shaded portion).

> **NOTE**
> 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 0.5º.
> If robot base is placed on uneven ground, it may result in the base breakage or low performance of the robot.

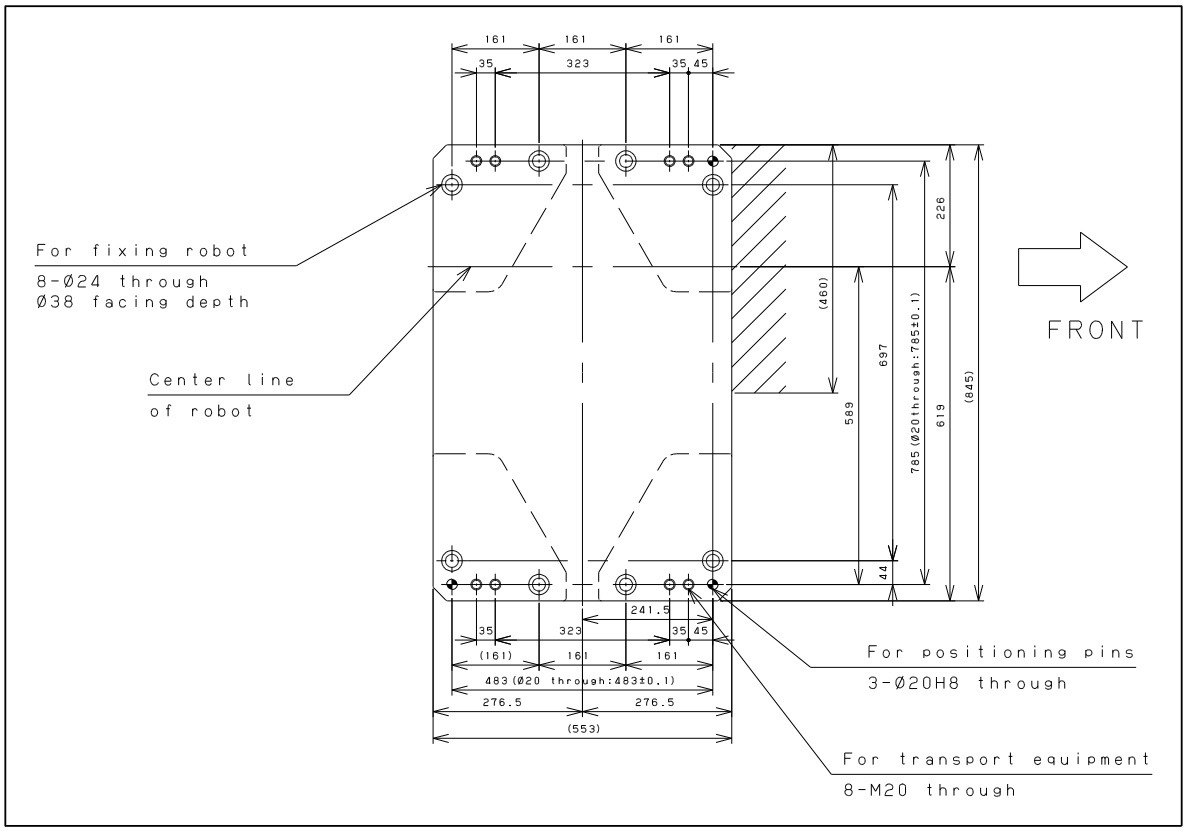


Fig. 10.2 (a) Dimensions of the robot base

Fig.10.2 (b) and Table 10.2 (a) and (b) show the force and moment applied to the robot mounting surface. Table 10.2 (c) and (d) indicate the stopping distance and time of the J2, J3 axis until the robot stopping by Power-Off stop or by Controlled stop after input of the stop signal. Refer to the data when considering the strength of the installation face.
The J1 axis is assumed to have a maximum speed of 2.5 m/s, an acceleration/deceleration time constant of 600 ms, and an Power-Off-stop time constant of 200 ms. Note that as the operating conditions of the J1 axis differ, the load to be applied also varies.

