FANUC Robot M-420*i*A
FANUC Robot M-421*i*A

MECHANICAL UNIT

OPERATOR'S MANUAL

B-81734EN/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.

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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.

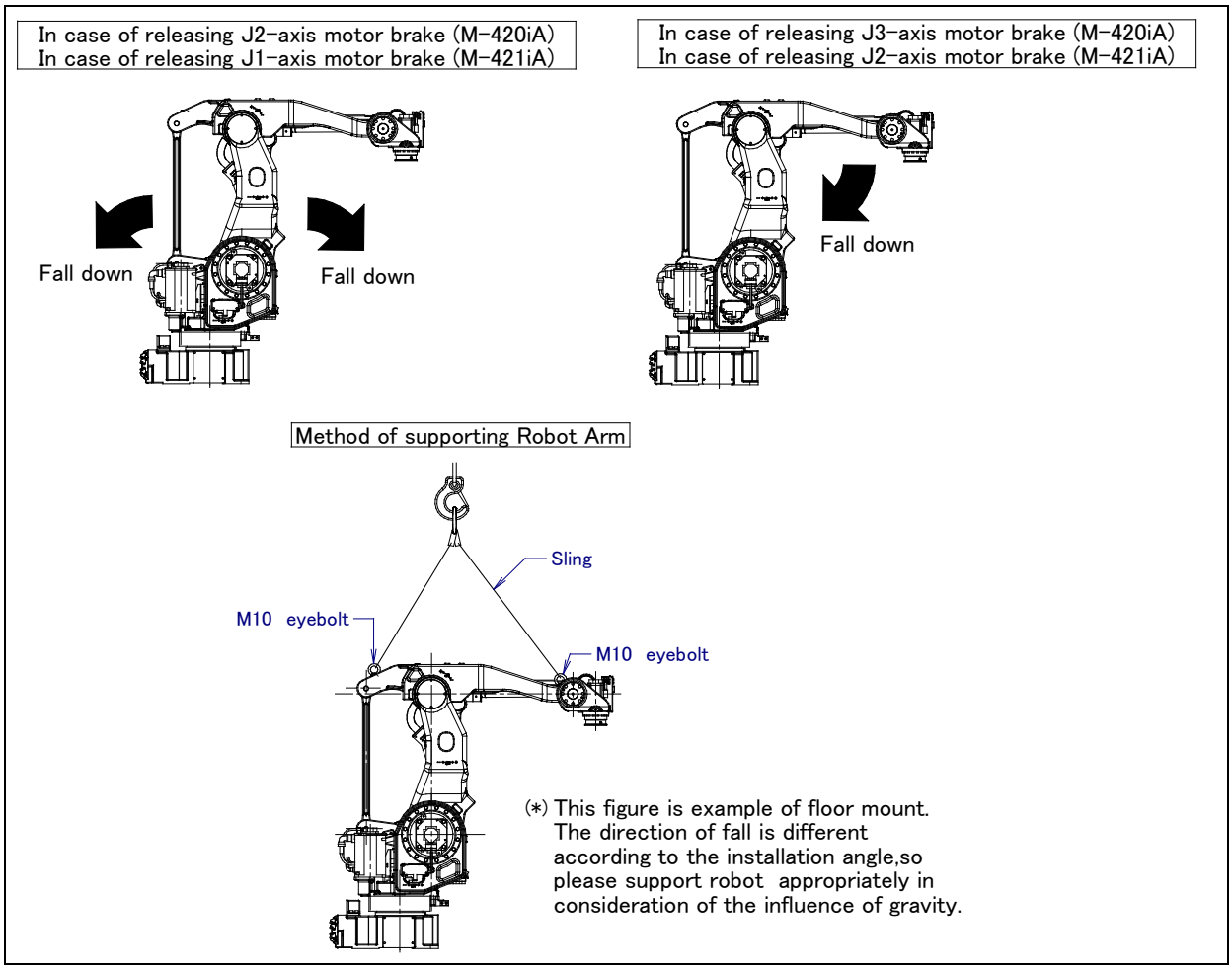


Fig. 3 (a) Releasing J2 and J3 motor brake and measures

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) When greasing, be sure to keep the grease outlet open.
2) Use a manual pump to grease.
3) Be sure to use specified grease.

> ⚠ **CAUTION**
> See Section 3.1 “REPLACING GREASE OF THE DRIVE MACHANISM” 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

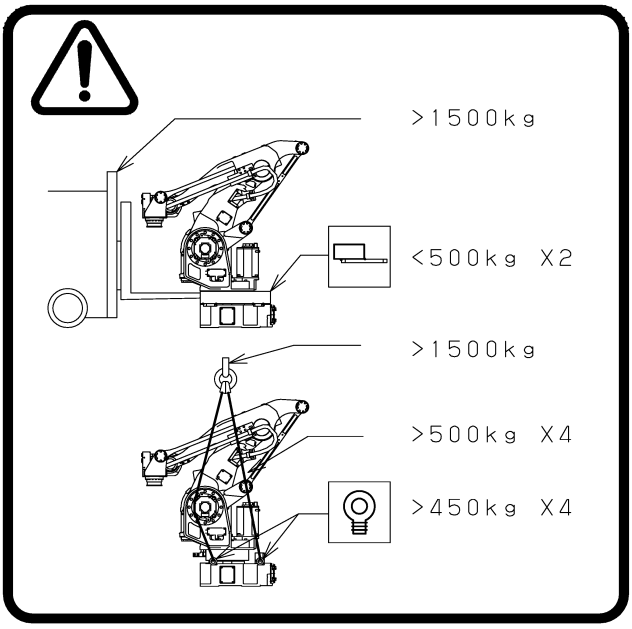


Fig. 4 (d) Transportation label

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 with a load capacity of 1500 kg or greater.
   - Keep the total weight of the robot to be transported to within 1,000 kg because the withstand load of the forklift bracket (option) is 5000 N (500 kgf).

2) Using a crane
   - Use a crane with a load capacity of 1500 kg or greater.
   - Use at least four slings each having a load capacity of 500 kg or greater.

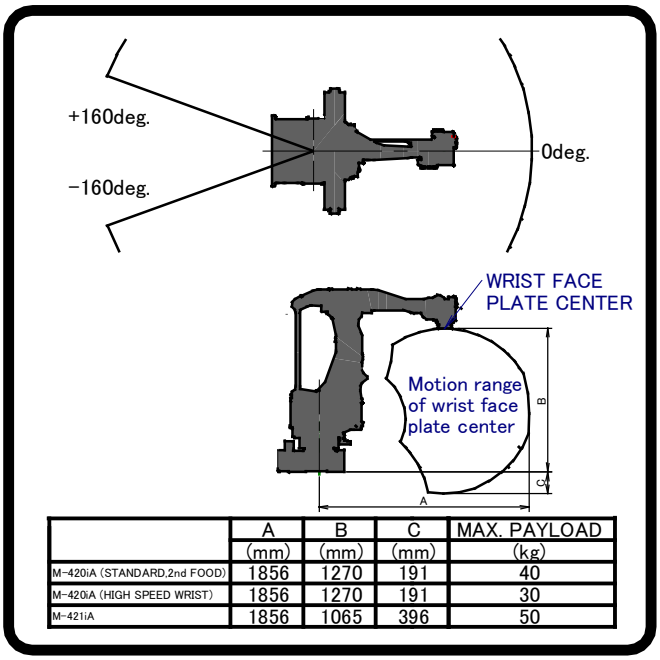
- Use at least four eyebolts each having an allowable load of 4500 N (450 kgf) or greater.

⚠ CAUTION
Transportation labels are model-specific. Before transporting the robot, see the transportation label.
- For M-420*i*A, the label is affixed to the J1 base side.
- For M-421*i*A, the label is affixed to the J1 base side.

See Section 9.1 TRANSPORTATION for explanations about the posture a specific model should take when it is transported.

(5) Operating space and payload mark label

Following label is added when CE specification is specified.



	A (mm)	B (mm)	C (mm)	MAX. PAYLOAD (kg)
M-420iA (STANDARD,2nd FOOD)	1856	1270	191	40
M-420iA (HIGH SPEED WRIST)	1856	1270	191	30
M-421iA	1856	1065	396	50

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

(6) Transportation prohibitive label (When transportation equipment option for a crane is specified)

Fig. 4 (f) Transportation prohibitive label

Description

Keep the following in mind when transporting the robot.

Do not pull eyebolts sideways

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

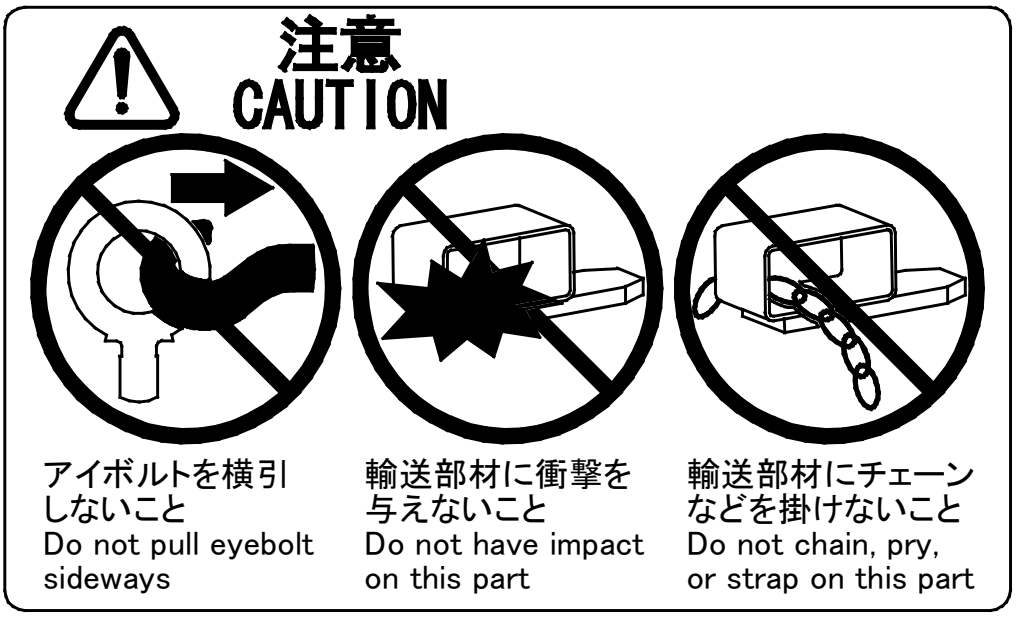


Fig. 4 (g) Transportation caution label

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 transport equipment.
3) Do not thread a chain or the like through a transport equipment.

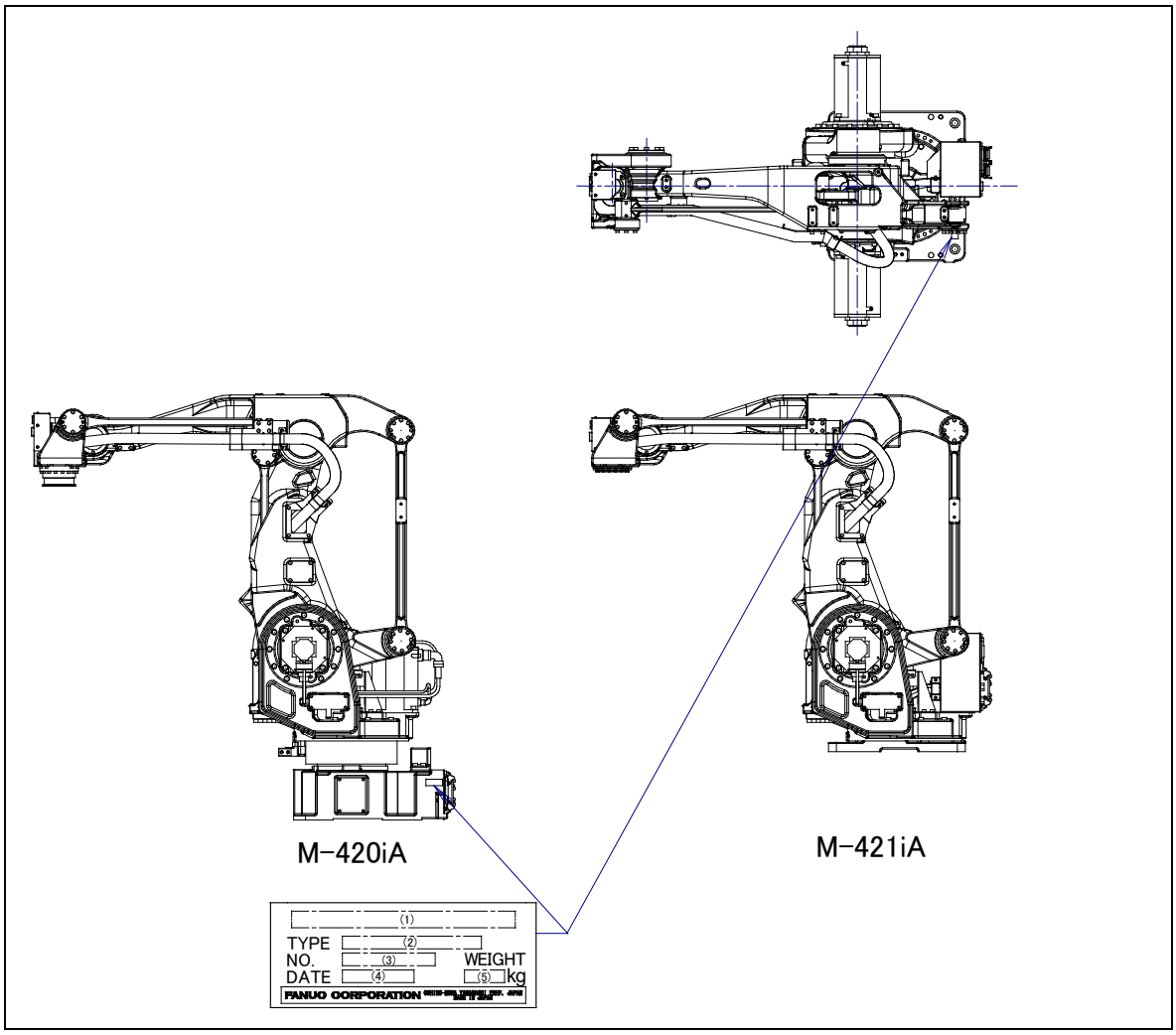
PREFACE

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

Model name	Mechanical unit specification No.	Maximum load	Controller
FANUC Robot M-420*i*A standard	A05B-1040-B201	40kg	R-J3*i*B
FANUC Robot M-420*i*A High-speed wrist	A05B-1040-B202	30kg	
FANUC Robot M-421*i*A	A05B-1040-B211	50kg	
FANUC Robot M-420*i*A 2nd food	A05B-1040-B221	40kg	
FANUC Robot M-420*i*A standard	A05B-1040-B231	40kg	R-30*i*A R-30*i*B
FANUC Robot M-420*i*A High-speed wrist	A05B-1040-B232	30kg	
FANUC Robot M-421*i*A	A05B-1040-B241	50kg	
FANUC Robot M-420*i*A 2nd food	A05B-1040-B251	40kg	

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.

⚠ CAUTION
Note that the models for the R-J3*i*B controller and those for the R-30*i*A/R-30*i*B controller partly differ in the specifications of mechanical unit cables.



Position of Label Indicating Mechanical Unit Specification Number

TABLE1

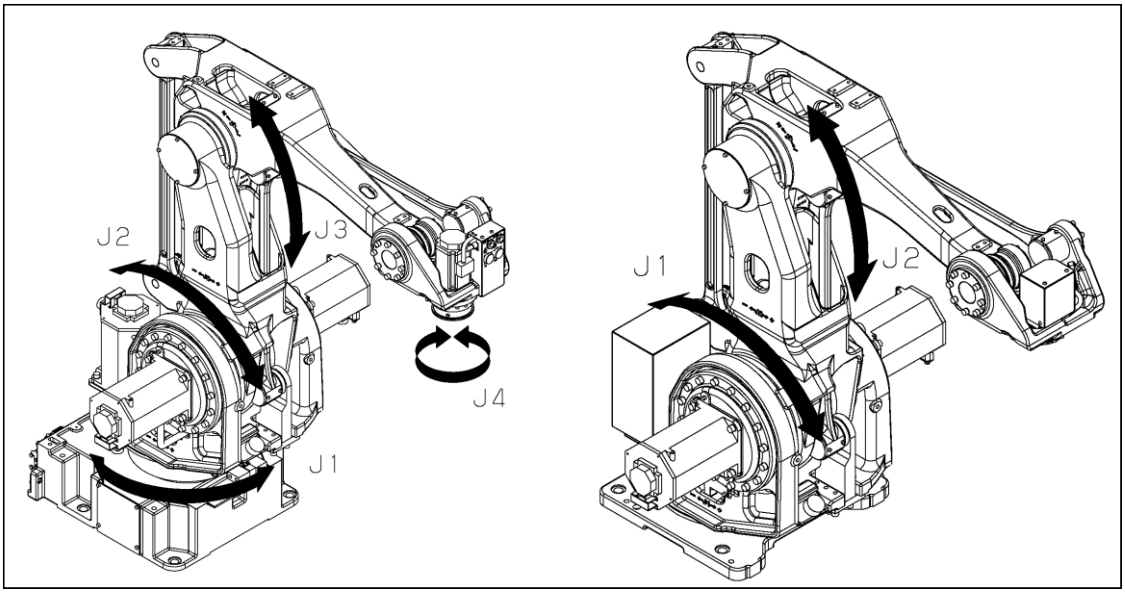
No.	(1)	(2)	(3)	(4)	(5)
CONTENTS	**-**	**TYPE**	**No.**	**DATE**	**WEIGHT kg (Without controller)**
LETTERS	FANUC Robot M-420*i*A Standard	A05B-1040-B201 A05B-1040-B231	SERIAL NO. IS PRINTED	PRODUCTION YEAR AND MONTH ARE PRINTED	620
	FANUC Robot M-420*i*A High-speed wrist	A05B-1040-B202 A05B-1040-B232			630
	FANUC Robot M-421*i*A	A05B-1040-B211 A05B-1040-B241			520
	FANUC Robot M-420*i*A 2nd food	A05B-1040-B221 A05B-1040-B251			620

Specifications 1

ITEM		M-420*i*A Standard		M-421*i*A	
Type		Articulated Type			
Controlled axes		4 axes (J1, J2, J3, J4)		2 axes (J1, J2)	
Installation		Floor mount			
Motion range		J1-axis	360°(6.28rad/s)		
		J2-axis	115°(2.01rad/s)	J1-axis	115°(2.01rad/s)
		J3-axis	100°(1.74rad/s)	J2-axis	100°(1.74rad/s)
		J4-axis	540°(9.42rad/s)		
Max motion speed (NOTE 1)		J1-axis	180°/s (3.14rad/s)		
		J2-axis	200°/s (3.49rad/s)	J1-axis	200°/s (3.49rad/s)
		J3-axis	200°/s (3.49rad/s)	J2-axis	200°/s (3.49rad/s)
		J4-axis	350°/s (6.11rad/s)		
Max. load capacity at wrist		40kg		50kg	
Allowable load moment at wrist		98N·m (10kgf·m)			
Allowable load inertia at wrist		2.5kg-m^2 (26kgf-cm-sec^2)			
Drive method		Electric servo drive by AC servo motor			
Repeatability		±0.5mm			
Weight	Mechanical unit	620kg		520kg	
	Controller	100kg		100kg	
Acoustic noise		76dB (NOTE 2)			
Installation environment		Ambient temperature: 0 - 45°C (NOTE 3) Ambient humidity Normally: 75%RH or less (No condensation allowed.) Short time (within one month): Max 95%RH (No condensation allowed.) Permitted altitude: Up to 1000 m above sea level. Vibration acceleration : 4.9m/s^2 (0.5G) or less Free of corrosive gases (NOTE 4)			

NOTE

1 During short distance motions, the axis speed may not reach the maximum value stated.
2 This value is equivalent continuous A-weighted sound pressure level that applied with ISO11201 (EN31201). This value is measured with the following conditions.
   - Maximum load and speed
   - Operating mode is AUTO
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, cutting oil splash and or other foreign substances.



M-420*i*A **M-421*i*A**

Specifications 2

ITEM		M-420*i*A High-speed wrist		M-420*i*A 2nd food
Type		Articulated Type		
Controlled axes		4 axes (J1, J2, J3, J4)		
Installation		Floor mount		
Motion range		J1-axis	360°(6.28rad/s)	360°(6.28rad/s)
		J2-axis	115°(2.01rad/s)	115°(2.01rad/s)
		J3-axis	100°(1.74rad/s)	100°(1.74rad/s)
		J4-axis	540°(9.42rad/s)	540°(9.42rad/s)
Max motion speed (NOTE 1)		J1-axis	180°/sec (3.14rad/s)	180°/sec (3.14rad/s)
		J2-axis	200°/sec (3.49rad/s)	200°/sec (3.49rad/s)
		J3-axis	200°/sec (3.49rad/s)	200°/sec (3.49rad/s)
		J4-axis	720°/sec (12.57rad/s)	350°/sec (6.11rad/s)
Max. load capacity at wrist		30kg		40kg
Allowable load moment at wrist		68N·m (7kgf·m)		98N·m (10kgf·m)
Allowable load inertia at wrist		2.5kg-m^2 (26kgf-cm-sec^2)		
Drive method		Electric servo drive by AC servo motor		
Repeatability		±0.5mm		
Weight	Mechanical unit	630kg		620kg
	Controller	100kg		
Acoustic noise		76dB (NOTE 2)		
Installation environment		Ambient temperature: 0 - 45°C (NOTE 3) Ambient humidity Normally: 75%RH or less No dew, nor frost allowed. Short time (within one month): Max 95%RH Permitted altitude: Up to 1000 m above sea level. 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 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, cutting oil splash and or other foreign substances.

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 HANDLING TOOL **B-81464EN-2**	Intended readers: Operator, programmer, maintenance technician, system designer Topics: Robot functions, operations, programming, setup, interfaces, alarms Use: Robot operation, teaching, system design
	MAINTENANCE MANUAL Standard : **B-81465EN** CE : **B-81465EN-1**	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 HANDLING TOOL **B-83124EN-2** ALARM CODE LIST **B-83124EN-6**	Intended readers: Operator, programmer, maintenance person, 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 controller	OPERATOR'S MANUAL BASIC FUNCTION **B-83284EN** ALARM CODE **B-83284EN-1** OPTIONAL FUNCTION **B-83284EN-2**	Intended readers: Operator, programmer, maintenance technician, system designer Topics: Robot functions, operations, programming, setup, interfaces, alarms Use: Robot operation, teaching, system design
	MAINTENANCE MANUAL **B-83195EN**	Intended readers: Maintenance technician, system designer Topics: Installation, start-up, connection, maintenance Use: Installation, start-up, connection, maintenance

This manual uses following terms.