NOTE
Table 10.2 (c) and (d) 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 10.2 (c) 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 10.2 (a) Force and moment on the robot mounting surface (on ceiling mount)

	At rest	At acceleration/ deceleration	At emergency stop
Fx[kN (kgf)]	0 (0)	5.4 (551)	18.0 (1832)
Fy[kN (kgf)]	0 (0)	7.9 (810)	23.8 (2431)
Fz[kN (kgf)]	18.2 (1859)	23.6 (2410)	36.2 (3690)
Mx[Nm (kgfm)]	2675 (273)	10888 (1111)	27303 (2786)
My[Nm (kgfm)]	10829 (1105)	23412 (2389)	54547 (5566)
Mz[Nm (kgfm)]	0 (0)	4792 (489)	14386 (1468)

Table 10.2 (b) Force and moment on the robot mounting surface (on wall mount)

	At rest	At acceleration/ deceleration	At emergency stop
Fx[kN (kgf)]	18.2 (1859)	23.6 (2410)	36.2 (3690)
Fy[kN (kgf)]	0 (0)	7.9 (810)	23.8 (2431)
Fz[kN (kgf)]	0 (0)	5.4 (551)	18.0 (1832)
Mx[Nm (kgfm)]	0 (0)	8212 (838)	24627 (2513)
My[Nm (kgfm)]	16219 (1655)	31125 (3176)	67649 (6903)
Mz[Nm (kgfm)]	2675 (273)	7468 (762)	17062 (1741)

⚠ WARNING
Perform ceiling mounting or wall mounting with due attention to safety.

Table 10.2 (c) Stopping time and distance until the robot stopping by Power off stop after input of stop signal

	J2-axis	J3-axis
Stopping time [ms]	335	132
Stopping distance [deg] (rad)	11.4 (0.20)	5.6 (0.10)

Table 10.2 (d) Stopping time and distance until the robot stopping by Controlled stop after input of stop signal

	J2-axis	J3-axis
Stopping time [ms]	648	672
Stopping distance [deg] (rad)	24.8 (0.43)	32.5 (0.57)

⚠ CAUTION
The values listed in Table 10.2 (a) and (b) assume that the operating conditions of the J1-axis traveling unit are as follows:
Maximum speed : 2.5 m/s
Acceleration/deceleration time constant : 600 ms
Time constant at emergency stop : 200 ms
If the operating conditions exceed the above values, the robot mechanism may be adversely affected. In such a case, slow down the operation.

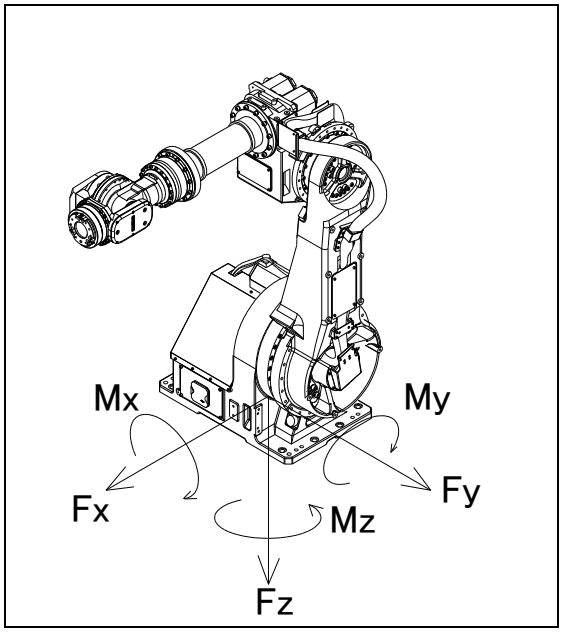
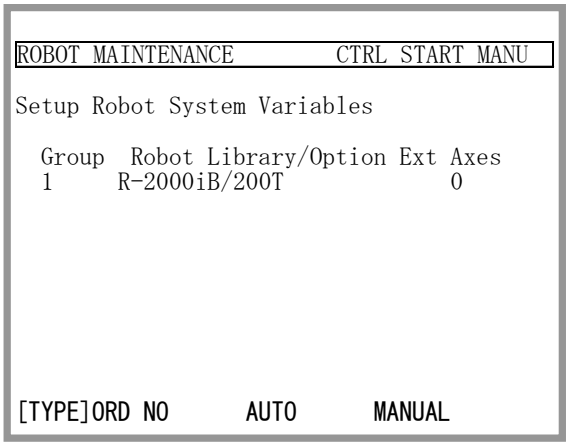