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

TABLE OF CONTENTS

1 CONFIGURATION

1.1 M-420*i*A CONFIGURATION

The configuration of the mechanical unit is shown in Fig.1.1 (a).

NOTE
For M-421*i*A configuration, see the Section 1.2.

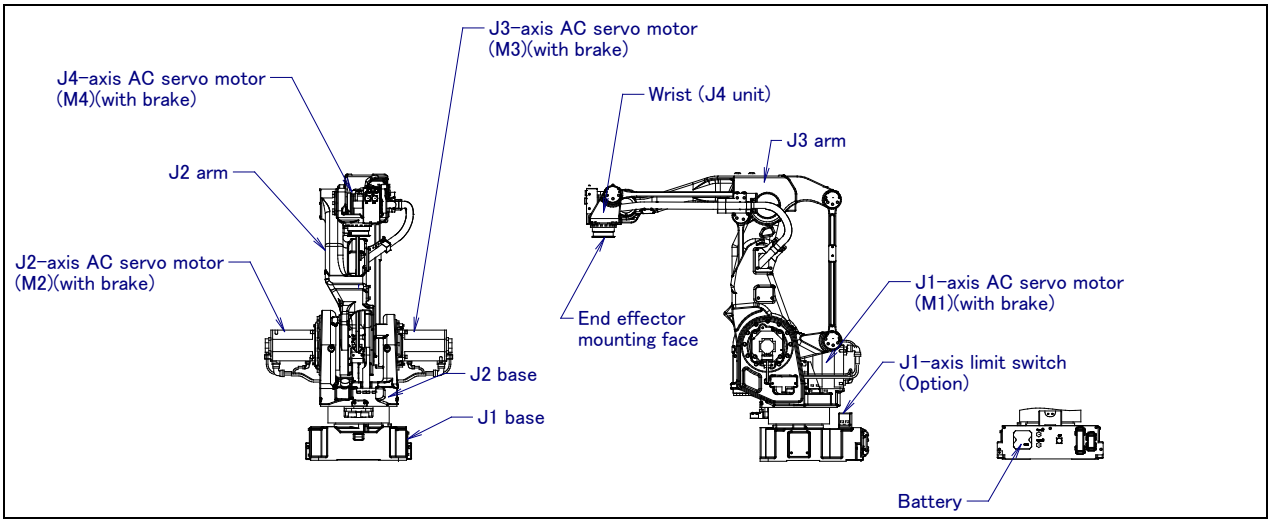


Fig. 1.1 (a) Mechanical Unit Configuration (M-420*i*A)

1.2 M-421*i*A CONFIGURATION

The configuration of the mechanical unit is shown in Fig.1.2 (a).

NOTE
For M-420*i*A configuration, see the Section 1.1.

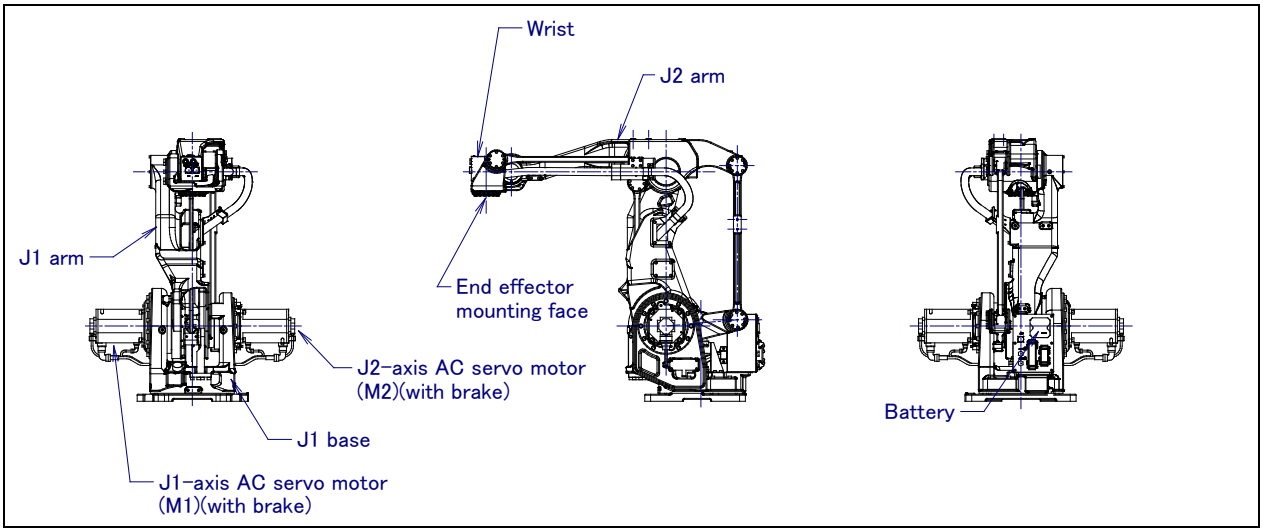


Fig. 1.2 (a) Mechanical Unit Configuration (M-421*i*A)

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.	21
	○					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 wear debris of the J1-axis swing stopper	Check whether wear debris is generated on the J1-axis swing stopper rotation part. If serious wear occurs on the part that generated the wear debris, replace the part.	3
	○					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.	4
	○ 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.	21
	○ 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"**	5
	○ 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.	6
	○ 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"**	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 end effector mounting bolts	Retighten the end effector mounting bolts. Refer to the following section for tightening torque information: **⇒"8.3 END EFFECTOR INSTALLATION TO WRIST"**	8
	○ 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.	9
	○ 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. Check that the J1-axis swing stopper rotates smoothly. **⇒"2.2.4 Check of Fixed Mechanical Stopper and Adjustable Mechanical Stopper"**	10
	○ 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).	11
			○			Replacing the mechanical unit batteries	Replace the mechanical unit batteries **⇒"3.3 REPLACING THE BATTERIES"**	12
				○		Supply grease to J2/J3-axis connection part bearing	Supply grease to J2/J3-axis connection part bearing **⇒"3.2 SUPPLYING GREASING**	17
		○ (*)		○ (*)		Replacing the grease of drive mechanism	Replace the grease of each axis reducer and gearbox (*) Periodic interval differs according to the model. M-420*i*A 2nd food : 1 year (3840 hours) Except M-420*i*A 2nd food : 3 years (11520 hours) **⇒"3.1 REPLACING THE GREASE OF THE DRIVE MECHANISM"**	13 to 16
					○	Replacing the mechanical unit cable	Replace the mechanical unit cable. Contact your local FANUC representative regarding replacing the cable.	19

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			
					○	Replacing the controller batteries	Replace the controller batteries **⇒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 (CE specification) (B-82595EN-1) R-30*i*A CONTROLLER MAINTENANCE MANUAL (RIA specification) (B-82595EN-2) R-J3*i*B CONTROLLER MAINTENANCE MANUAL (B-81465EN) R-J3*i*B CONTROLLER MAINTENANCE MANUAL (CE specification) (B-81465EN-1) R-J3*i*B CONTROLLER MAINTENANCE MANUAL (RIA specification) (B-81505EN)"**	22

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.

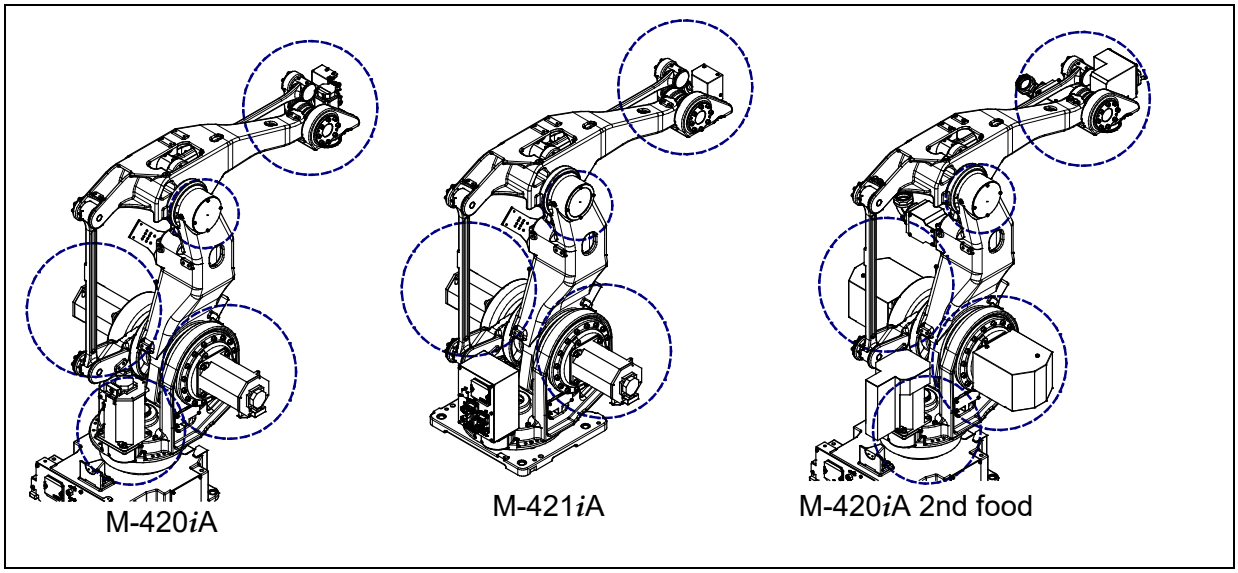


Fig. 2.2.1 (a) Check parts of oil seepage

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)

> ⚠ **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.

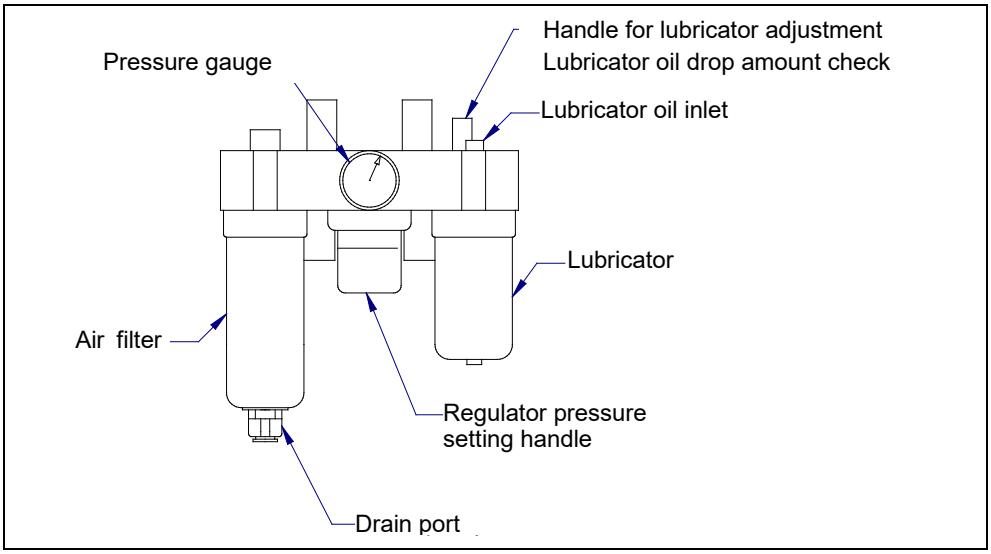


Fig. 2.2.2 (a) Air control set (option)

2.2.3 Check the Mechanical Unit Cables and Connectors

Check points of the mechanical unit cables

Fixed part cables can interfere with the J1, J2, and J3 movable parts and peripheral equipment.

* For the J1-axis, inspect the cables from above the J2 base and from the side by removing the metal plate on the side of the J1 base.

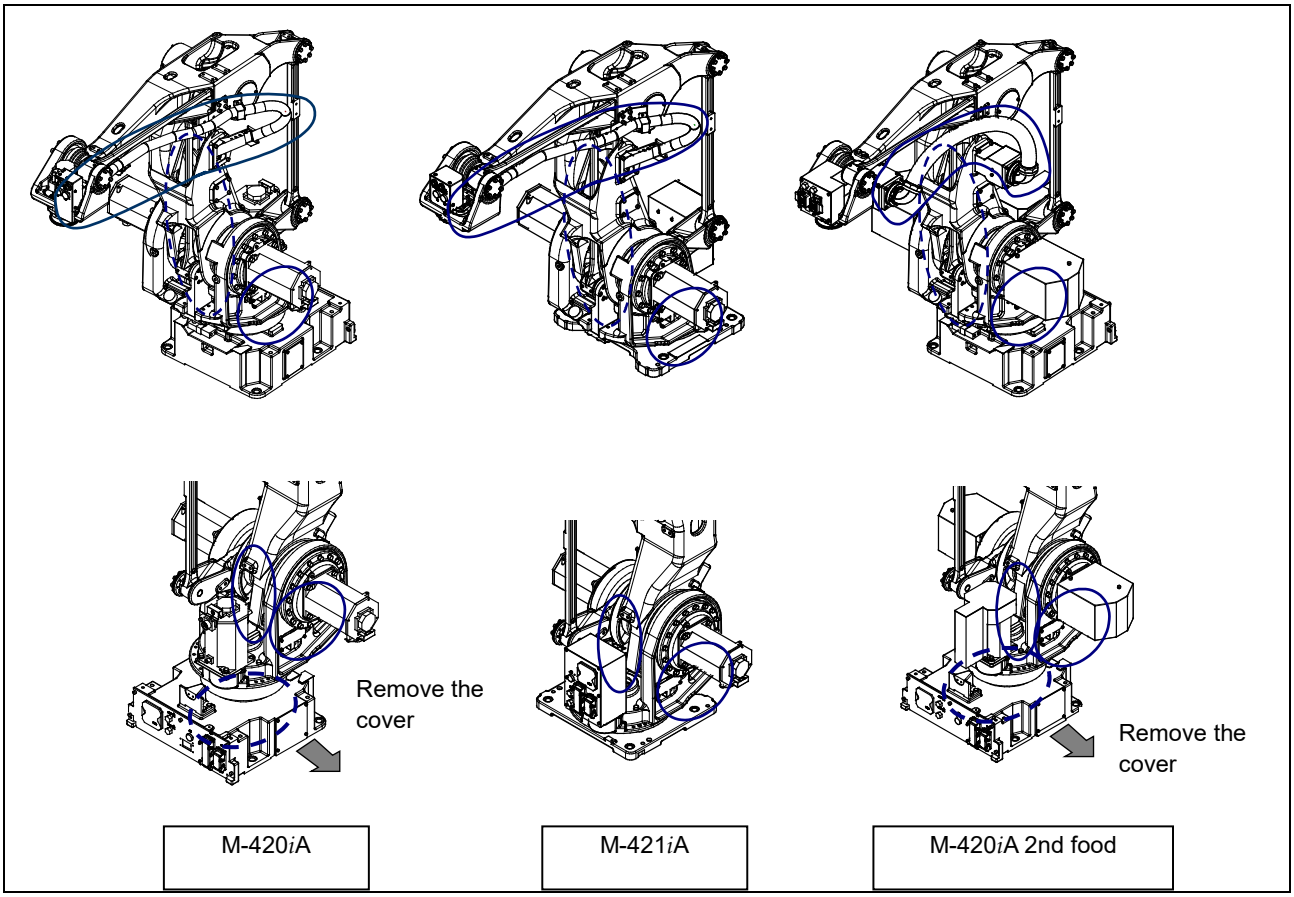


Fig. 2.2.3 (a) Inspection points of the mechanical unit cables

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.

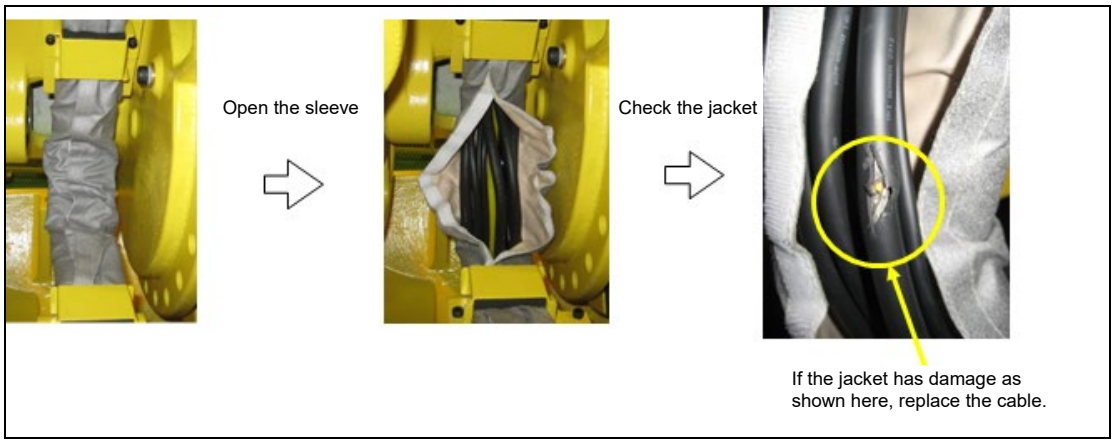


Fig. 2.2.3 (c) Cable check method

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.

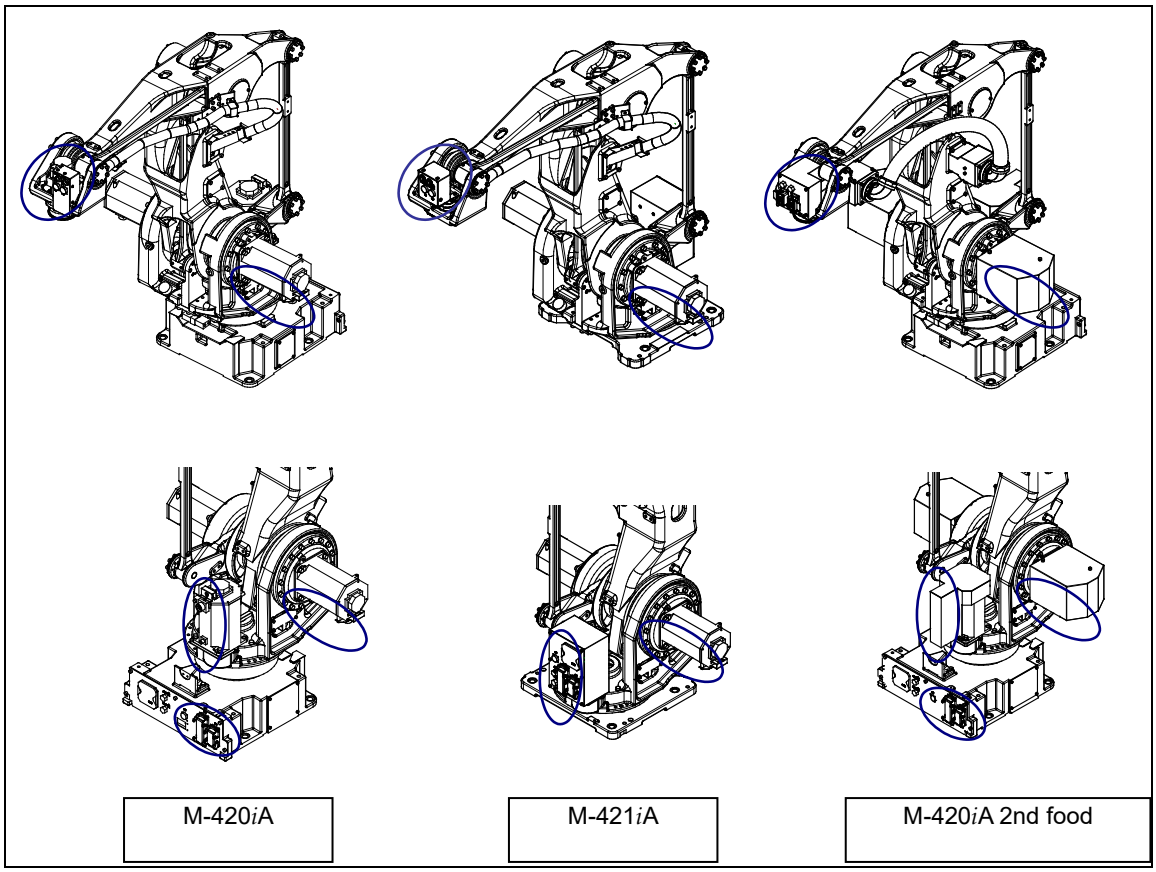


Fig. 2.2.3 (d) Connector Inspection points

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. Be sure to check the tightness of the mounting bolts of the J1-axis swing stopper.
- Check that the J1-axis swing stopper rotates smoothly.
- Refer to Subsection 5.1.3 for details regarding the adjustable mechanical stopper.

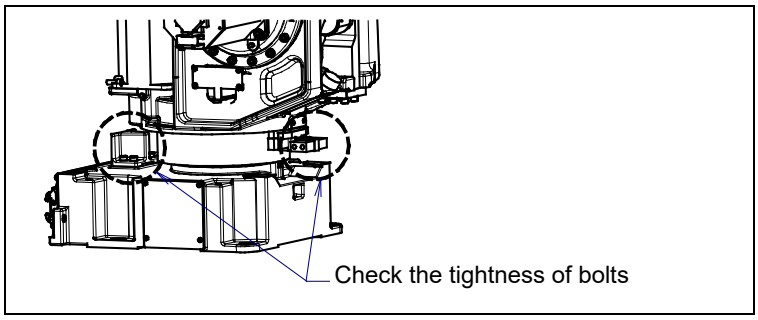


Fig. 2.2.4 (a) Check of fixed mechanical stopper and adjustable mechanical stopper

3 PERIODIC MAINTENANCE

3.1 REPLACING GREASE OF THE DRIVE MECHANISM

For M-420*i*A with standard specification or M-421*i*A with high-speed wrist specification, replace the grease of the reducers of J1, J2, J3, and J4 axis every three years or 11520 hours by using the following procedures.
For M-420*i*A with 2nd food specification, replace the grease of the reducers of J1, J2, J3, and J4 axis every one-year or 3840 hours by using the following procedures. See Table 3.1 (a) for the grease name and the quantity.

Table 3.1 (a) Grease for periodical replacement
(3-year periodical replacement for M-420*i*A standard or High-speed wrist or M-421*i*A)
(1-year periodical replacement for M-420*i*A 2nd food)

Models	Supply position		Grease name	Quantity	Gun tip pressure
M-420*i*A	Standard or High-speed wrist	J1-axis reducer	(Spec: A98L-0040-0174)	3690g (4100ml)	0.1 MPa or less (NOTE)
		J2-axis reducer		1030g (1140ml)	
		J3-axis reducer		950g (1060ml)	
		J4-axis reducer		160g (180ml)	
	2nd food	J1-axis reducer	(Spec: A98L-0040-0186)	3690g (4100ml)	
		J2-axis reducer		1030g (1140ml)	
		J3-axis reducer		950g (1060ml)	
		J4-axis reducer		160g (180ml)	
M-421*i*A	J1-axis reducer		(Spec: A98L-0040-0174)	1030g (1140ml)	
	J2-axis reducer			950g (1060ml)	

NOTE
When using a hand pump, apply grease approximately once per 2 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.

Set the robot to the postures listed below to replace or supply grease.

Table 3.1 (b) Postures for greasing

Models	Supply position	Posture			
		J1	J2	J3	J4
M-420*i*A	J1-axis reducer	Arbitrary	Arbitrary	Arbitrary	Arbitrary
	J2-axis reducer		0°		
	J3-axis reducer		0°	0°	
	J4-axis gearbox		Arbitrary	Arbitrary	
M-421*i*A	J1-axis reducer	0°	Arbitrary		
	J2-axis reducer	0°	0°		

⚠ CAUTION
If the robot is used at the high-duty that requires a cooling unit (fan), shorten the standard greasing cycle to half.

⚠ CAUTION
Failure to follow proper lubrication procedures may cause the suddenly increase of the grease bath internal pressure and the damage to the seal, which could lead to grease leakage and abnormal operation. When greasing, observe the following cautions.

1 Before starting greasing, remove the plugs or bolts of grease outlets to allow the grease to come out.
2 Using a manual greasing pump, grease gently and slowly.
3 Avoid using a pneumatic pump driven from a factory pneumatic line as much as possible.
Even when using of Table 3.1 (a) or less during application of grease.
4 Use specified grease. Use of non-approved grease may damage the reducer or lead to other problems.
5 After applying grease, release the remaining pressure within the grease bath as described in the procedure in Subsection 3.1.3.
6 To prevent an accident such as a fall or fire, remove all the excess grease from the floor and robot.
7 If no old grease is pushed out from the grease outlet soon or if only an extremely small amount of old grease is pushed out when new grease is supplied into the grease inlet, it is likely that grease is leaking because of a damaged sealing or a similar break.

3.1.1 Grease Replacement for M-420*i*A

Grease replacement procedure for the J1, J2, J3, and J4-axis reducers

⚠ CAUTION
Do not confuse the grease inlet of the J4-axis reducer with the grease inlet of the wrist joint bearing in Fig.3.2 (b) in Section 3.2 since their locations are close to each other.

1 Move the robot to the greasing posture described in Section 3.1.
2 Turn off controller power.
3 Remove the seal bolt shown the Fig.3.1.1 (a), (b), and (c) from the grease outlet.
4 Supply new grease until new grease is output from the grease outlet.
5 After applying grease, release the remaining pressure within the grease bath as described in the procedure in Section 3.1.3.

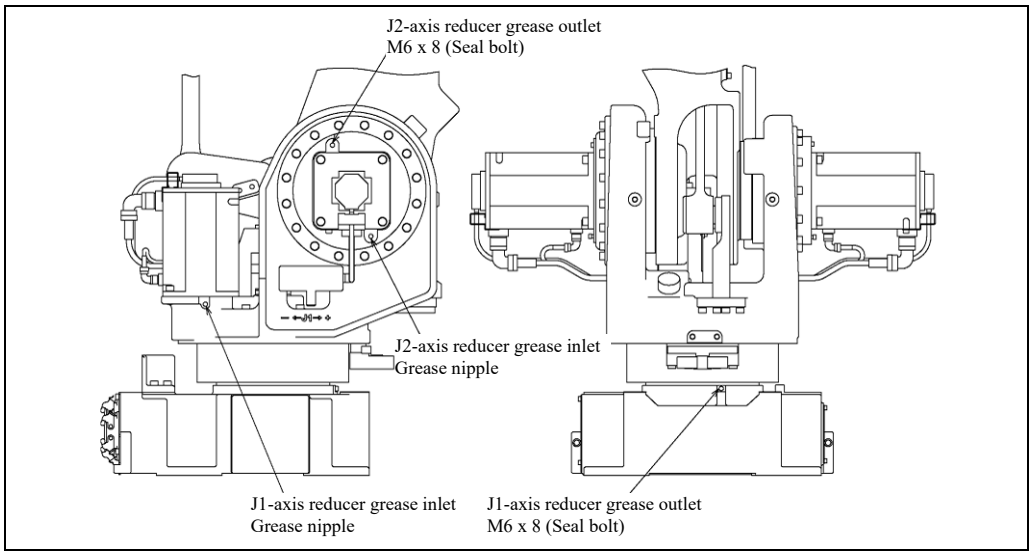


Fig. 3.1.1 (a) Replacing Grease of J1/J2-axis Reducer (M-420*i*A)

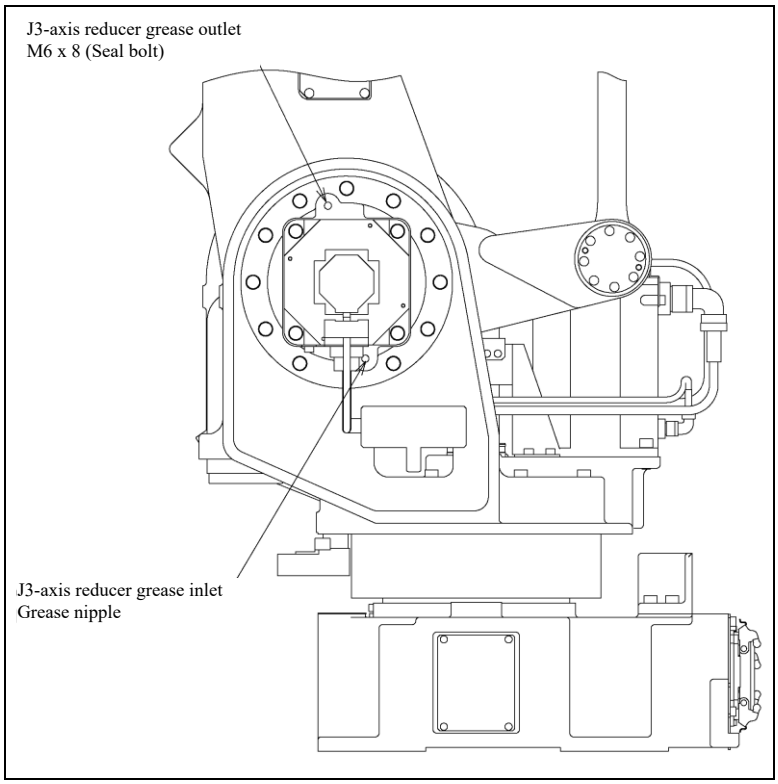


Fig. 3.1.1 (b) Replacing Grease of J3-axis Reducer (M-420*i*A)

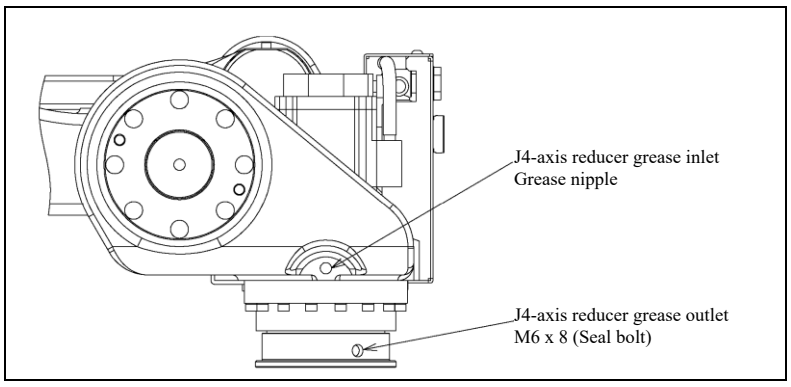


Fig. 3.1.1 (c) Replacing Grease of J4-axis Reducer (M-420*i*A)

3.1.2 Grease Replacement Procedure for the M-421*i*A

Grease replacement procedure for the J1-axis and J2-axis

For explanations about how to replace grease for J1-axis and J2-axis, read "J2-axis" and "J3-axis", respectively, as "J1-axis" and "J2-axis" in Section 3.1.1, "Grease Replacement Procedure for the J1-Axis/ J2-Axis/J3-Axis and J4-Axis Gearbox".
Note, however, that the M-421*i*A has neither J3-axis nor J4-axis.

3.1.3 Procedure for Releasing Remaining Pressure within the Grease Bath

To release the remaining pressure in the grease bath after applying grease, operate the robot for 20 minutes or more as described in the table below with the grease nipple of the grease inlet and the seal bolt of the grease outlet left open for the J1-axis reducer and J4-axis reducer, and the seal bolt of the grease outlet left open for the J2-axis reducer and J3-axis reducer. At this time, attach the recovery bag under the grease inlet and grease outlet to prevent drained grease from splattering.

Table 3.1.3 (a) (M-420*i*A)

Operating axis / Supply position	J1-axis	J2-axis	J3-axis	J4-axis
J1-axis reducer	Axis angle of 60° or more OVR 100%	Arbitrary		
J2-axis reducer	Arbitrary	Axis angle of 60° or more OVR 100%	Arbitrary	
J3-axis reducer	Arbitrary		Axis angle of 60° or more OVR 100%	Arbitrary
J4-axis gearbox	Arbitrary			Axis angle of 60° or more OVR 100%

Note) Operate the robot with the grease inlet and grease outlet left open for the J1-axis reducer and J4-axis reducer, and the grease outlet left open for the J2-axis reducer and J3-axis reducer.

Table 3.1.3 (b) (M-421*i*A)

Operating axis / Supply position	J1-axis	J2-axis
J1-axis reducer	Axis angle of 60° or more OVR 100%	Arbitrary
J2-axis reducer	Arbitrary	Axis angle of 60° or more OVR 100%

Note) Operate the robot with the grease outlet left open.

If the above operation cannot be performed due to the environment, adjust the operating time according to the operating angle. (When the maximum allowable axis angle is 30°, operate the robot for 40 minutes, twice a specified length of time.)
If you grease multiple axes, you can exercise multiple axes at the same time.
After the above operation is performed, attach the grease nipple to the grease inlet and the seal bolt to the grease outlet. When the seal bolt or grease nipple is reused, be sure to seal it with seal tape.

3.2 SUPPLYING GREASE

Be sure to supply grease to the machine at the timing (cumulative operation time or period whichever earlier) specified in Table 3.2 (a). Adjust the greasing timing if your robot is installed in an adverse environment. Supply grease immediately if water is splashed to the robot. When supplying grease, observe the precautions described in Section 3.1.
Table 3.2 (a), Fig.3.2 (a), and Fig.3.2 (b) indicate the parts of the robot to be greased. Table 3.2 (b) lists alternative greases. Table 3.2 (c) describes the posture in which the robot must be kept when it is greased.

NOTE
If the robot is used at the high-duty that requires a cooling unit (fan), shorten the standard greasing cycle to half.

Table 3.2 (a) Greasing

Robot model	Supply position	Specified grease	Amount of grease	Greasing method	Cumulative operation time (duration)
M-420*i*A Standard High-speed wrist	J3 arm connecting position bearing	SHELL ALVANIA GREASE S2 (Spec.: A98L-0004-0602#CTG)	20ml	Supply grease through a grease nipple.	11520 hours (3 years)
	Wrist connecting position bearing		10ml		
M-420*i*A 2nd food	J3 arm connecting position bearing	SHELL CASSIDA GREASE EPS2 (Spec.: A98L-0040-0187#1KG)	20ml		3840 hours (1 year)
	Wrist connecting position bearing		10ml		
M-421*i*A	J2 arm connecting position bearing	SHELL ALVANIA GREASE S2 (Spec.: A98L-0004-0602#CTG)	20ml		11520 hours (3 years)
	Wrist connecting position bearing		10ml		

NOTE
After grease is supplied, old grease is pushed out from the bearing's rotating section. Wipe off the old grease immediately after greasing and when required after operations of 50 to 100 hours since the greasing.

Table 3.2 (b) Substitutes for ALVANIA GREASE S2

Mobile	Mobilux EP2
JXTG Nippon Oil & Energy Corporation	Multinoc 2
JXTG Nippon Oil & Energy Corporation	Epinoc AP-2
Idemitsu Kosan Co., Ltd.	Eponex grease No. 2
Cosmo Oil Co., Ltd.	Dynamax No. 2
Showa Shell Sekiyu K.K.	Shell Gadus S2 V100 2

Table 3.2 (c) Posture for Greasing

Robot	Supply position	Posture			
		J1	J2	J3	J4
M-420*i*A	Bearing of J3 arm connecting position	Arbitrary	0°	0°	Arbitrary
	Bearing of wrist connecting position		Arbitrary	Arbitrary	
M-421*i*A	Bearing of J2 arm connecting position	0°	0°		
	Bearing of wrist connecting position	Arbitrary	Arbitrary		

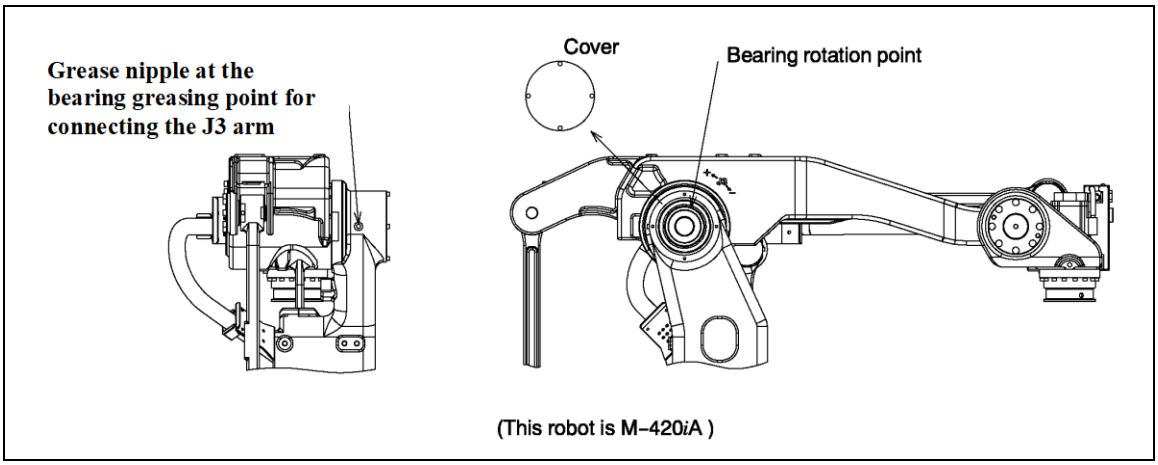


Fig. 3.2 (a) Greasing for Bearing (J3 arm Connection: M-420*i*A) (J2 arm Connection: M-421*i*A)

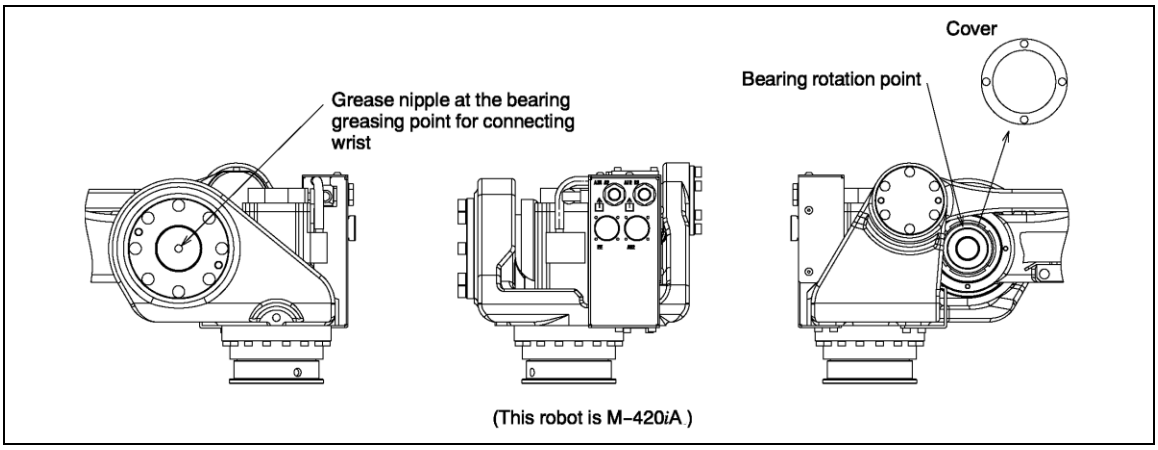


Fig. 3.2 (b) Greasing for Bearing (Common to M-420*i*A and M-421*i*A)

3.3 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 when the backup battery voltage drop alarm occurs.

Procedure for replacing the batteries

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

> ⚠ **CAUTION**
> Replacing the batteries with the power supply 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.

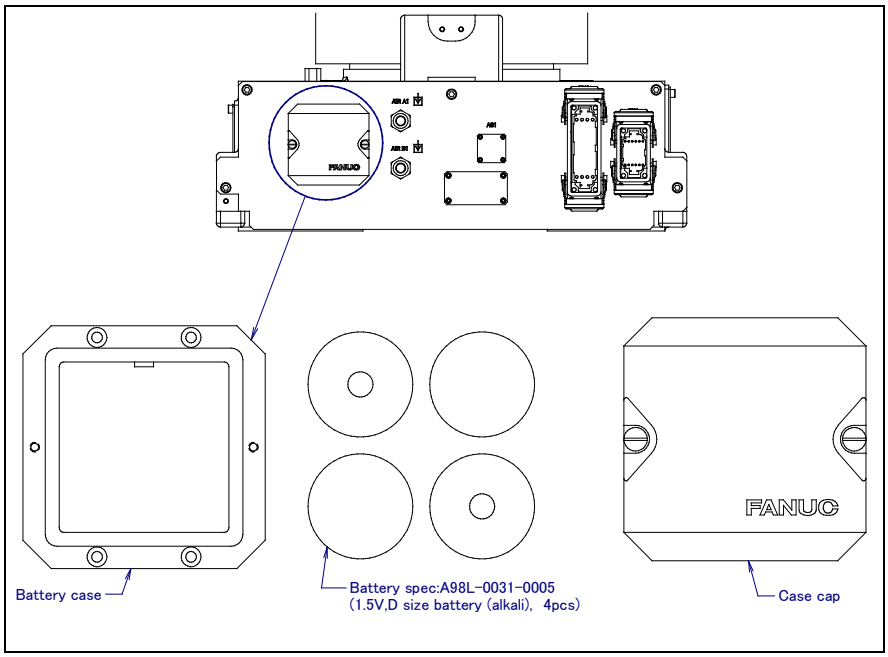


Fig. 3.3 (a) Replacing Batteries (M-420*i*A)

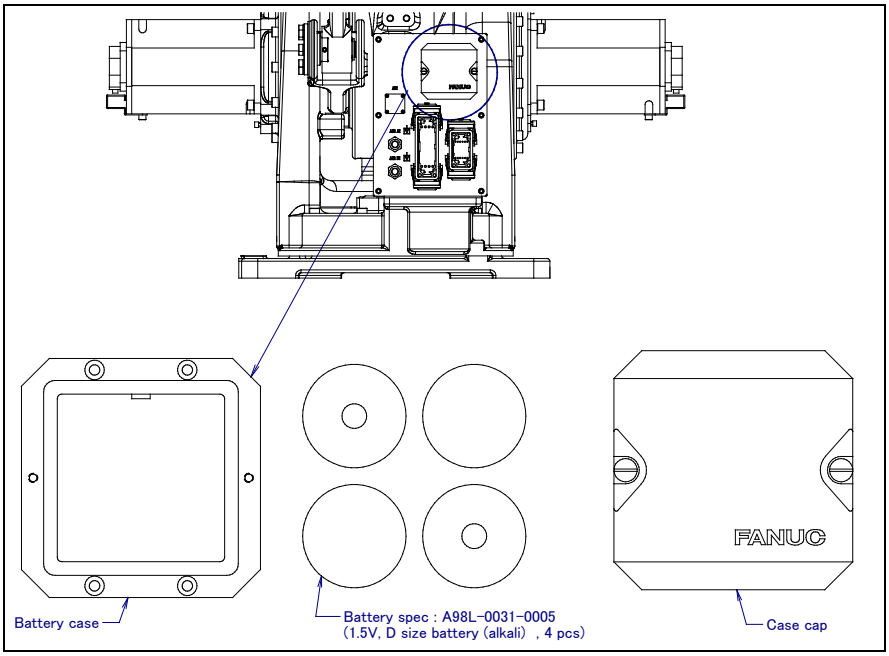


Fig. 3.3 (b) Replacing Batteries (M-421*i*A)

4 TROUBLE SHOOTING

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, it is necessary to keep an accurate record of problems and to take proper corrective actions.

4.1 TROUBLESHOOTING

Table 4.1 (a) shows the main mechanical unit problems and their causes. If a cause of remedy is unclear, please contact your local FANUC representative representative.

Table 4.1 (a) Troubleshooting

Symptom	Description	Cause	Measure
Vibration Noise	- As the robot operates, its base plate lifts off the floor plate. - There is a gap between the base plate and the floor plate. - There is a crack in the weld that fastens the base plate to the floor plate.	[Base plate and floor plate fastening] - It is likely that the base plate is not securely fastened to the floor plate because of poor welding. - If the base plate is not securely fastened to the floor plate, it lifts as the robot operates, allowing the base and floor plates to strike each other, which, in turn, leads to vibration.	- Re-weld the base plate to the floor plate. - If the weld is not strong enough, increase its width and length.
	- The J1 base lifts off the base plate as the robot operates. - There is a gap between the J1 base and base plate. - A J1 base retaining bolt is loose.	[J1 base fastening] - It is likely that the robot J1 base is not securely fastened to the base plate. - Probable causes are a loose bolt, an insufficient degree of surface flatness, or contamination caught between the base plate and floor plate. - If the robot is not securely fastened to the base plate, the J1 base lifts from the base plate as the robot operates, allowing the base and floor plates to strike each other, which, in turn, leads to vibration.	- If a bolt is loose, apply LOCTITE and tighten it to the appropriate torque. - Adjust the base plate surface flatness to within the specified tolerance. - If there is any contamination, remove it. - As the robot operates, the rack or floor on which the robot is mounted vibrates.
	- The rack or floor plate vibrates during operation of the robot.	[Rack or floor] - It is likely that the rack or floor is not sufficiently rigid. - If the rack or floor is not sufficiently rigid, reaction from the robot deforms the rack or floor, leading to vibration.	- Reinforce the rack or floor to make it more rigid. - If it is impossible to reinforce the rack or floor, modify the robot control program; doing so might reduce the amount of vibration.

Symptom	Description	Cause	Measure
Vibration Noise (Continued)	- Vibration becomes more serious when the robot adopts a specific posture. - If the operating speed of the robot is reduced, vibration stops. - Vibration is most noticeable when the robot is accelerating. - Vibration occurs when two or more axes operate at the same time.	[Overload] - It is likely that the load on the robot is greater than the maximum rating. - It is likely that the robot control program is too demanding for the robot hardware. - It is likely that the ACCELERATION value is excessive.	- Check the maximum load that the robot can handle once more. If the robot is 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).
	- 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 contamination 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 contamination caught in a gear, bearing, or within a reducer is causing 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 by not greasing.	- Operate one axis at a time to determine which axis is vibrating. - Remove the motor, and replace the gear, the bearing, and the reducer. For the spec. of parts and the method of replacement, contact FANUC. - Using the robot within its maximum rating prevents problems with the drive mechanism. - Using the specified grease at the recommended interval will prevent problems.