Fig. 10.2 (b) Force and moment during Power-Off Stop

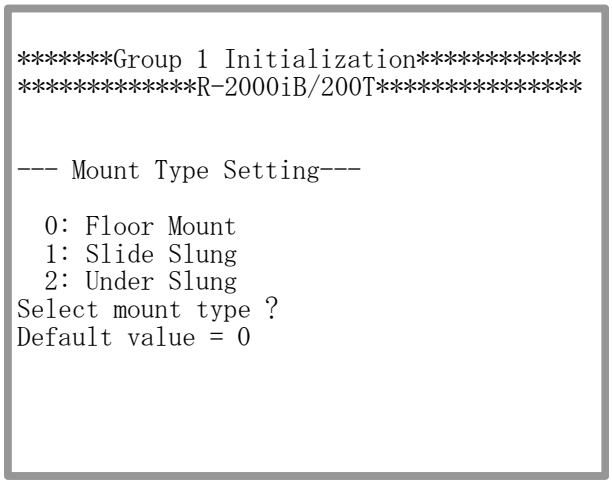
10.2.1 Angle of Mounting Surface Setting

To change the installation type, be sure to set the mounting angle referring to the procedure below. Refer to specifications in “PREFACE” 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.

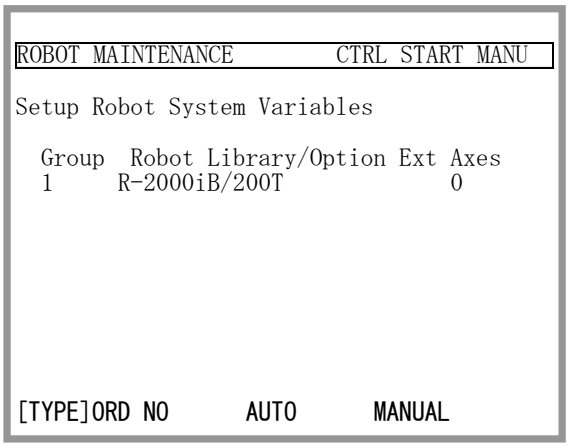


5 Press the [F4] key.
6 Press the [ENTER] key until screen below is displayed.



7 To change to the floor mount, input “0”.
To change to the wall mount (slide slung), input “1”.
To change to the upside-down mount (under slung), input “2”.

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



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

10.3 MAINTENANCE AREA

Fig. 10.3 (a) shows the maintenance area of the mechanical unit. Dotted line area is necessary for mastering. Be sure to leave enough room for the robot to be mastered.