Symptom	Description	Cause	Measure
Vibration Noise (Continued)	- The cause of problem cannot be identified from examination of the floor, rack, or mechanical unit.	[Controller, cable, and motor] - If a failure occurs in a controller circuit, preventing control commands from being supplied to the motor normally, or preventing motor information from being sent to the controller normally, vibration might occur. - 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.
	- 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.

Symptom	Description	Cause	Measure
Vibration Noise (Continued)	- 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 face 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 the tightness of the following retaining bolts for each axis. If any of these bolts is loose, apply LOCTITE and tighten with appropriate torque - Motor retaining bolt - Reducer retaining bolt - Reducer shaft retaining bolt - Base retaining bolt - Arm retaining bolt - Casting retaining bolt - End effecter retaining bolt
Motor overheating	- The motor overheated due to a rise in ambient temperature. - After a cover was attached to the motor, the motor overheated. - After the robot control program or the load was changed, the motor overheats.	[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 current is above the specified permissive average current.	- Reducing the ambient temperature is the most effective means of preventing overheat. - Having the surroundings of the motor well ventilated enables the motor to release heat efficiently, thus preventing overheat. - If there is a source of heat nearby, it is advisable to install shielding to protect the motor from heat radiation. - Relaxing the robot control program and load condition is effective to reduce the average current, thus, preventing overheat. - The teach pendant can monitor the average current. Check the average current when the robot control program runs.

Symptom	Description	Cause	Measure
Motor overheating	- After a robot control parameter (load setting etc.) 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 overheat.	- As for load setting, Input an appropriate parameter referring to Section 8.5.
	- 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.
			  - 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.
			  - Inside the reducer
			  - Inside the wrist
			- Seal bolts are used in the locations stated below.
			  - Grease drain outlet
			- Replace the grease nipple.

Dropping axis	- An axis falls because the brake failed.
	- An axis falls with the brake applied.
		[Brake drive relay and motor]
		- It is likely that the brake drive relay contacts are stuck to each other keeping the brake current flowing, thus preventing the brake from operating when the motor is de-energized.
		- 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 soaked through the motor, causing the brake to slip.
			- Check whether the brake drive relay contacts are stuck to each other or not. If they are stuck, replace the relay.
			- Replace the motor after confirming the following symptoms.
			  - Brake shoe is worn out
			  - Brake main body is damaged
			  - Oil soaked through the motor

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 the reducer to slip. - It is likely that the Pulsecoder is fautly.	- 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.

Symptom	Description	Cause	Measure
Displacement (Continued)	- Displacement occurs only in a 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.
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 M-420*i*A

NOTE
For M-421*i*A, refer to the Section 5.2.

5.1.1 Axis Limits Setup (M-420*i*A)

NOTE
For M-421*i*A, refer to the Subsection 5.2.1.

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 software settings (All axes) (See the Section 5.3)
- Axis limit mechanical stopper (J1 axis) (See the Subsection 5.1.2)
- Axis limit switches ((J1 axis only) optional) (See the Subsection 5.1.3)

⚠ CAUTION
1 Changing the movable range of any axis affects the operation range of the robot. To avoid trouble, carefully consider a possible effect of the change to the movable range of each axis in advance. Otherwise, it is likely that an unexpected condition occurs; for example, an alarm may occur in a previous taught position.
2 For the J1-axis, do not count merely on software-based limits to the movable range when changing the movable range of the robot. Use mechanical stoppers together so that damage to peripheral equipment and injuries to human bodies can be avoided. In this case, make the software-specified limits match the limits based on the mechanical stoppers.
3 Mechanical stoppers are physical obstacles. The robot cannot move beyond them. For the J1-axis, it is possible to re-position the mechanical stoppers. For J2 and J3 axes, the mechanical stoppers are fixed. For the J4 axis, only software-specified limits are available.
4 Movable mechanical stoppers (J1-axis) 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.

5.1.2 Zero Point Position and Motion Limit (M-420*i*A)

NOTE
For M-421*i*A, refer to the Subsection 5.2.2.

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.5.1.2 (a) to (e) show the zero point and motion limit, and mechanical stopper position of each axis and the detection position (J1 axis only (option)).

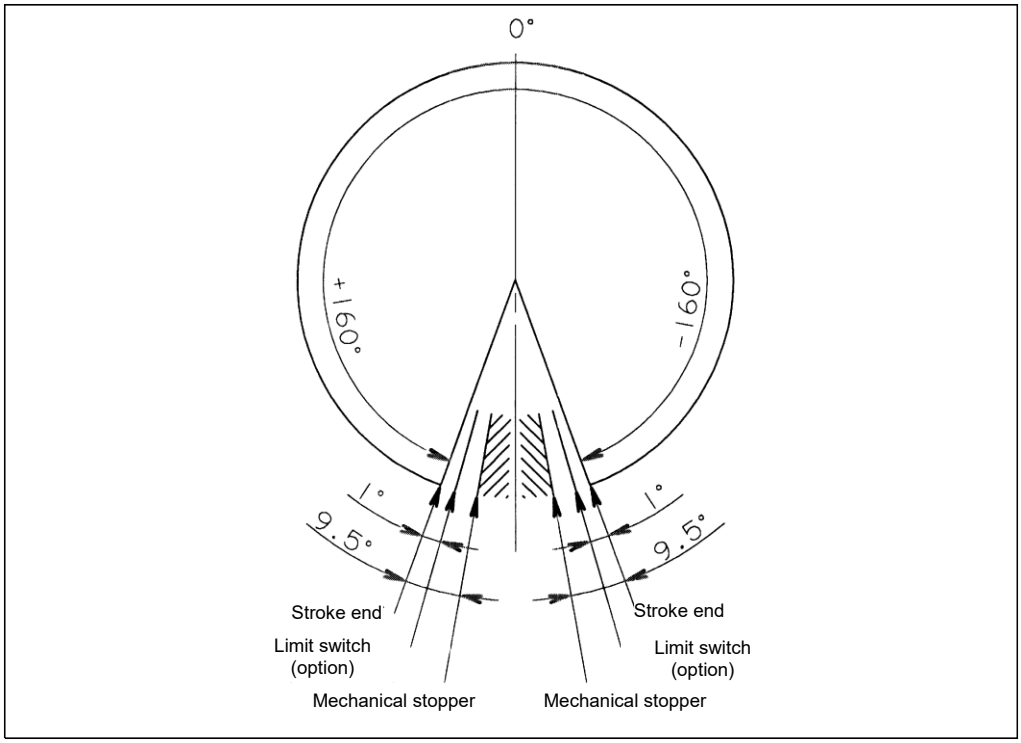
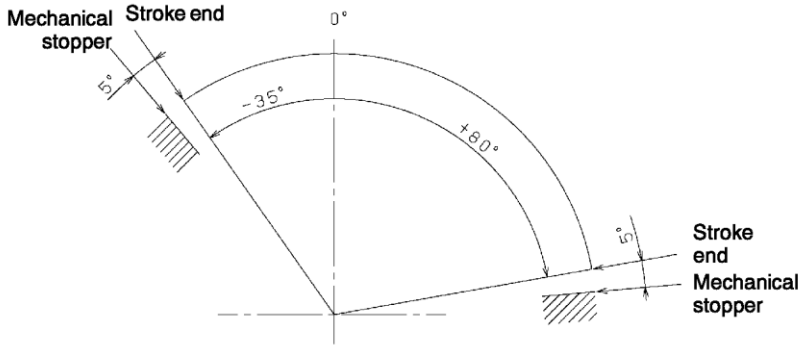


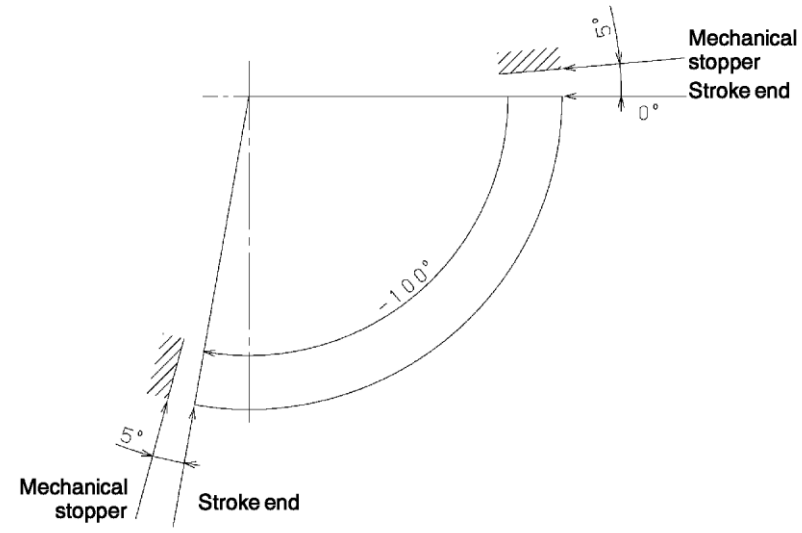
Fig. 5.1.2 (a) Zero point and motion limit of J1-axis (M-420*i*A)

NOTE
Adjustment for change of J1-axis stroke and the limit switch (option) is shown in the Subsection 5.1.3.



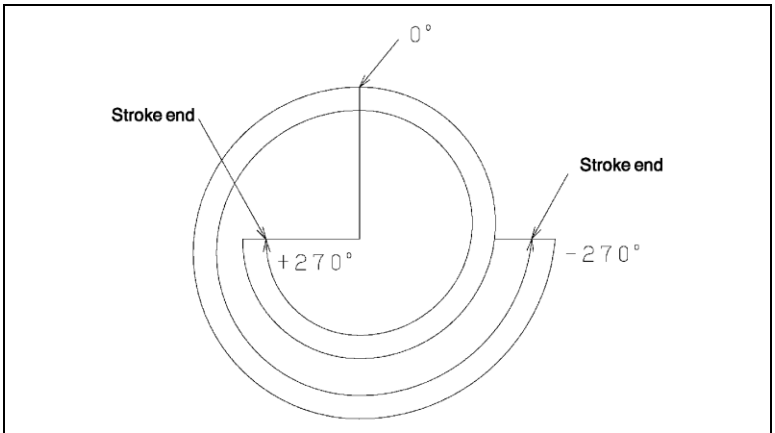
CAUTION
Motion limit is restricted by the J3-axis position.

Fig. 5.1.2 (b) Zero point and motion limit of J2-axis (M-420*i*A)



CAUTION
Motion limit is restricted by the J2-axis position.

Fig. 5.1.2 (c) Zero Point and motion limit of J3-axis (M-420*i*A)



CAUTION
J4-axis doesn't have the mechanical stopper.

Fig. 5.1.2 (d) Zero point and motion limit of J4-axis (M-420*i*A)

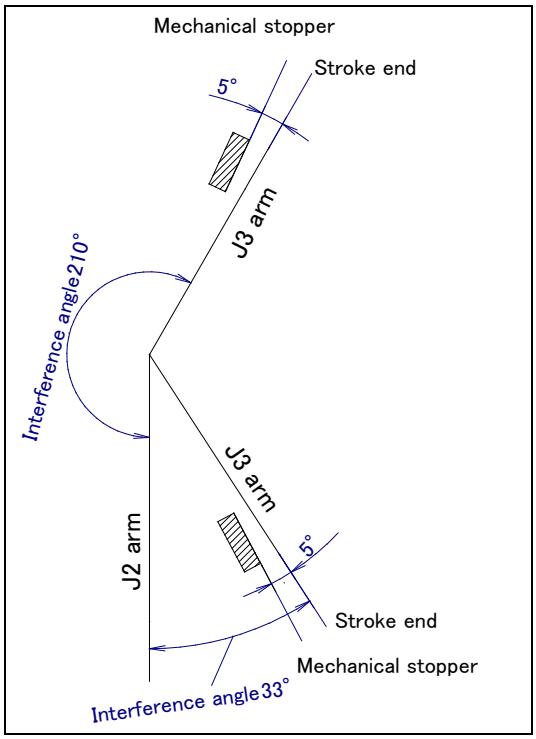


Fig. 5.1.2 (e) Interference angle of J2-axis and J3-axis (M-420*i*A)

5.1.3 Changing J1-axis Stroke and Adjustment of J1 Limit Switch (M-420*i*A Option)

The J1-axis stroke can be limited depending on the operating environment of the robot. The stroke can be changed by changing the locations of the dog and mechanical stopper and the settings of the variable number. (See Fig.5.1.3 (a), (b), and Table 5.1.3)
The stroke can be changed every 15 degrees in the upper limit of +10 degrees to +160 degrees and the lower limit of -160 degrees to -10 degrees.
(60 degrees and more are required between Upper limit stopper and Lower limit stopper (See Fig.5.1.3 (c))

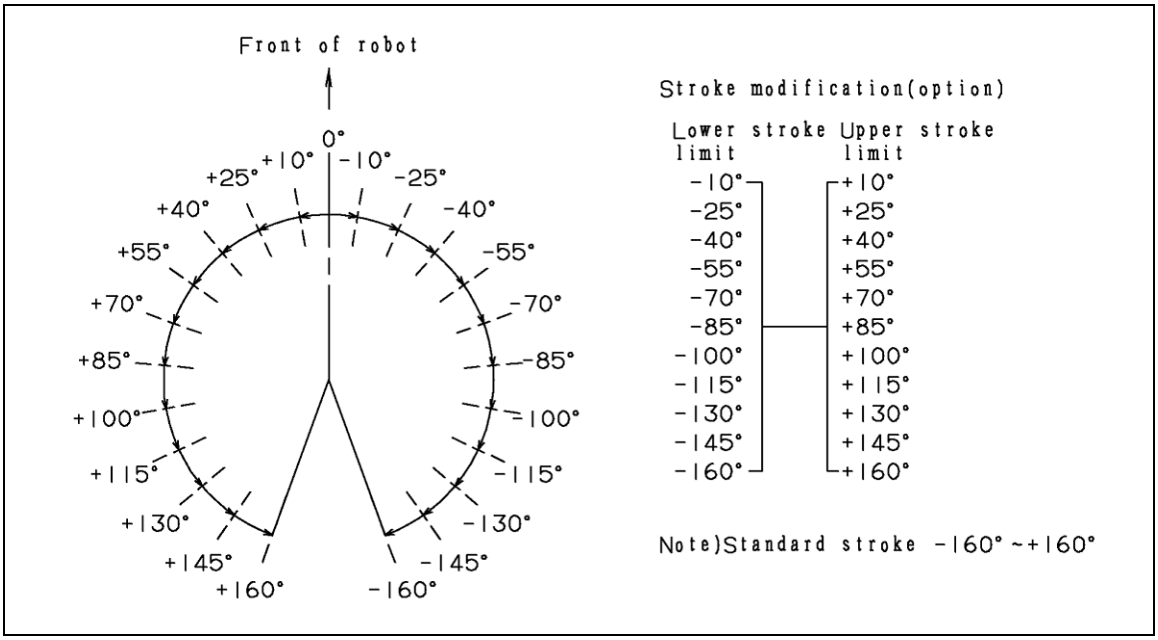


Fig. 5.1.3 (a) Changing J1-axis stroke (M-420*i*A Option)

(1) Re-positioning the mechanical stopper (option)
Re-position the mechanical stopper as shown in Fig.5.1.3 (b) so that it matches the desired stroke.

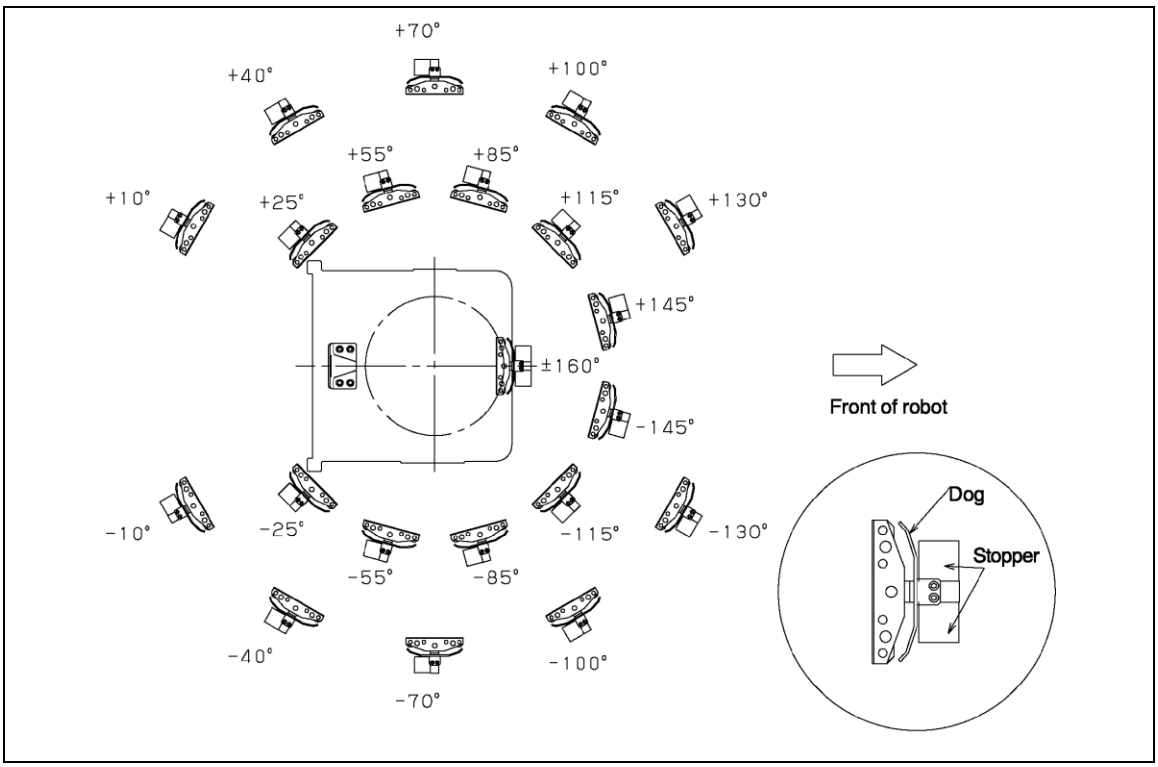


Fig. 5.1.3 (b) Re-positioning the mechanical stopper (M-420*i*A Option)

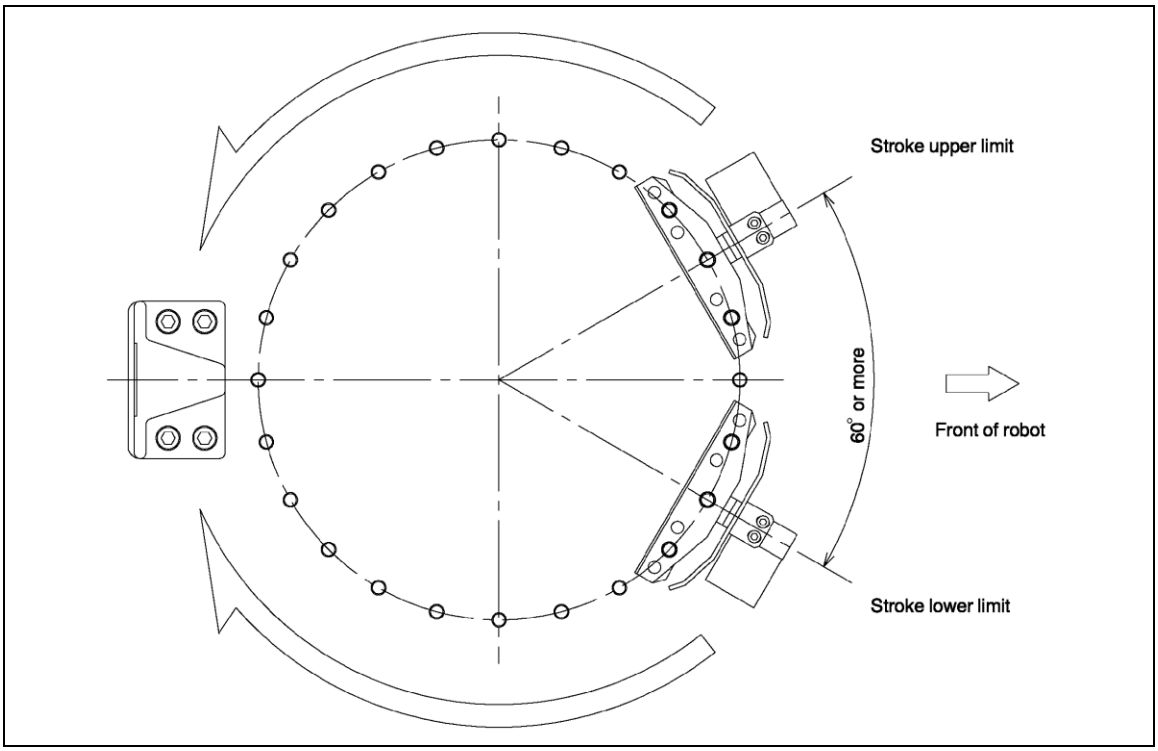


Fig. 5.1.3 (c) Cautions for mounting the mechanical stopper (M-420*i*A Option)

(2) Adjusting Limit Switch (Option)

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 bolts (2 pcs of M6: length 10, 2pcs of M6: length 12) secure the J1-axis limit switch (see Fig.5.1.3 (d).)

3 Adjust the position of the limit switch in such a way that the switch is activated at approx 1.0 degree from the stroke end. To be specific, set the limit switch in such a position that only one of the contact area setting indication lines at the tip of the switch is hidden when the limit switch touches the dog (see Fig.5.1.3 (d)).

4 When the limit switch operates and detects over travel (OT), the robot stops, and an error message, “J1-AXIS 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. 1.0 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, and then turn it on again to restart the controller.

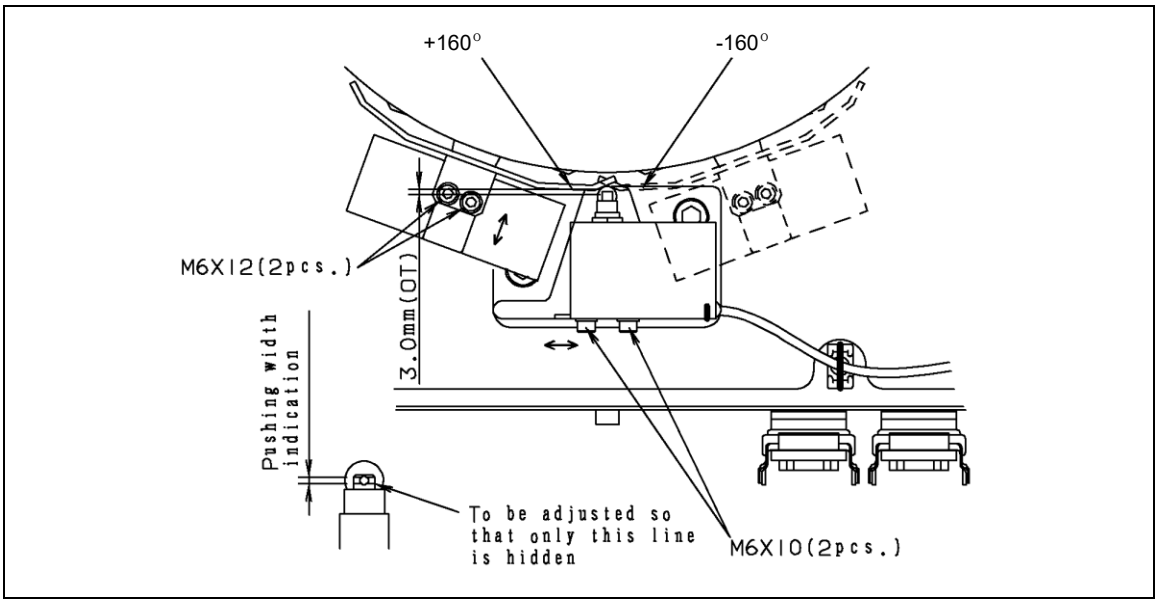


Fig. 5.1.3 (d) Adjusting J1-axis limit switch (M-420*i*A Option)

(3) Changing the system variables
Set the system variables listed in Table 5.1.3 (a) so that they match the new positions of the dog and mechanical stopper.

Table 5.1.3 (a) Changing the system variables (M-420*i*A)

Setting position	System variable	
	Stroke lower limit $PARAM_GROUP.$LOWERLIM[1]	Stroke upper limit $PARAM_GROUP.$UPPERLIM[1]
-160°	-160	
-145°	-145	
-130°	-130	
-115°	-115	
-100°	-100	
-85°	-85	
-70°	-70	
-55°	-55	
-40°	-40	
-25°	-25	
-10°	-10	
+10°		10
+25°		25
+40°		40
+55°		55
+70°		70
+85°		85
+100°		100
+115°		115
+130°		130
+145°		145
+160°		160

NOTE
1 The interval between the upper and lower stoppers must be at least 60 degrees (see Fig.5.1.3 (c)).
2 If the newly set operation area does not include the 0-degree position, it is necessary to perform zero-position mastering so that the 0-degree position is included.

5.2 M-421*i*A

NOTE
See Section 5.1 for explanations about the M-420*i*A.

5.2.1 Changing the Movable Range

NOTE
See Subsection 5.1.1 for explanations about the movable range of each axis of the M-420*i*A.

Setting a new movable range for each axis of the robot can change the robot's movable range from its standard setting.
Changing the robot movable range is useful for the following conditions.

- The operation range of the robot is limited when it is running.
- There is an area where the robot interferes with a tool or peripheral device.
- The length of a cable or hose attached for an application is limited.

The following method is available, which can keep the robot from going out of the necessary movable range.

- Software-based limit to the movable range (for all axes) (See Section 5.3.)

⚠ CAUTION
1 Changing the movable range of any axis affects the operation range of the robot. To avoid trouble, carefully consider a possible effect of the change to the movable range of each axis in advance. Otherwise, it is likely that an unexpected condition occurs; for example, an alarm may occur in a previous taught position.
2 Mechanical stoppers are physical obstacles. The robot cannot move beyond them. For all axes, the mechanical stoppers are fixed.

5.2.2 Zero Point Position and Motion Limit

NOTE
For M-420*i*A, see the Subsection 5.1.2.

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.5.2.2 (a) and (b) show the zero point and motion limit, and mechanical stopper position of each axis.

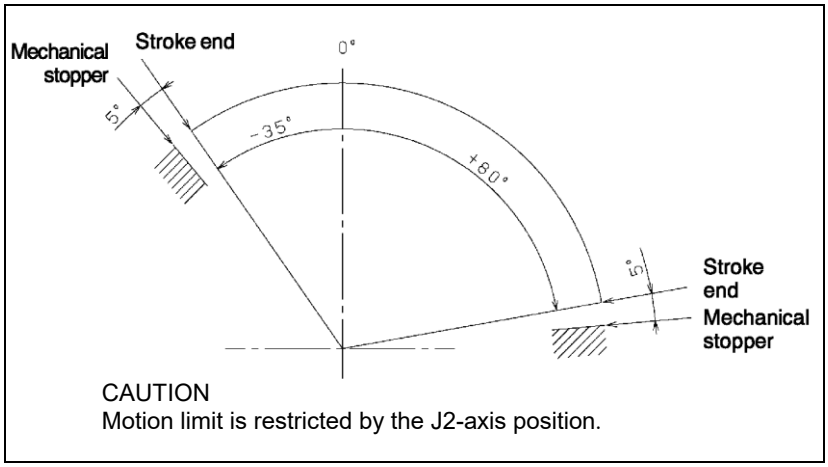


Fig. 5.2.2 (a) Zero point and motion limit of J1-axis (M-421*i*A)

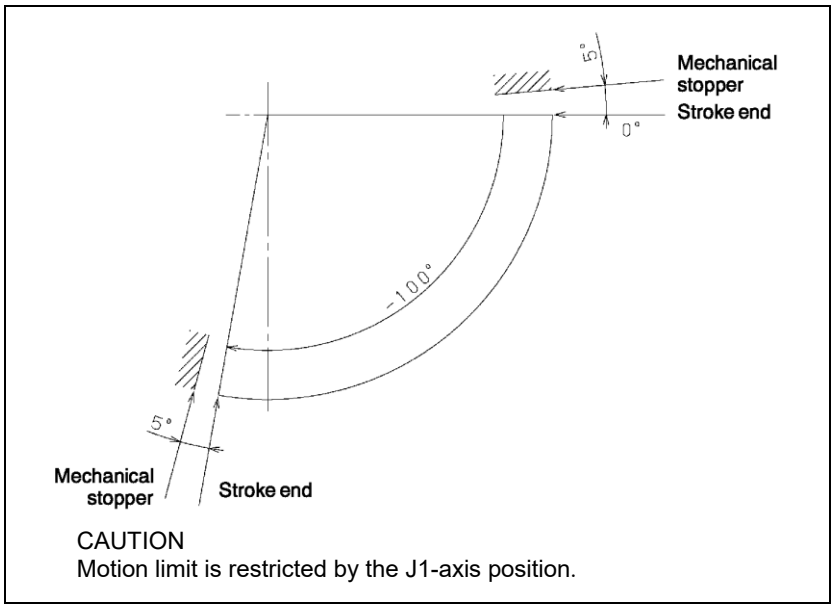


Fig. 5.2.2 (b) Zero point and motion limit of J2-axis (M-421*i*A)

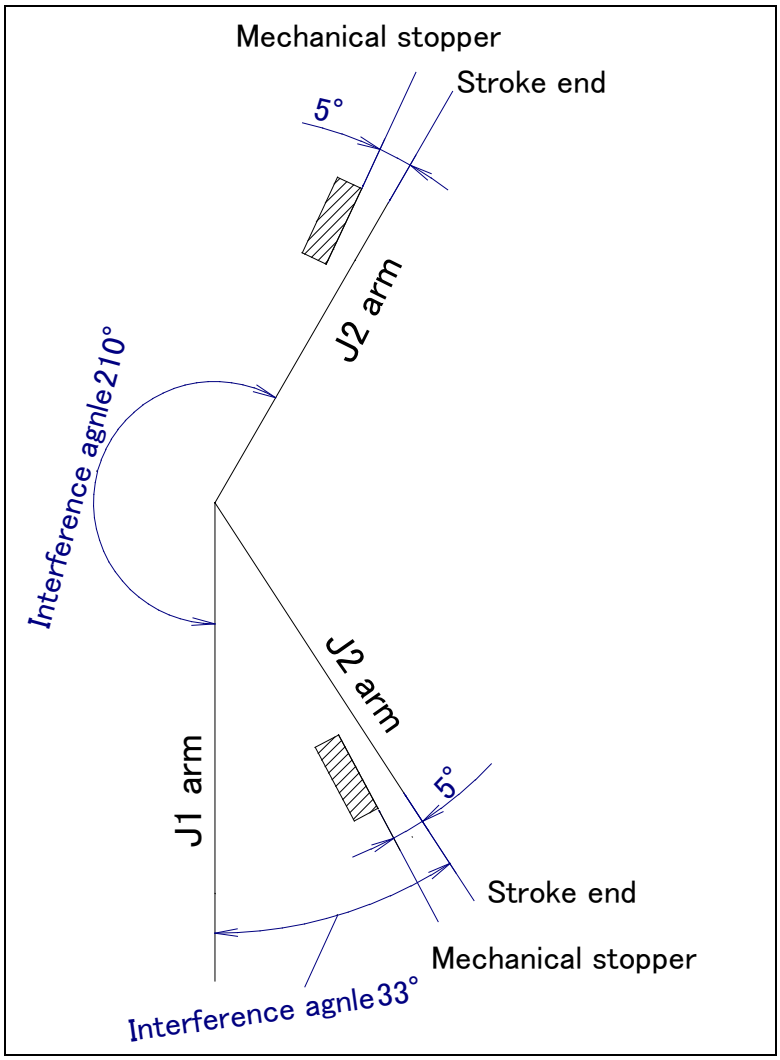


Fig. 5.2.2 (c) Interference angle of J1-axis and J2-axis (M-421*i*A)

5.3 SOFTWARE SETTING

Axis limit software settings are upper and lower motion degree limitations. The limits can be set for all robot axes and will stop robot motion if the robot is calibrated.

Procedure Setting up Axis Limits

Step

1 Press the [MENU] key.
2 Select [SYSTEM].
3 Press F1 [TYPE].
4 Select [Axis Limits]. The following screen will be displayed.

System Axis Limits JOINT 100%
Group1 1/16

AXIS	GROUP	LOWER	UPPER	
1	1	-150.00	150.00	deg
2	1	-60.00	75.00	deg
3	1	-110.00	50.00	deg
4	1	-240.00	240.00	deg
5	1	0.00	0.00	deg
6	1	0.00	0.00	deg
7	1	0.00	0.00	mm
8	1	0.00	0.00	mm
9	1	0.00	0.00	mm

[TYPE]

⚠ WARING
1 0.00 indicates the robot does not have these axes.
2 Do not depend on J1 axis limit software settings to control the motion range of your robot. Use the axis limit switches or mechanical stopper also; otherwise, injury to personnel or damage to equipment could occur.

5 Move the cursor to the desired axis range and type the new value using the numeric keys on the teach pendant.

System Axis Limits 2/16

AXIS	GROUP	LOWER	UPPER	
2	1	-44.00	100.00	deg

[TYPE]

6 Perform the setting for all axes.
7 Cycle the power of the controller in the cold start mode so the new settings are enabled.

⚠ WARNING
You must turn off the controller and then turn it back on to use the new information; otherwise injury to personnel or damage to equipment could occur.

5.4 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.

5.4.1 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 controller and mechanical units periodically. An alarm will be issued to warn the user of a low battery voltage.

Mastering method

Table 5.4.1 (a) describes the following mastering methods. If 7DC2 (V8.20P) or former software is installed, "Quick Mastering for Single Axis" has not been supported.

Table 5.4.1 (a) Types of Mastering

Fixture position mastering	Mastering performed with the mastering fixture before shipping.
Zero position mastering (witness mark mastering)	Mastering which 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	Mastering which performed for one axis at a time. The mastering position for each axis can be specified by the user. Useful in performing mastering on a specific axis.
Mastering data entry	Enter the Mastering data directly.

Once mastering is performed, it is necessary to carry out positioning, or calibration. Positioning is an operation in which the controller reads the current pulse count value to sense the current position of the robot.

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

> ⚠ **CAUTION**
> 1 If mastering is performed incorrectly, the robot may behave unexpectedly. This is very dangerous. Therefore, the positioning screen is designed to appear only when the $MASTER_ENB system variable is 1 or 2. After performing positioning, press F5 [DONE] on the positioning screen. The $MASTER_ENB system variable is reset to 0 automatically, thus hiding the positioning screen.
> 2 It is recommended that you back up the current mastering data before performing mastering.

5.4.2 Resetting Alarms and Preparing for Mastering

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

Alarm displayed

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

Procedure

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

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

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

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.

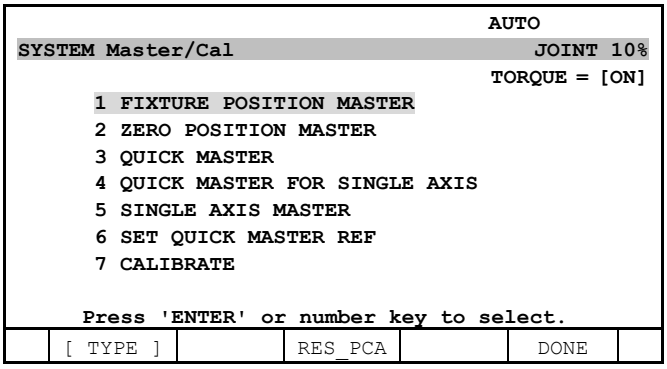
5.4.3 Zero Degree Mastering

Zero position mastering (witness mark mastering) is performed with all axes set at the 0-degree position. A zero position mark (witness mark) is attached to each robot axis (Fig. 5.4.3 (a)). This mastering is performed with all axes set at the 0-degree position using their respective witness marks. Zero position mastering involves a visual check, and might not be highly accurate. It should be used only as a quick-fix method.

Zero-position Mastering Procedure

1 Press the [MENU] key to display the screen menu.
2 Select [0 NEXT] and press [6 SYSTEM].

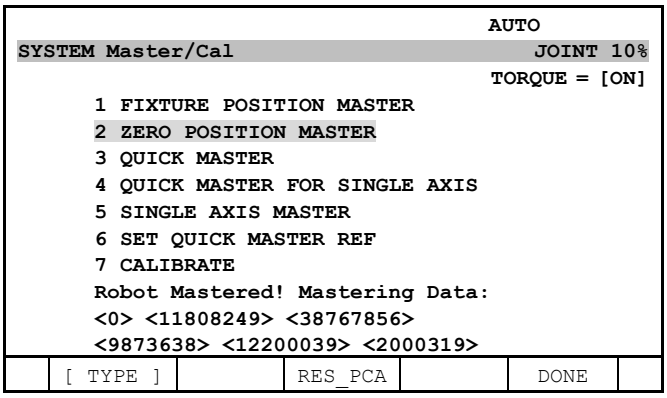
3 Press F1 [TYPE].
4 Select [Master/Cal].



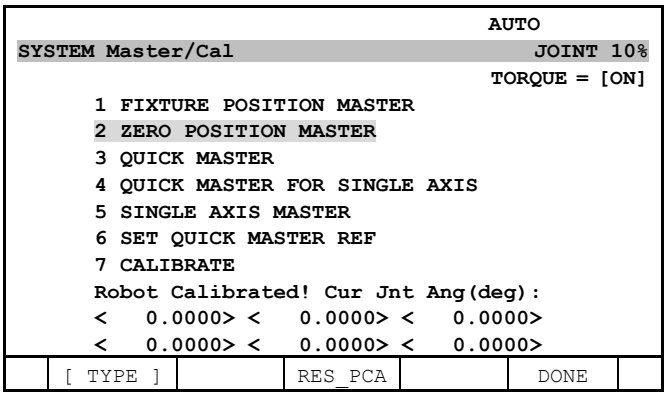
5 Release brake control, and jog the robot into a posture for mastering.

NOTE
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, turn off the controller power and on again.

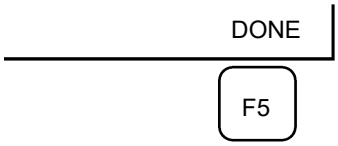
6 Select [2 Zero Position Master]. Press F4 [YES].



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



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



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

Table 5.4.3 (a) Posture with Position Marks Aligned

Axis	Position	
	M-420*i*A	**M-421*i*A**
J1-axis	0 deg	0 deg
J2-axis	0 deg	0 deg
J3-axis	0 deg	
J4-axis	0 deg	

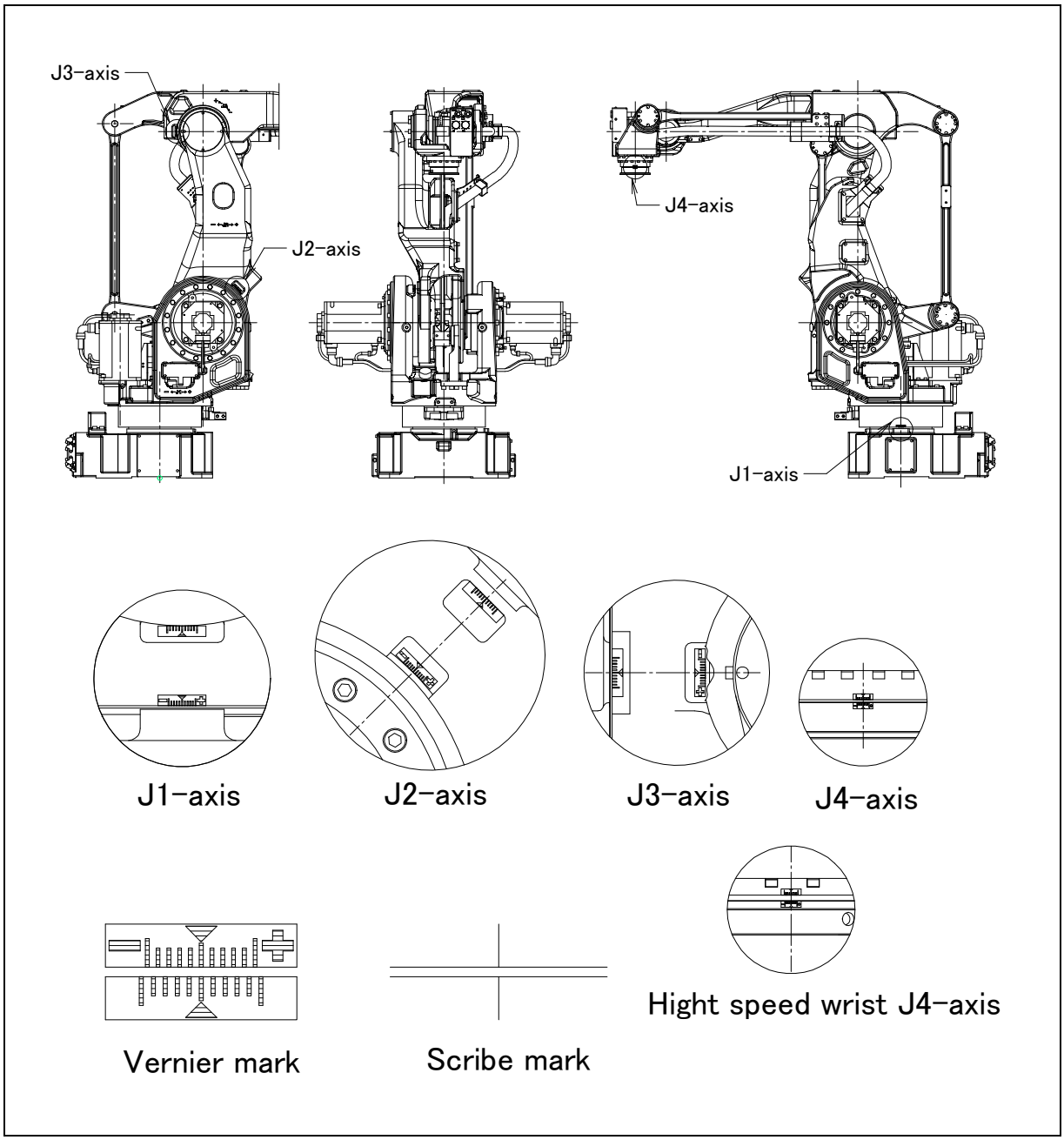


Fig. 5.4.3 (a) zero-position mark (witness mark) for each axis (M-420*i*A)

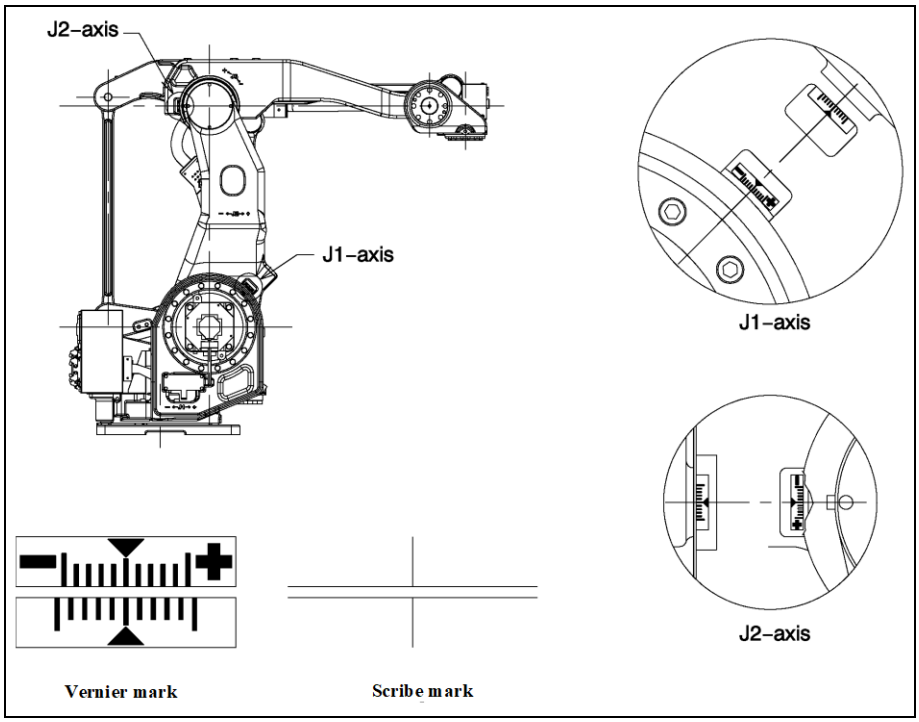


Fig. 5.4.3 (b) zero-position mark (witness mark) for each axis (M-421*i*A)

5.4.4 Quick Mastering

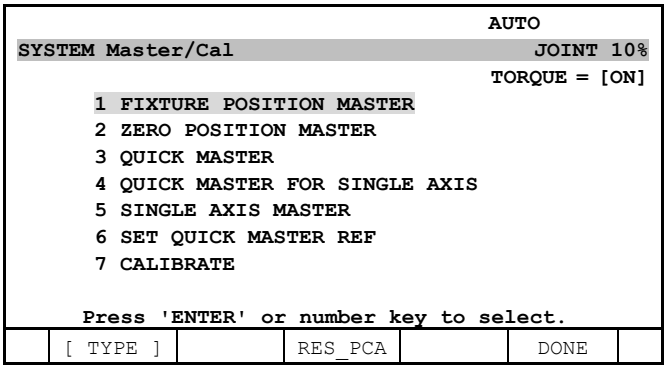
Quick mastering is performed at a user-specified position. The corresponding count value is obtained from the rotation speed of the Pulsecoder connected to the relevant motor and the rotation angle within one rotation. Quick mastering uses the fact that the absolute value of a rotation angle within one rotation will not be lost.
Quick mastering is factory-performed at the position indicated in Table. 5.4.3(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.