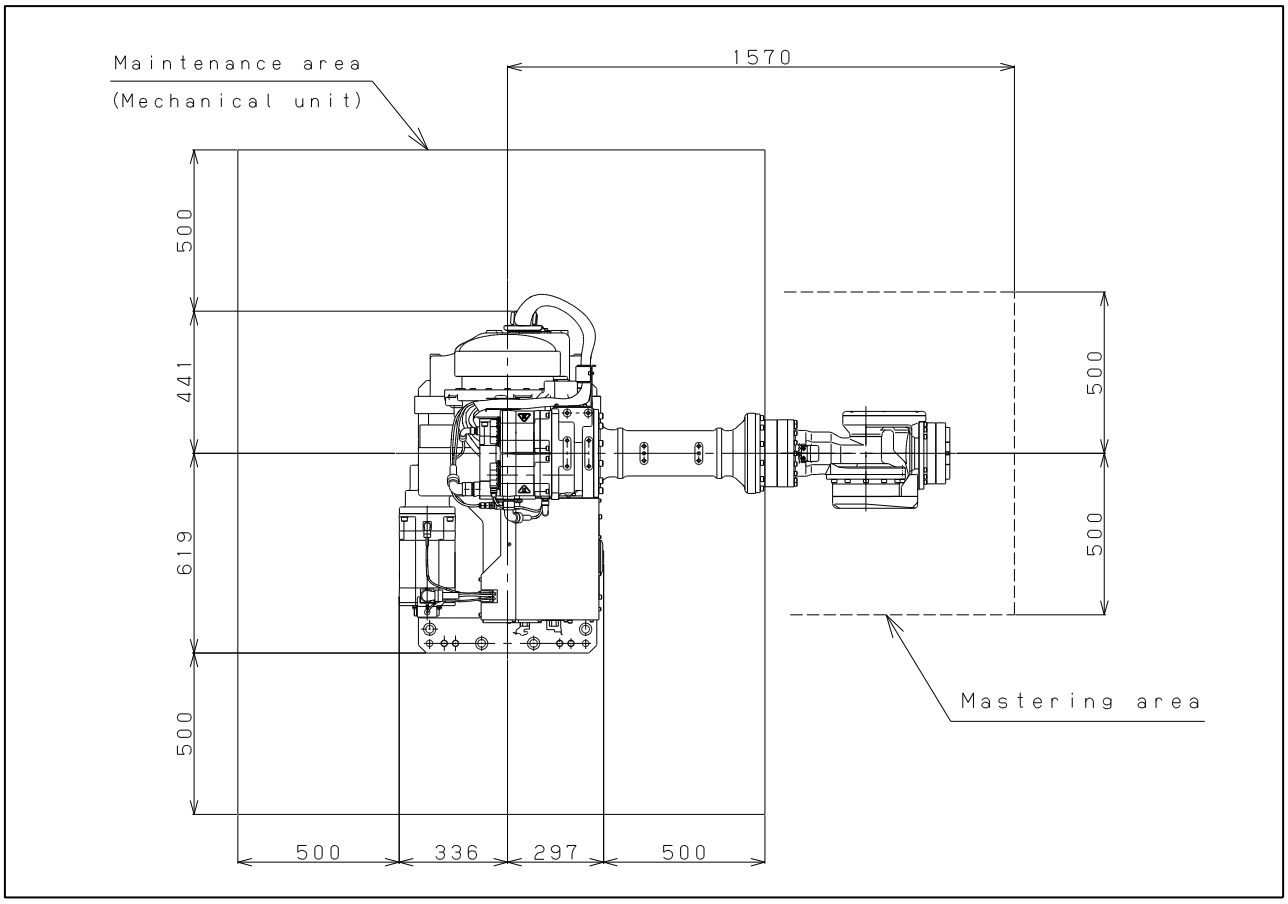


Fig. 10.3 (a) Maintenance area

10.4 AIR PIPING (OPTION)

Fig. 10.4 (a) shows how to connect air hose to the robot. If the air control set is specified as an option, the air hose between the mechanical unit and the air control set is provided. Mount the air control set using the information in Fig. 10.4 (b).

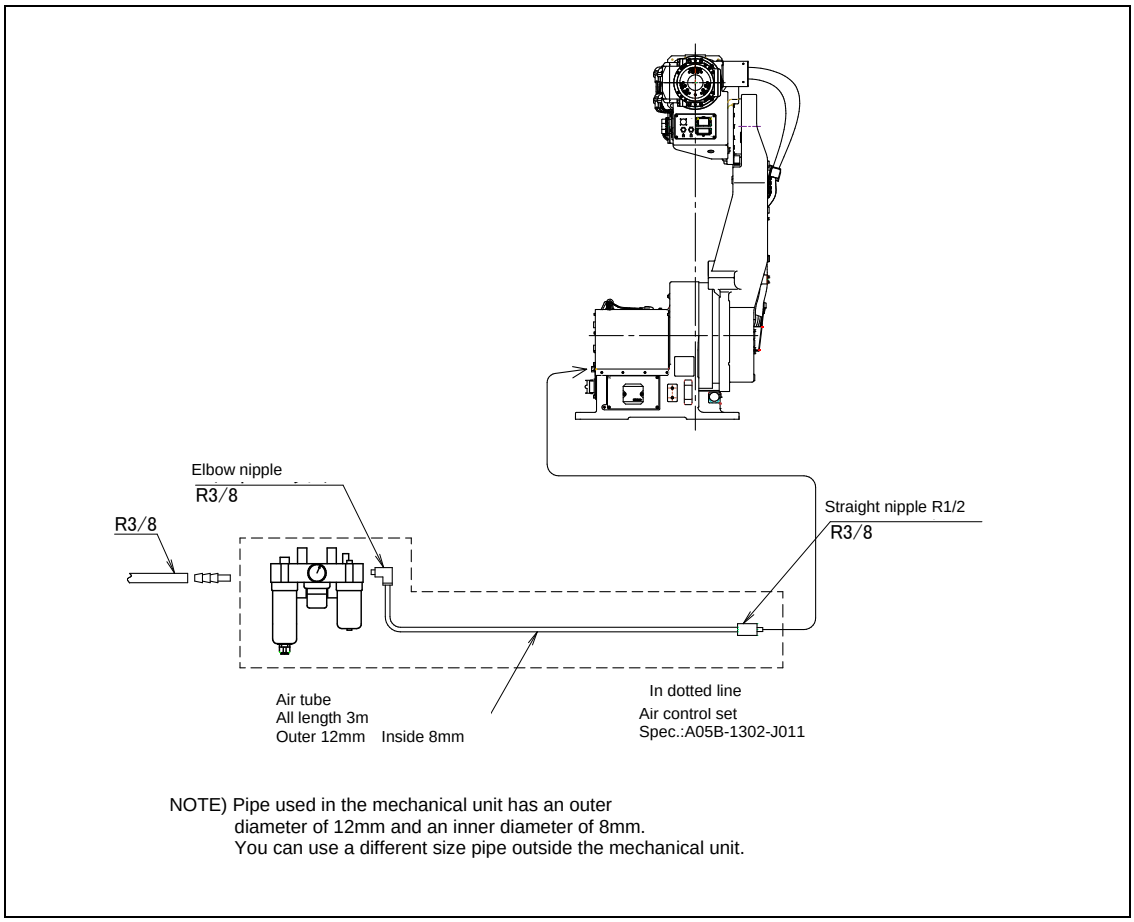


Fig. 10.4 (a) Air piping option

Air control set

Fill the lubricator having three air components to the specified level with turbine oil #90 to #140. The machine tool builder is required to prepare mounting bolts.

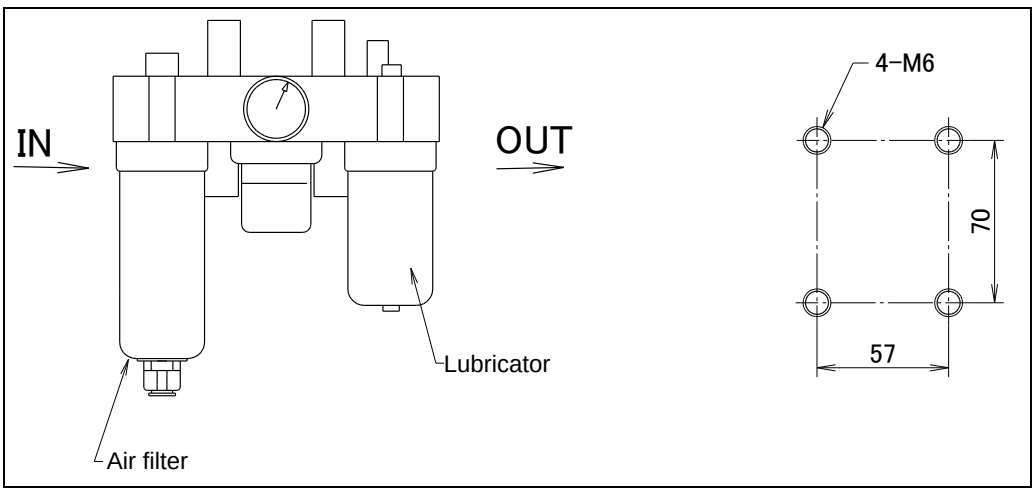


Fig. 10.4 (b) Air control set option

10.5 INSTALLATION CONDITIONS

Refer to caution below and specification of “PREFACE” about installation conditions.