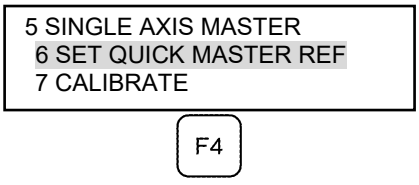
Procedure Recording the Quick Mastering Reference Position

Step

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



3 Release brake control, and jog the robot to the quick mastering reference position.
4 Select [6 SET QUICK MASTER REF] and press F4 [YES]. Quick mastering reference position is saved.

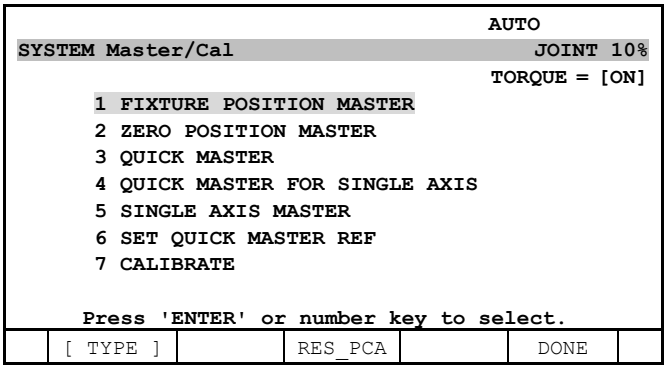


⚠ CAUTION
If the robot has lost mastering data due to mechanical disassembly or repair, you cannot perform this procedure. In this case, perform Fixture position mastering or zero –position mastering is required to restore mastering data.

Procedure of Quick Mastering

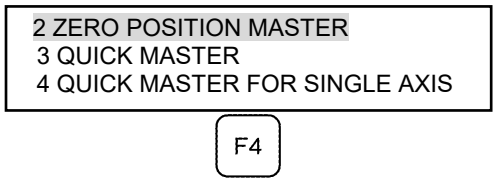
Step

1 Display the Master/Cal screen.



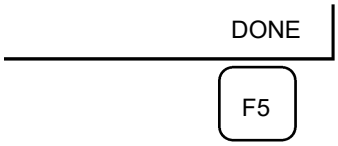
2 Release brake control, and jog the robot to the quick mastering reference position.

3 Move the cursor to [QUICK MASTER] and press the [ENTER] key. Press F4, [YES]. Quick mastering data is memorized.



4 Move the cursor to [CALIBRATE] and press the [ENTER] key. Calibration is executed. Calibration is executed by power on again.

5 After completing the calibration, press F5 [Done].



6 Return brake control to original setting, and cycle power of the controller.

5.4.5 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.

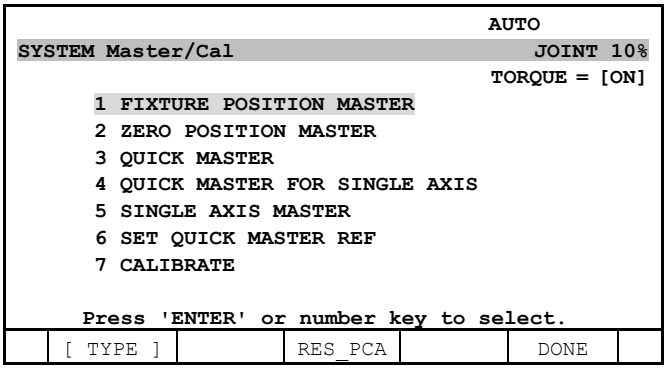
Quick mastering is factory-performed at the position indicated in Table 5.4.3 (a). Do not change the setting unless there is any problem.

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.)

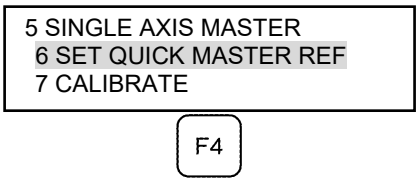
⚠ CAUTION
1 Quick mastering can be used, if the pulse count value is lost, for example, because a low voltage has been detected on the backup battery for the pulse counter.
2 Quick mastering cannot be used, after the motor is replaced or after the mastering data is lost from the robot controller.

Procedure Recording the Quick Mastering Reference Position

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



3 Release brake control, and jog the robot to the quick mastering reference position.
4 Select [6 SET QUICK MASTER REF] and press F4 [YES]. Quick mastering reference position will be set.



⚠ 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 is required to restore mastering data.

Procedure of Quick Mastering for single axis

1 Display the Master/Cal screen.

```
                                        AUTO
SYSTEM Master/Cal                     JOINT 10%
                                    TORQUE = [ON]
      1 FIXTURE POSITION MASTER
      2 ZERO POSITION MASTER
      3 QUICK MASTER
      4 QUICK MASTER FOR SINGLE AXIS
      5 SINGLE AXIS MASTER
      6 SET QUICK MASTER REF
      7 CALIBRATE

     Press 'ENTER' or number key to select.
|  | [ TYPE ] |  | RES_PCA |  | DONE |  |
```

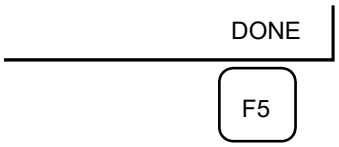
2 Select [4 QUICK MASTER FOR SINGLE AXIS]. You will see the quick master for single axis screen.

```
                                        AUTO
QUICK MASTER FOR SINGLE AXIS          JOINT 10%
                                  TORQUE =   [ON]
   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)   [2]
E1   0.000      (0.000)      (0)   [2]
E2   0.000      (0.000)      (0)   [2]
|  |  |  |  |  | EXEC |  |
```

3 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.

```
                                        AUTO
QUICK MASTER FOR SINGLE AXIS          JOINT 10%
                                  TORQUE =   [ON]
   ACTUAL POS  (MSTR POS) (SEL) [ST]
J5   0.000      (0.000)      (1)   [2]
J6   0.000      (0.000)      (1)   [2]
|  |  |  |  |  | EXEC |  |
```

4 Turn off brake control, then jog the robot to the quick mastering reference position.
5 Press F5 [EXEC]. Mastering is performed. So, [SEL] is reset to 0, and [ST] is re-set to 2.
6 Select [7 CALIBRATE] and press F4 [YES]. Calibration will be executed. Calibration is executed by cycling power.
7 After completing the calibration, press F5 Done.



8 Return brake control to original setting, and cycle power of the controller.

5.4.6 Single Axis Mastering

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

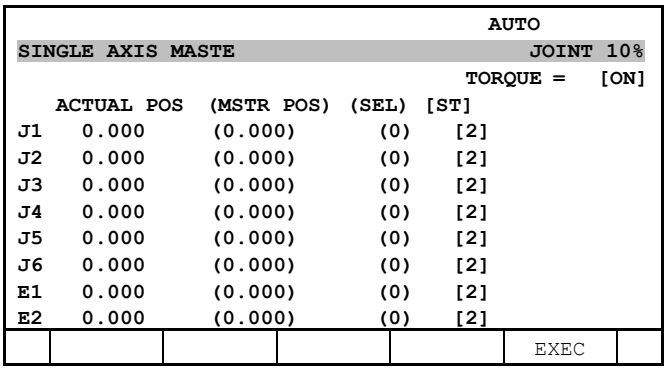
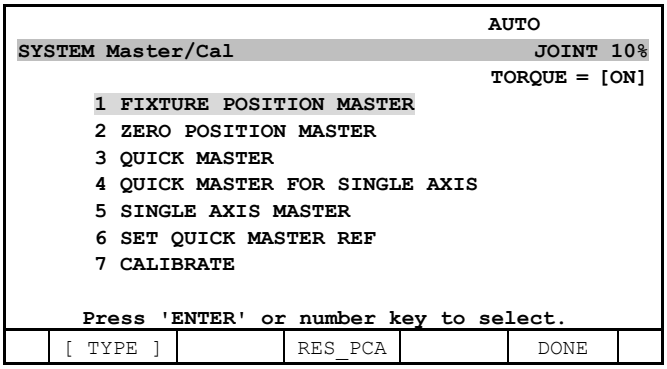


Table 5.4.6 (a) Items set in single axis mastering

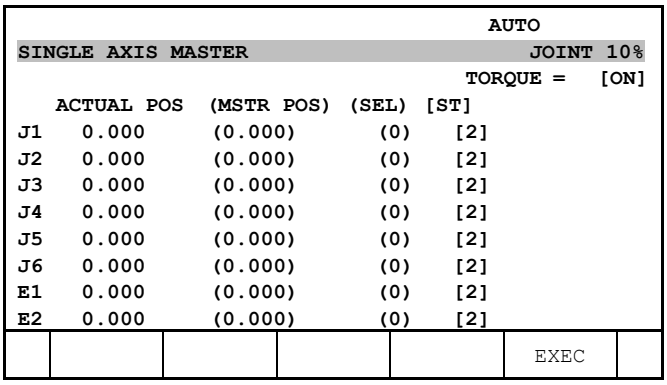
Item	Description
Current position (ACTUAL AXIS)	The current position of the robot is displayed for each axis in degree units.
Mastering position (MSTR POS)	A mastering position is specified for an axis to be subjected to single axis mastering. It would be convenient if it is set to 0 degree position.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

Procedure of Single axis mastering

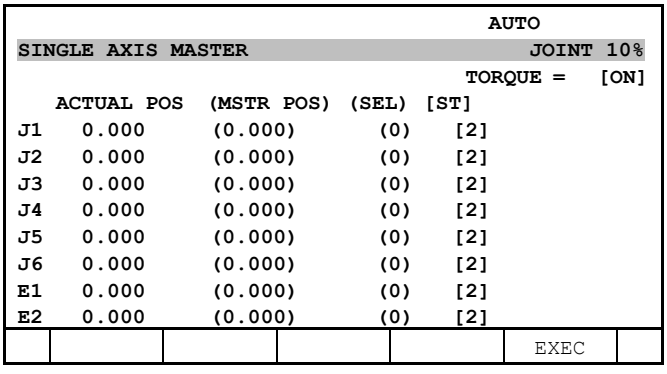
1 Select [6 SYSTEM].
2 Select [Master/Cal].



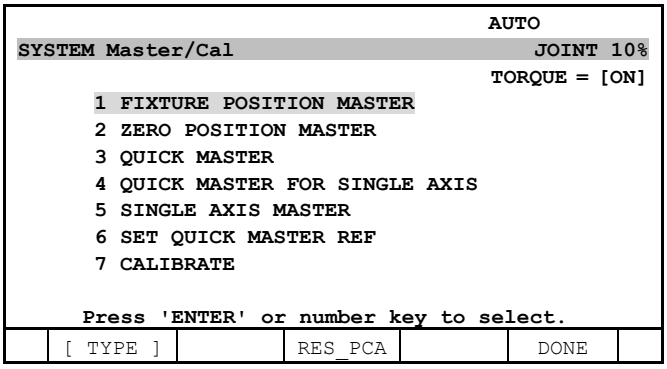
3 Select [5 SINGLE AXIS MASTER]. The following screen will be displayed.



4 For the axis to which to perform single axis mastering, set (SEL) to “1.” Setting of [SEL] is available for one or more axes.
5 Turn off brake control, then jog the robot to the mastering position.
6 Enter axis data for the mastering position.
7 Press F5 [EXEC]. Mastering is performed. So, [SEL] is reset to 0, and [ST] is re-set to 2 or 1.

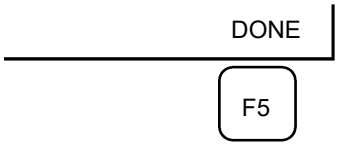


8 When single axis mastering is completed, press the [PREV] key to resume the previous screen.



9 Select [7 CALIBRATE], then press F4 [YES]. Positioning is performed. Alternatively, turn off the controller power and on again. Positioning is performed.

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



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

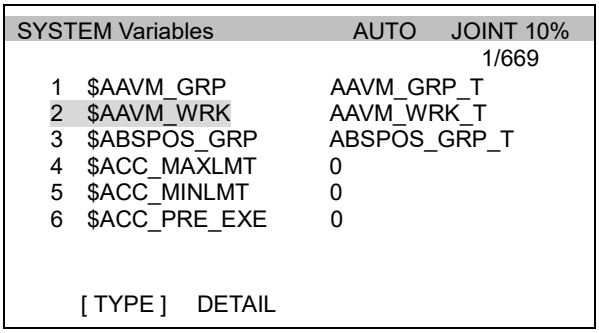
5.4.7 Mastering Data Entry

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

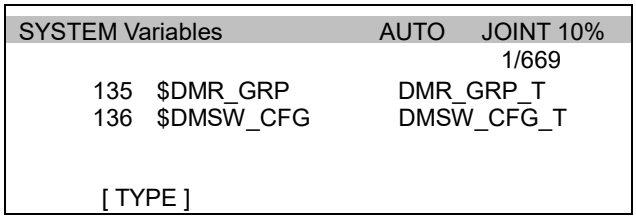
Mastering data entry method

1 Press the [MENU] key, then press [0 NEXT] and select [6 SYSTEM].

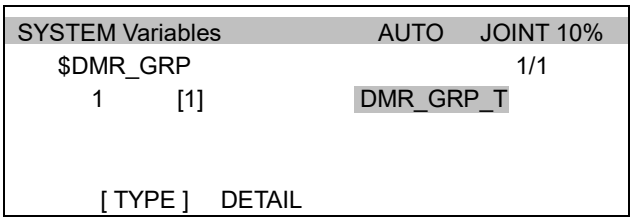
2 Press F1 [TYPE]. Select [Variables]. The system variable screen will be displayed.

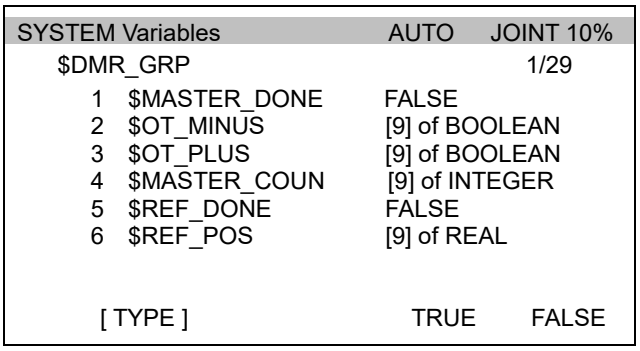


3 Change the mastering data. The mastering data is saved to the $DMR_GRP.$MASTER_COUN system variable.

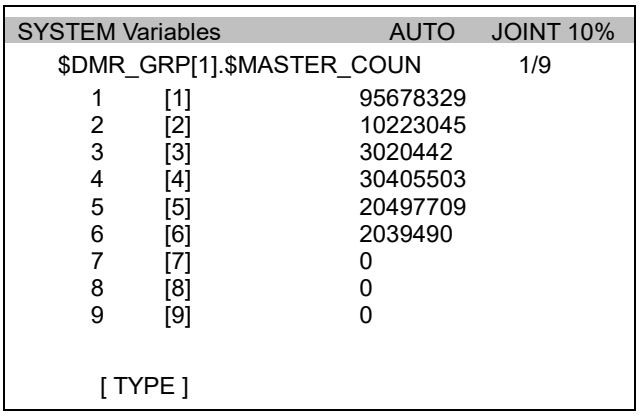


4 Select $DMR_GRP.

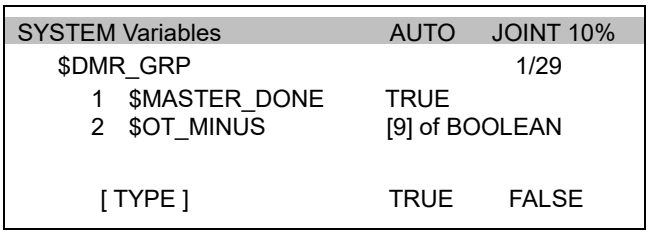




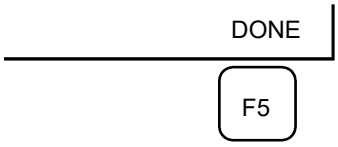
5 Select $MASTER_COUN, and enter the mastering data you have recorded.



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



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



5.5 VERFYING MASTERING

1 How to verify that the robot is mastered properly:
Usually, positioning is performed automatically when the power is turned on. To check whether mastering has been performed correctly, examine if the current displayed position matches the actual robot position by using one or more of the procedures described below:
(1) Reproduce a particular point in a program. Check whether the point agrees with the specified position.
(2) Set all axes of the robot to their 0-degree (0rad) positions. Check that the zero-degree position marks indicated in Subsection 5.4.3 are aligned. There is no need to use any visual aid.

If the displayed and actual positions do not match, the counter value for a Pulsecoder may have been invalidated as a result of an alarm described below 2. Alternatively, the mastering data in system variable $DMR_GRP.$MASTER_COUN may have been overwritten as a result of an operation error or some other reason.
Compare the data with the values indicated on the supplied data sheet. This system variable is overwritten whenever mastering is performed. Whenever mastering is performed, record the value of the system variable on the data sheet.

2 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 5.4.2.), 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.
(3) CKAL, RCAL, PHAL, CSAL, DTERR, CRCERR, STBERR, and SPHAL, alarms
Contact the FANUC because the Pulsecoder may be defective.

6 PIPING AND WIRING

6.1 WIRING DIAGRAM OF M-420*i*A

Fig.6.1 (a) to (d) show the wiring diagram of the M-420*i*A.

NOTE
For M-421*i*A, see the Section 6.2.

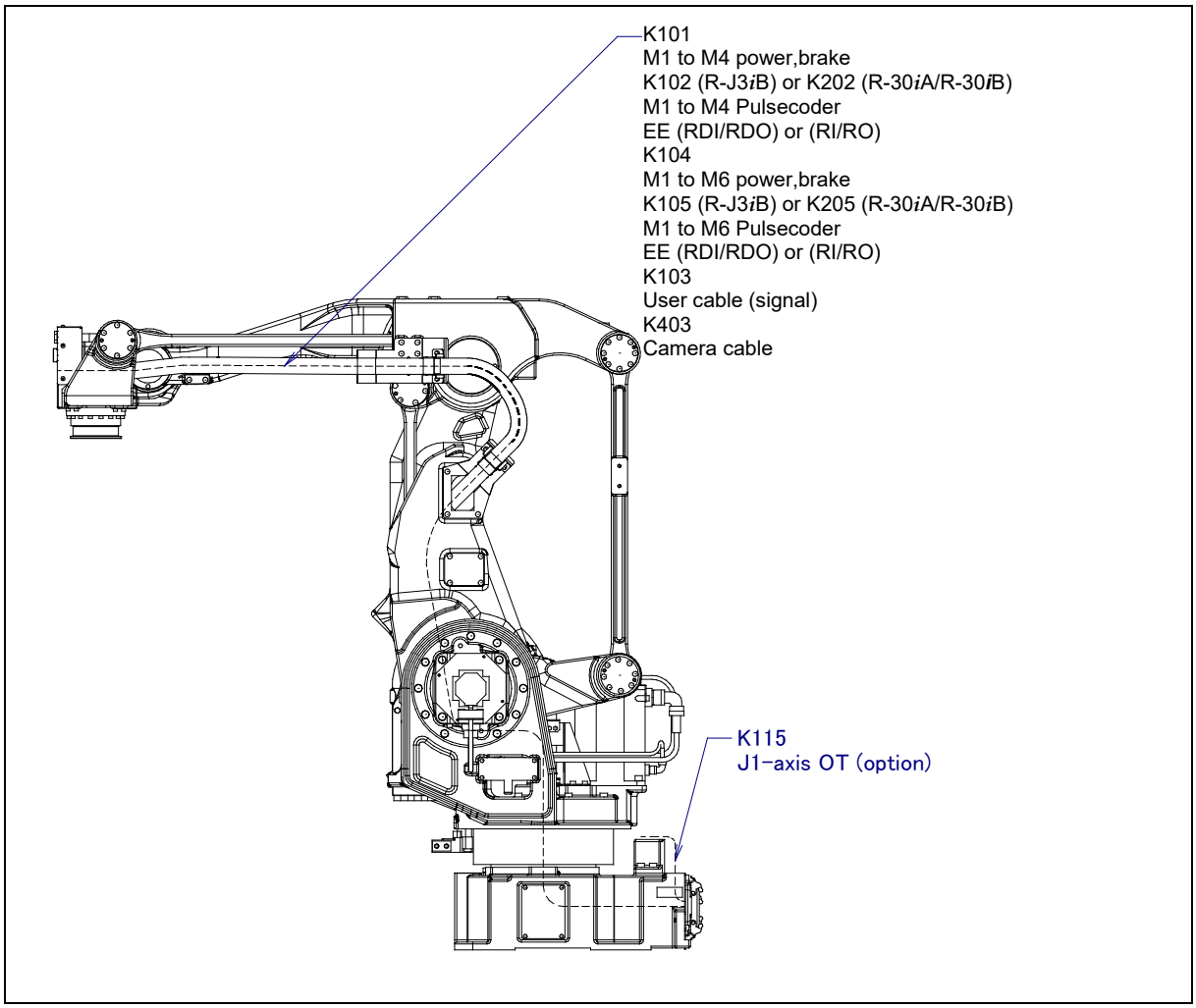


Fig. 6.1 (a) Wiring diagram (M-420*i*A Standard/High-speed Wrist)

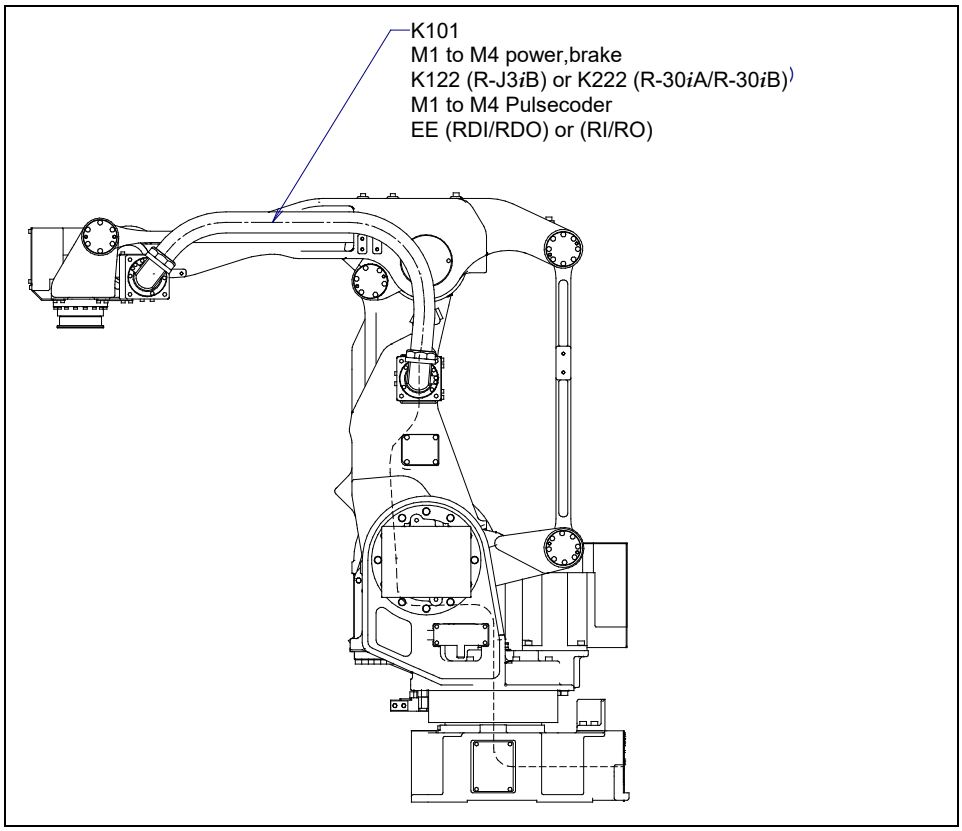


Fig. 6.1 (b) Wiring block diagram (M-420*i*A 2nd Food)

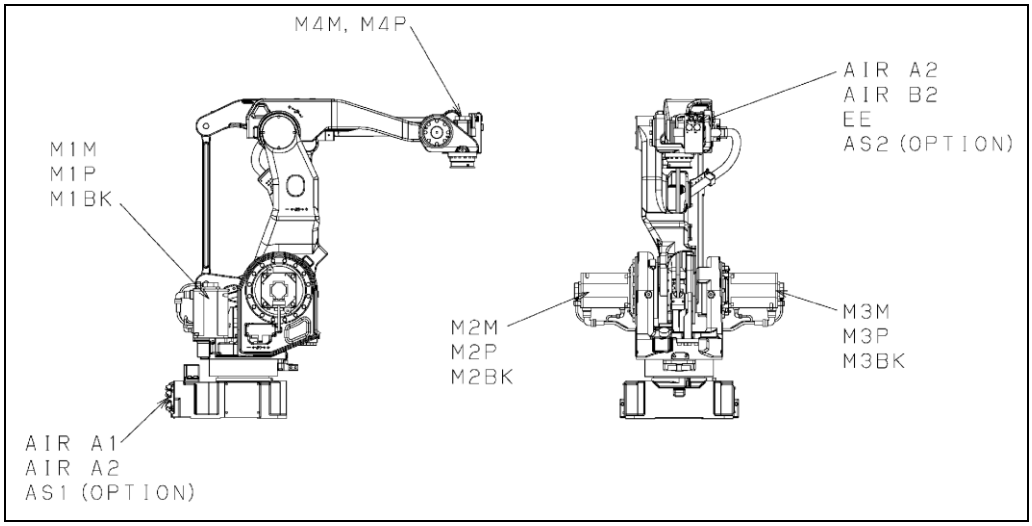


Fig.6.1 (c) Connector location (M-420*i*A Standard/High-speed Wrist)

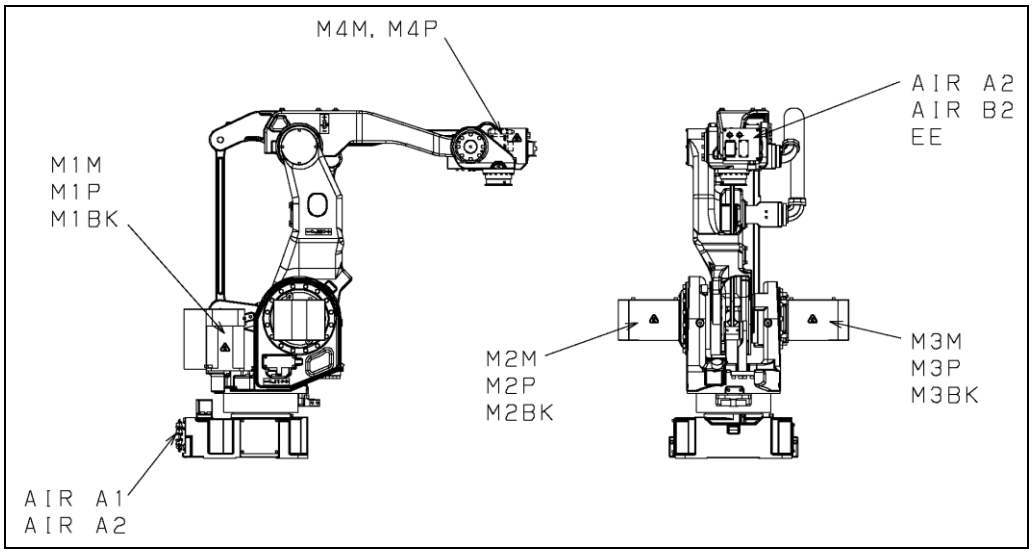


Fig.6.1 (d) Connector location (M-420*i*A 2nd Food)

6.2 WIRING DIAGRAM OF M-421*i*A

Fig.6.2 (a) to (b) show the wiring diagram of the M-421*i*A.

NOTE
For M-420*i*A, see the Section 6.1.

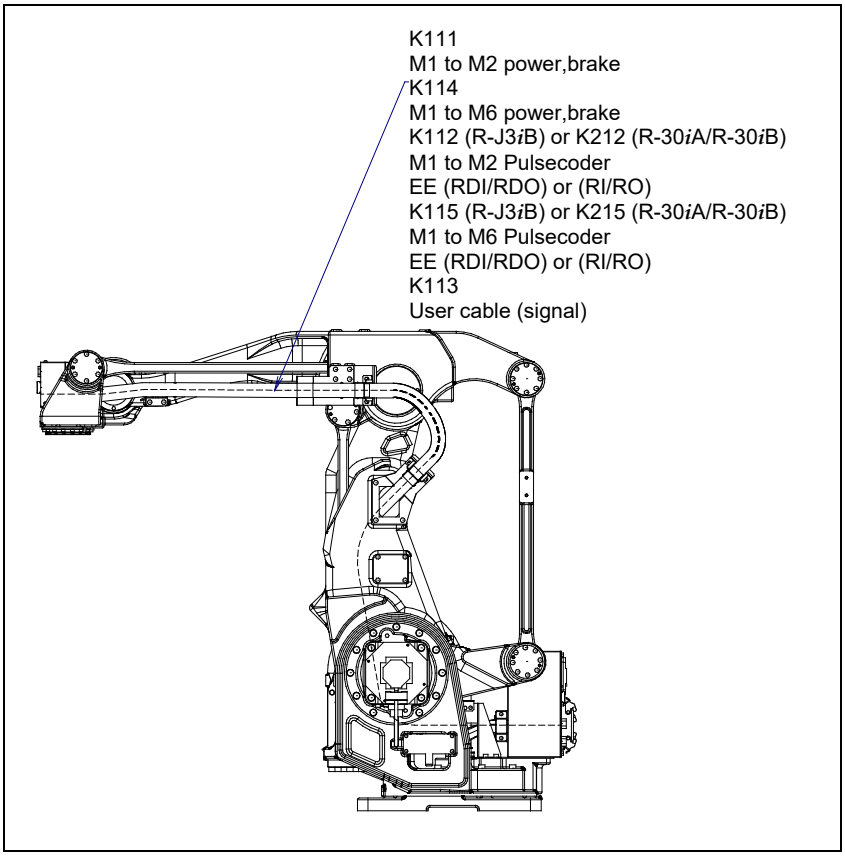


Fig. 6.2 (a) Wiring Diagram (M-421*i*A)

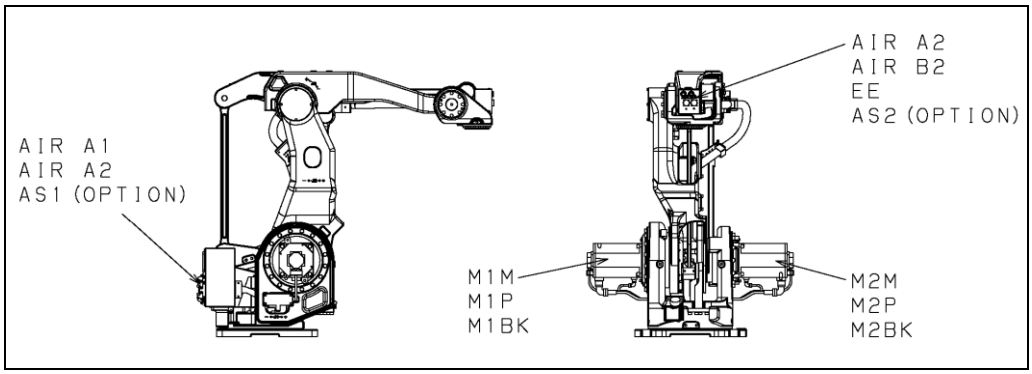


Fig. 6.2 (b) Connector Location (M-421*i*A)

7 ROBOT OPERATING SPACE

Fig.7 (a) to (c) show the external dimensions and operation space of the robots. Fig.7 (d) and (e) show the operations of the robots.
When installing peripheral equipment, be careful to clear away any objects that are in the robot's motion path in normal operation.

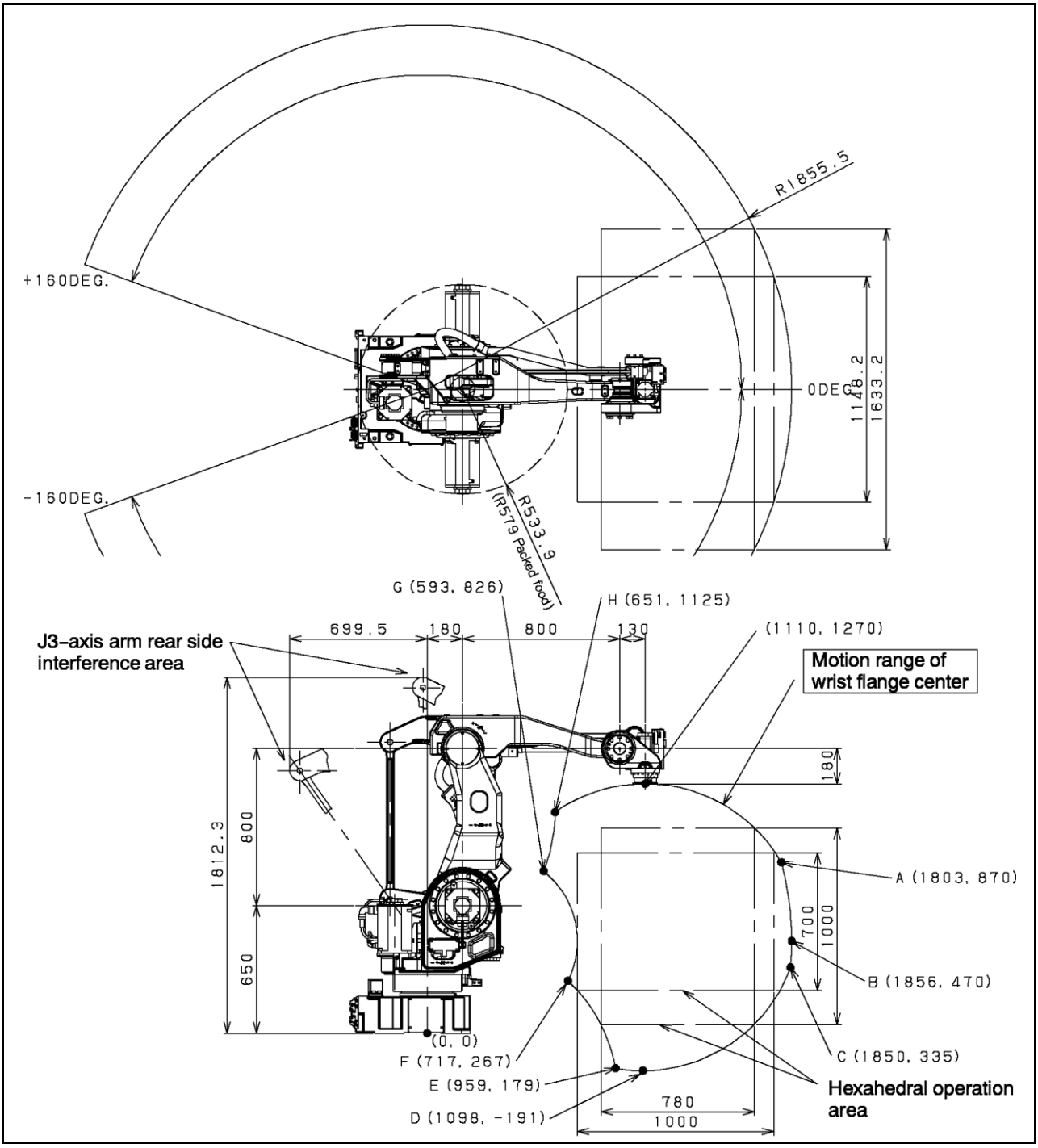


Fig.7 (a) External dimension and operating space (M-420*i*A Standard/2nd food)

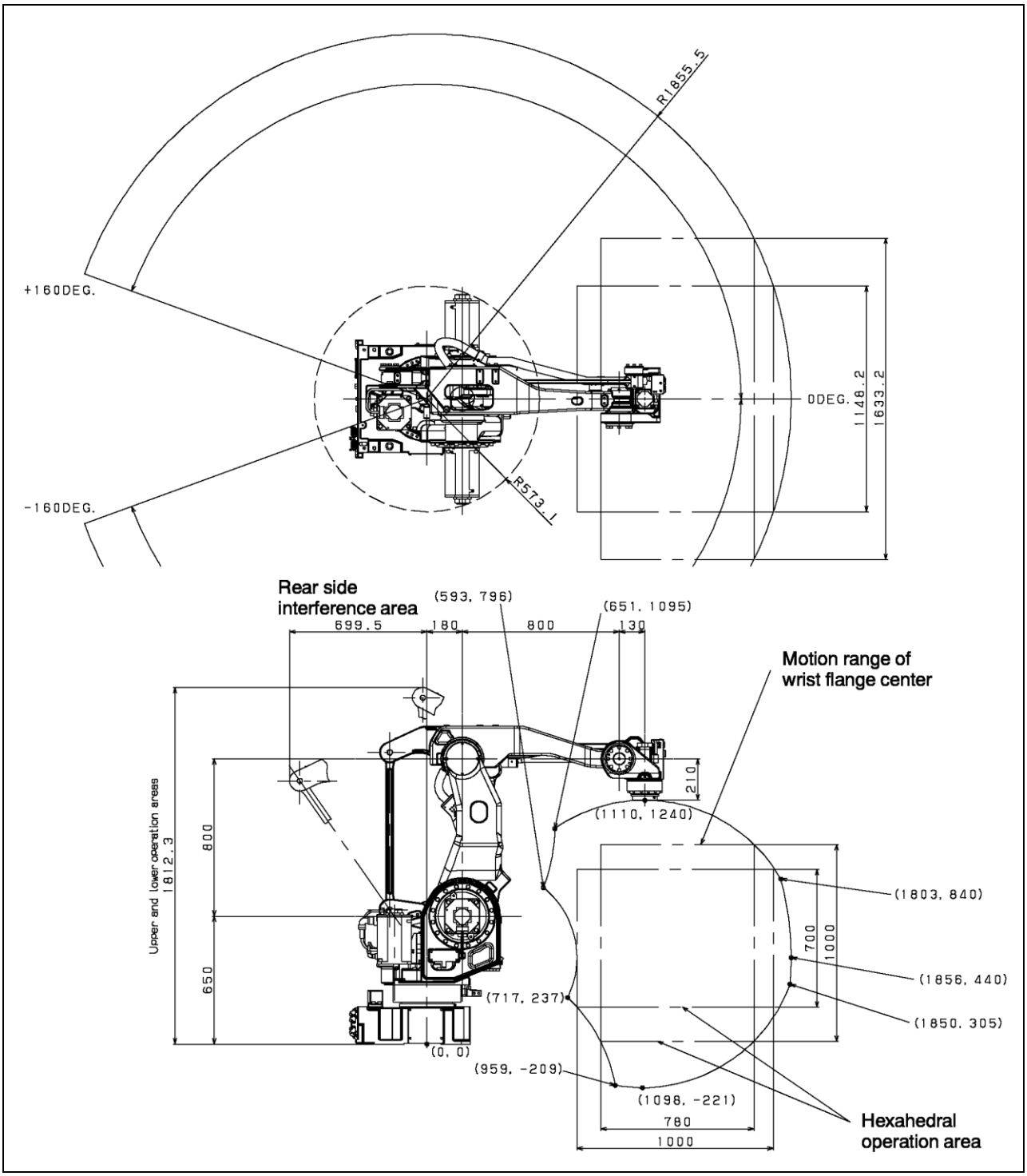


Fig.7 (b) External dimension and operating space (M-420*i*A High-speed wrist)

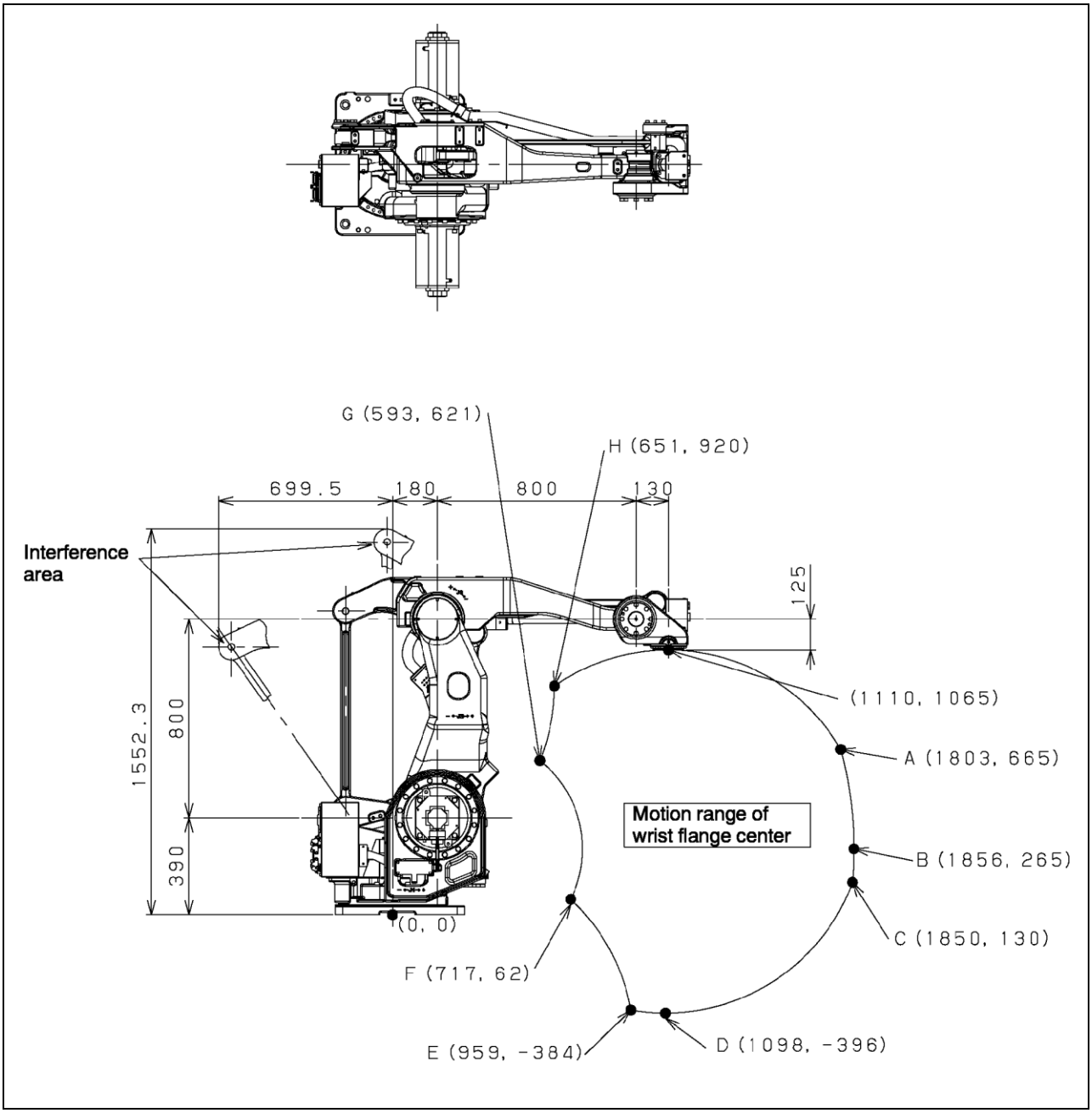


Fig.7 (c) External dimensions and operating space (M-421*i*A)

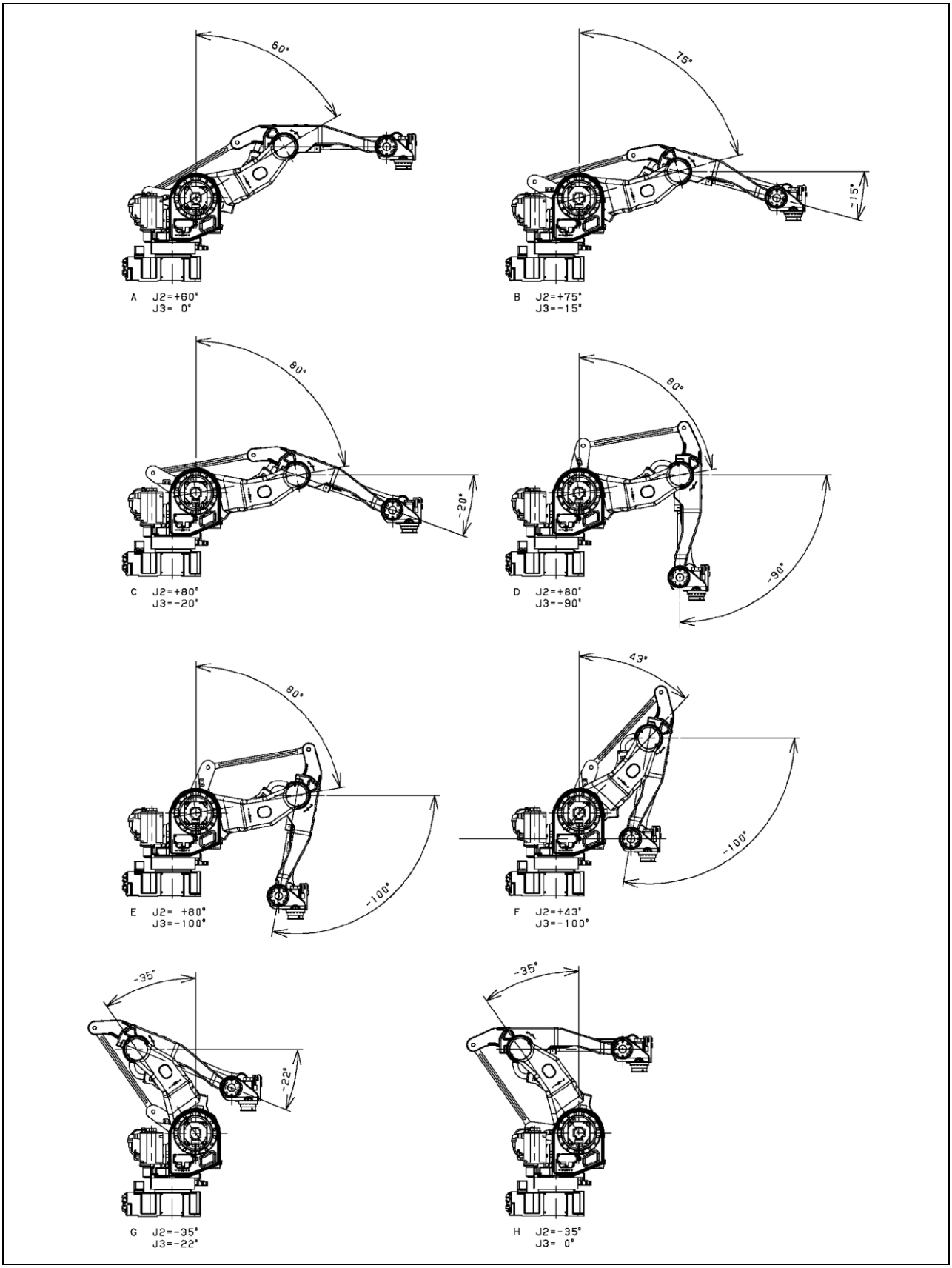


Fig.7 (d) Operation (M-420*i*A)