10.6 STORAGE

When storing the robot, place it on a level surface with the same posture for transportation. (See Section 10.1)

11 CONNECTION WITH THE CONTROLLER

The robot is connected with the controller via the power cable, the signal cable and the earth cable. Connect these cables to the connectors on the back of the robot base. For details on air and option cables, see Chapter 9.

> ⚠ **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.

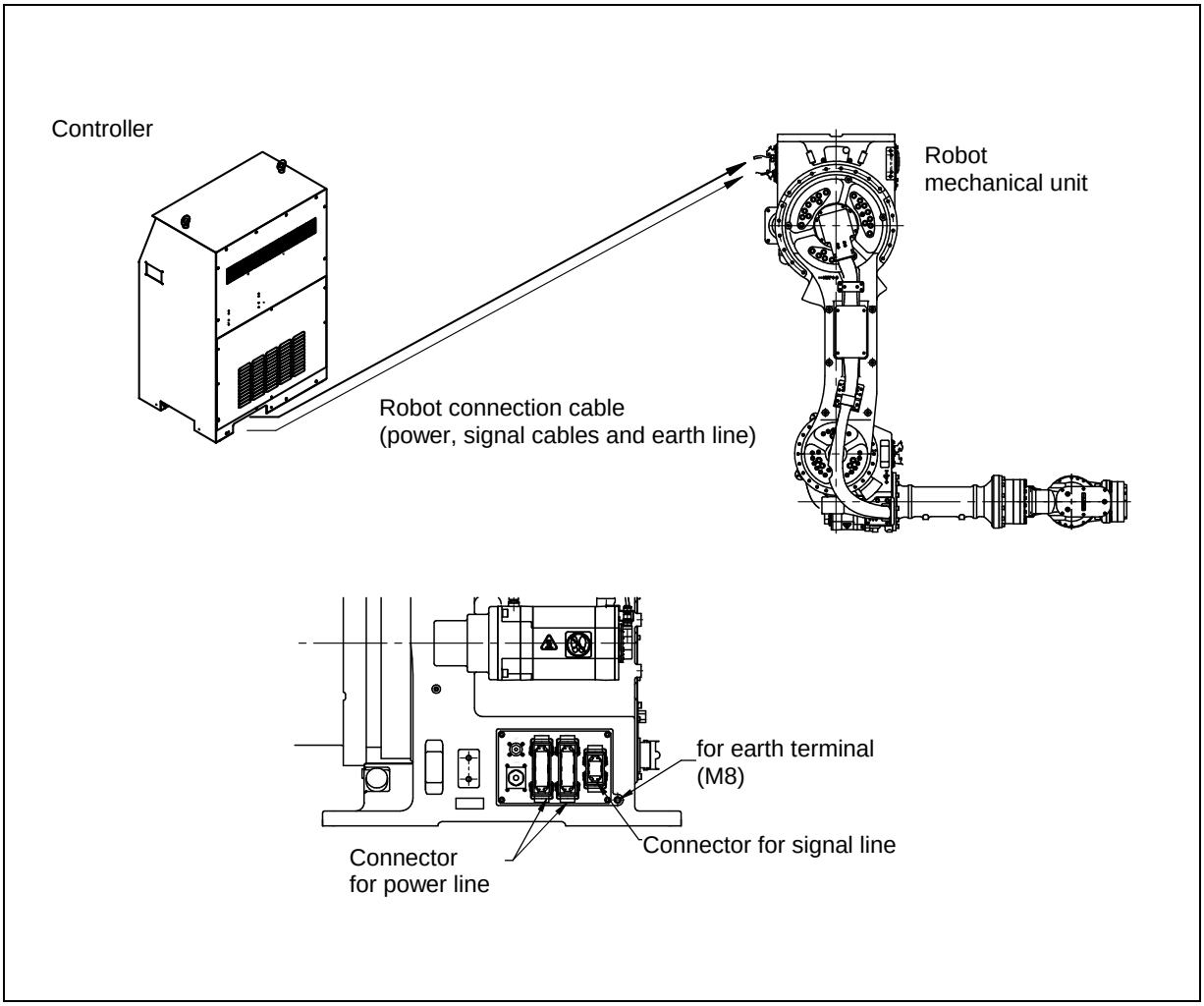


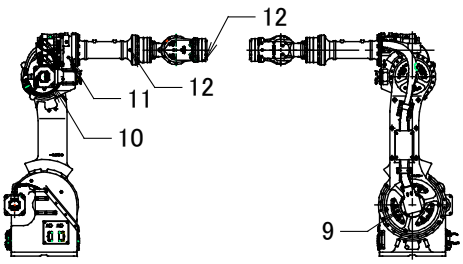
Fig. 11 (a) Cable connection

APPENDIX

A PERIODIC MAINTENANCE TABLE

FANUC Robot R-2000*i*A/200T, R-2000*i*B/200T **Periodic Maintenance Table**

Items			Check time	Grease amount	First check 320	3 months 960	6 months 1920	9 months 2880	1 year 3840	4800	5760	6720	2 years 7680	8640	9600	10560
	1	Check for external damage or peeling paint	0.1H	—		○	○	○	○	○	○	○	○	○	○	○
	2	Check damages of the cable protective sleeves	0.1H	—		○	○	○	○	○	○	○	○	○	○	○
	3	Check for water	0.1H	—		○	○	○	○	○	○	○	○	○	○	○
	4	Check the mechanical cable.(damaged or twisted)	0.2H	—		○			○				○			
	5	Check damage of the end effector (hand) cable	0.1H	—		○			○				○			
	6	Check tightness of each axis motor and other exposed connector	0.2H	—		○			○				○			
	7	Retightening the end effector mounting bolts	0.2H	—		○			○				○			
	8	Retightening the external main bolts	2.0H	—		○			○				○			
	9	Check the fixed mechanical stopper and the adjustable mechanical stopper	0.1H	—		○			○				○			
	10	Clean spatters, sawdust and dust	1.0H	—		○			○				○			
	11	Replacing batteries *1 *3	0.1H	—							●					
	12	Replacing grease of J2 axis reducer *1	1.0H	13950 ml												
	13	Replacing grease of J3 axis reducer *1	0.5H	2440 ml												
	14	Replacing grease of J4-axis gearbox *1	0.5H	1620 ml												
	15	Replacing grease of WRIST (J4/J5/J6) axis reducer *1	1.0H	4400 ml												
	16	Replacing cable of mechanical unit *1	4.0H	—												
Controller	17	Check the teach pendant , operation box connection cable and robot connection cable	0.2H	—		○			○				○			
Controller	18	Cleaning the controller ventilation system	0.2H	—	○	○	○	○	○	○	○	○	○	○	○	○
Controller	19	Replacing batteries *1 *3	0.1H	—												



Greasing points

*1 Refer to “REPLACING UNITS Chapter of MAINTENANCE ” of the following manuals.

R-J3*i*B CONTROLLER MAINTENANCE MANUAL（Standard） (B-81465EN)
R-J3*i*B CONTROLLER MAINTENANCE MANUAL（For CE） (B-81465EN-1)
R-J3*i*B CONTROLLER MAINTENANCE MANUAL（For RIA） (B-81505EN)
R-30*i*A CONTROLLER MAINTENANCE MANUAL (Standard) (B-82595EN),
R-30*i*A CONTROLLER MAINTENANCE MANUAL (For CE) (B-82595EN-1),
R-30*i*A CONTROLLER MAINTENANCE MANUAL (For RIA) (B-82595EN-2),
R-30*i*B/R-30*i*B Plus CONTROLLER MAINTENANCE MANUAL (B-83195EN)

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

*3 Regardless of the operating time, replace the mechanical unit batteries at 1.5 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
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○				○				○				○				○					8
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				●																	19

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. After you screw the bolts into the threaded holes, remove any excess LOCTITE.

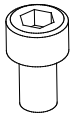
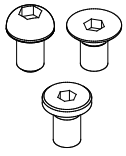
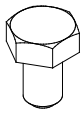
Use the following strength bolts. Comply with any bolt specification instructions.
Hexagon socket head bolt made of steel:

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	———	———	———	———	———	———
								

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REVISION RECORD

Edition	Date	Contents
01	Jul., 2022	

B-82464EN/01

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