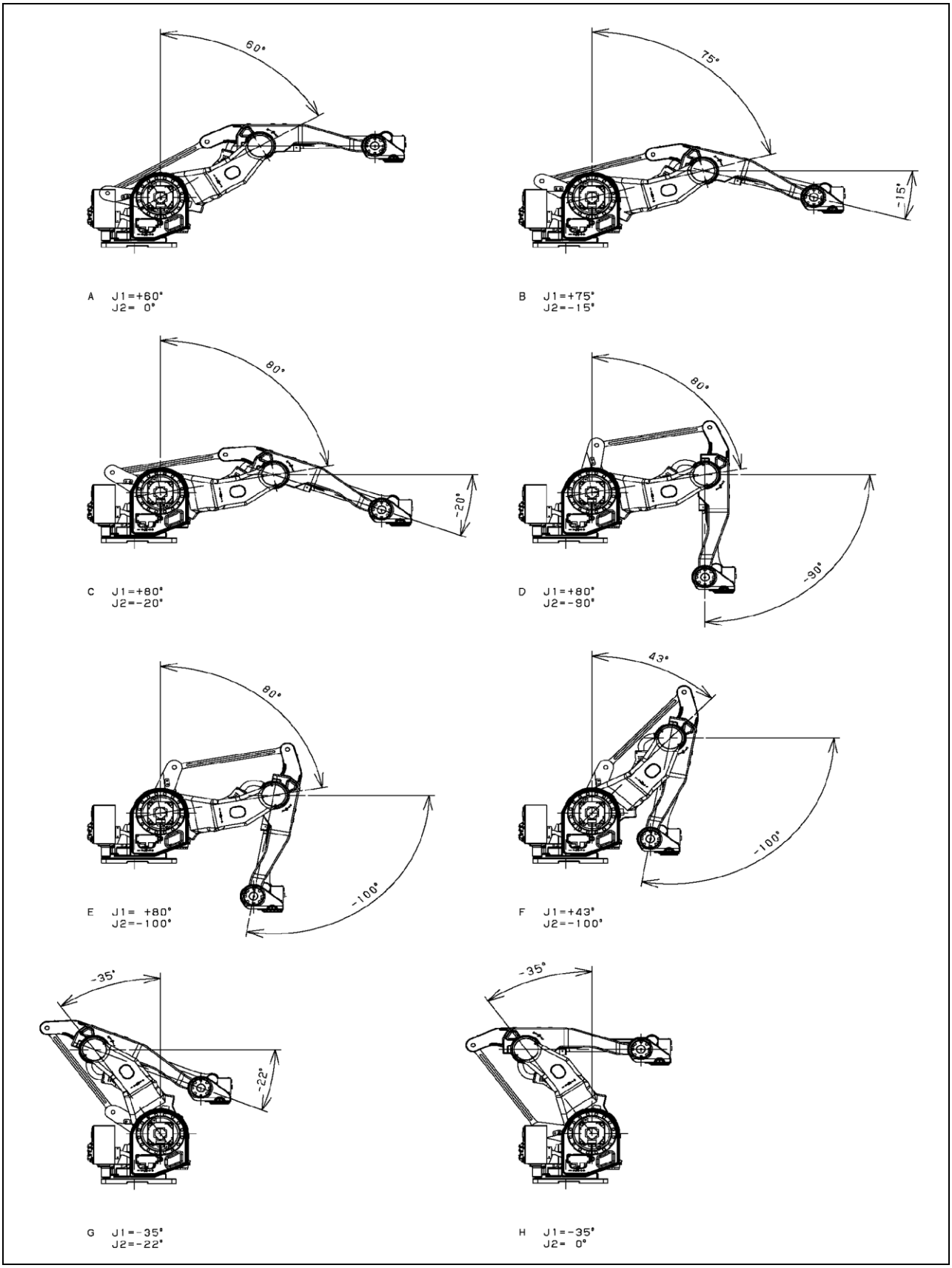


Fig.7 (e) Operation (M-421*i*A)

8 EQUIPMENT INSTALLATION TO THE ROBOT

8.1 WRIST LOAD CONDITIONS

Fig.8.1 (a) to (c) are diagrams to limit loads applied to the wrist. Apply a load within the region indicated in the graph. Apply the conditions of the allowable load moment and the allowable load inertia.
In any case, keep the total load inertia (including the form inertia) around the central axis within 2.5 kg-m^2.

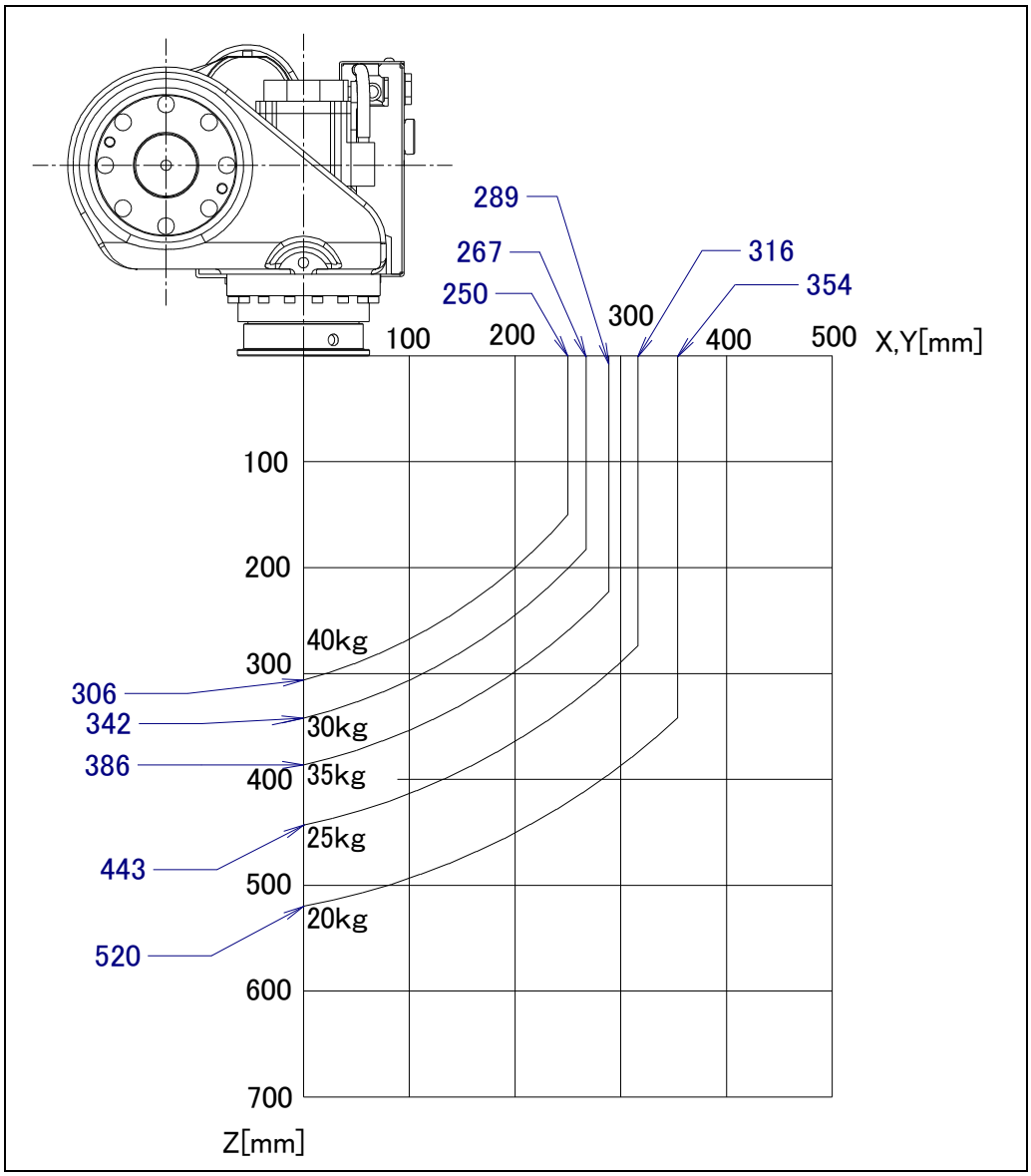


Fig. 8.1 (a) Wrist load diagram (M-420*i*A Standard/2nd food)

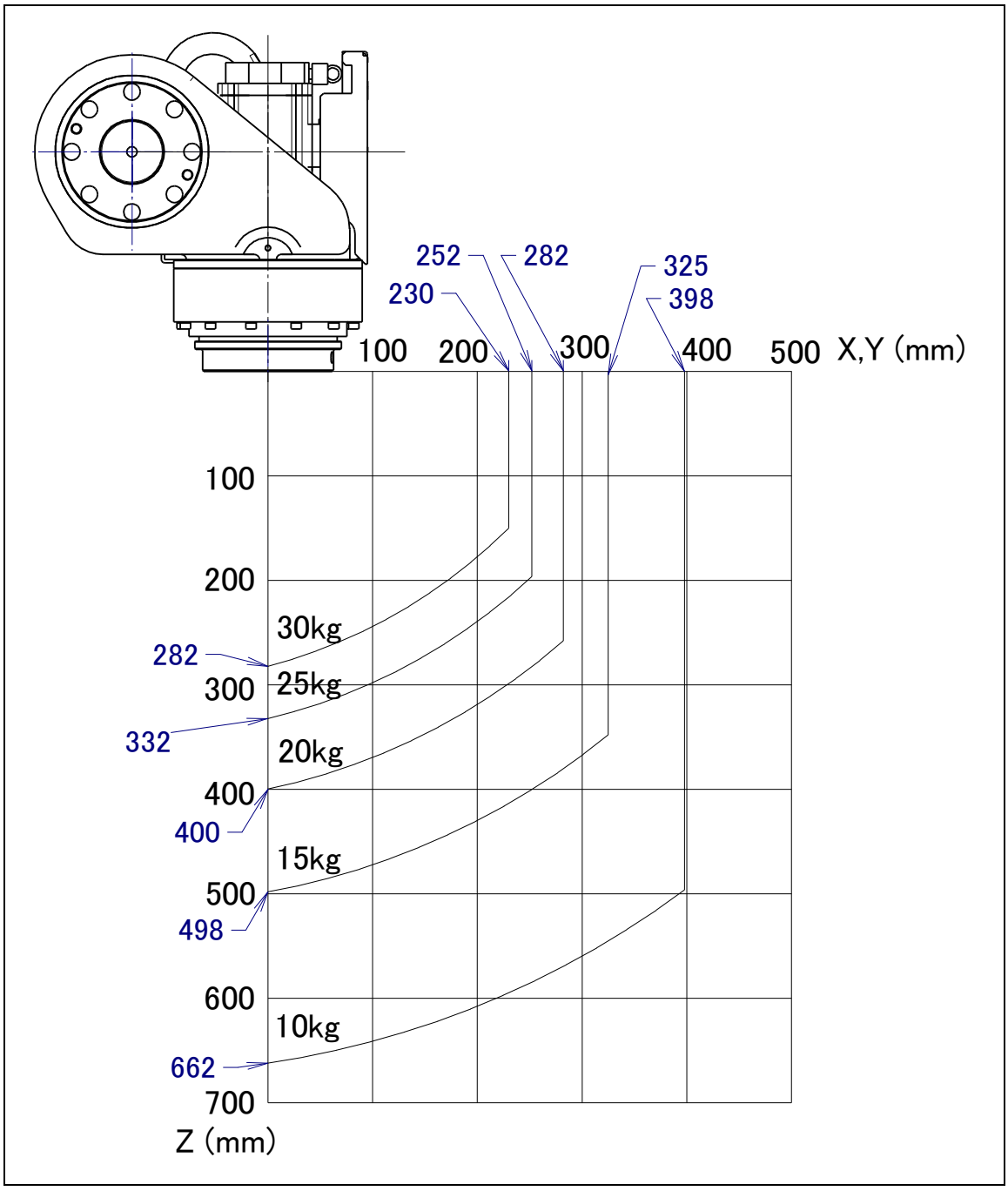


Fig. 8.1 (b) Wrist load diagram (M-420*i*A High-speed wrist)

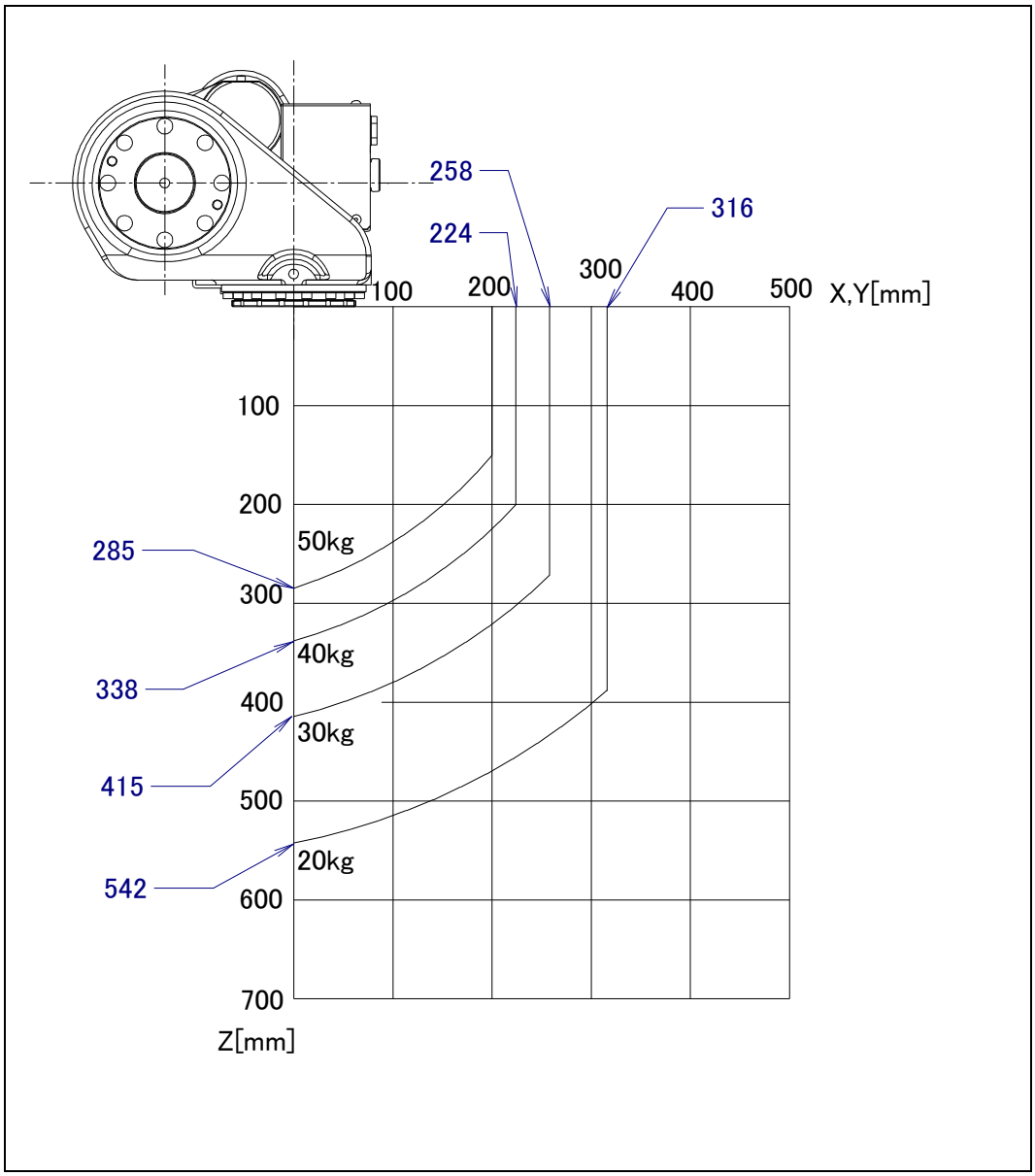


Fig. 8.1 (c) Wrist load diagram (M-421*i*A)

Table 8.1 (a) Specification for the wrist section (M-420*i*A Standard, M-421*i*A)

Item	M-420*i*A Standard	M-421*i*A
Max. load capacity at wrist	40kg	50kg
Allowable load moment at wrist	98N·m (10kgf·m)	
Allowable load inertia at wrist	2.5kg·m^2 (26kgf·cm·s^2)	

Table 8.1 (b) Specification for the wrist section (M-420*i*A High-speed wrist, M-420*i*A 2nd food)

Item	M-420*i*A High-speed wrist	M-420*i*A 2nd food
Max. load capacity at wrist	30kg	40kg
Allowable load moment at wrist	68N·m (7kgf·m)	98N·m (10kgf·m)
Allowable load inertia at wrist	2.5kg·m^2 (26kgf·cm·s^2)	

8.2 ARM LOAD CONDITIONS

Table 8.2 (a) shows the arm load conditions.
See the Section 8.4 for the installation location and the dimension of installation surface.

Table 8.2 (a) Installation condition of loads to be added

Models	Installation site	Loads	Condition
M-420*i*A	J3 arm	10kg	The total weight of the load and the load of wrist is 40kg or less.
M-421*i*A	J2 arm	10kg	The total weight of the load and the load of wrist is 50kg or less.

8.3 END EFFECTOR INSTALLATION TO WRIST

Fig.8.3 (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 C 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.

32N·m (330kgf·cm) (See Appendix B)

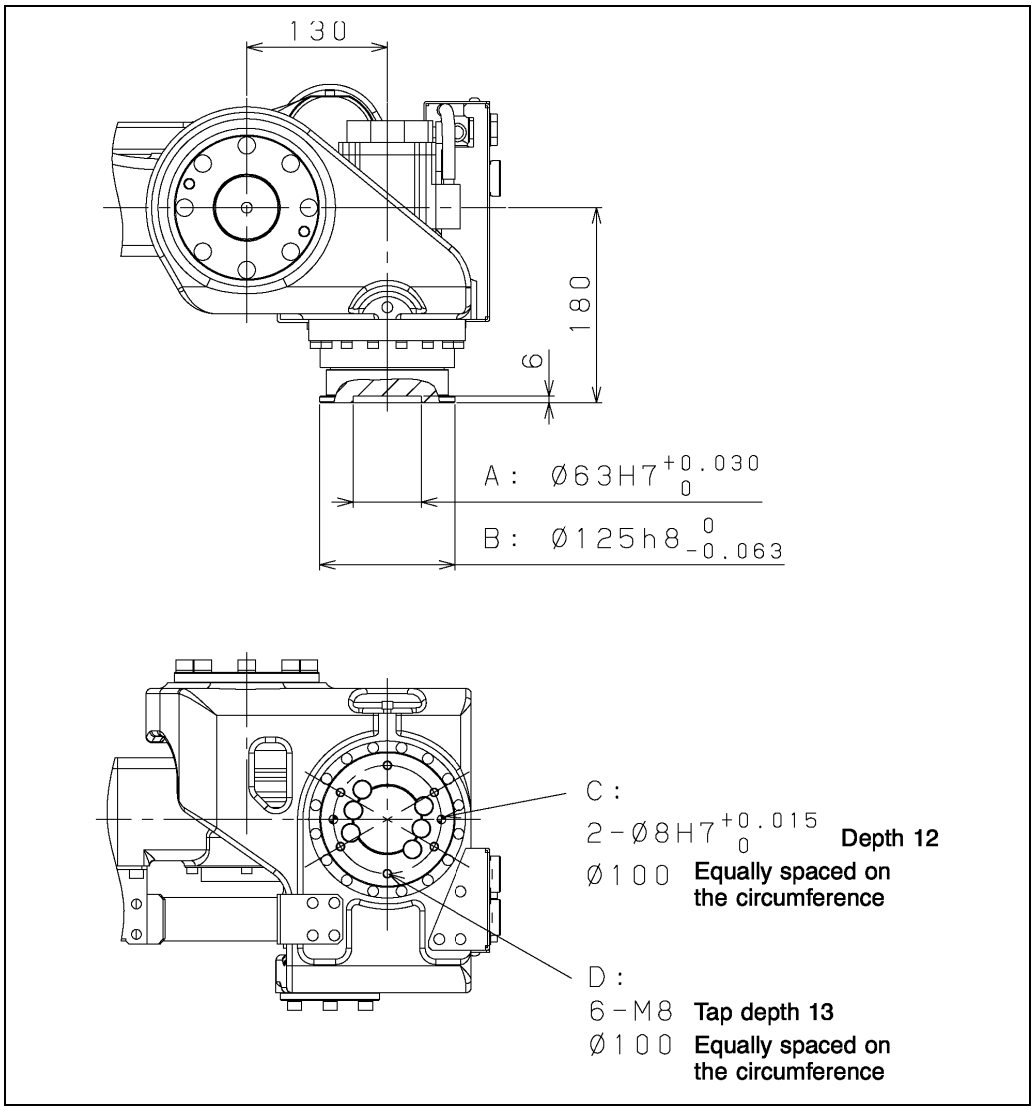


Fig. 8.3 (a) End effector mounting Face (M-420*i*A Standard/2nd food)

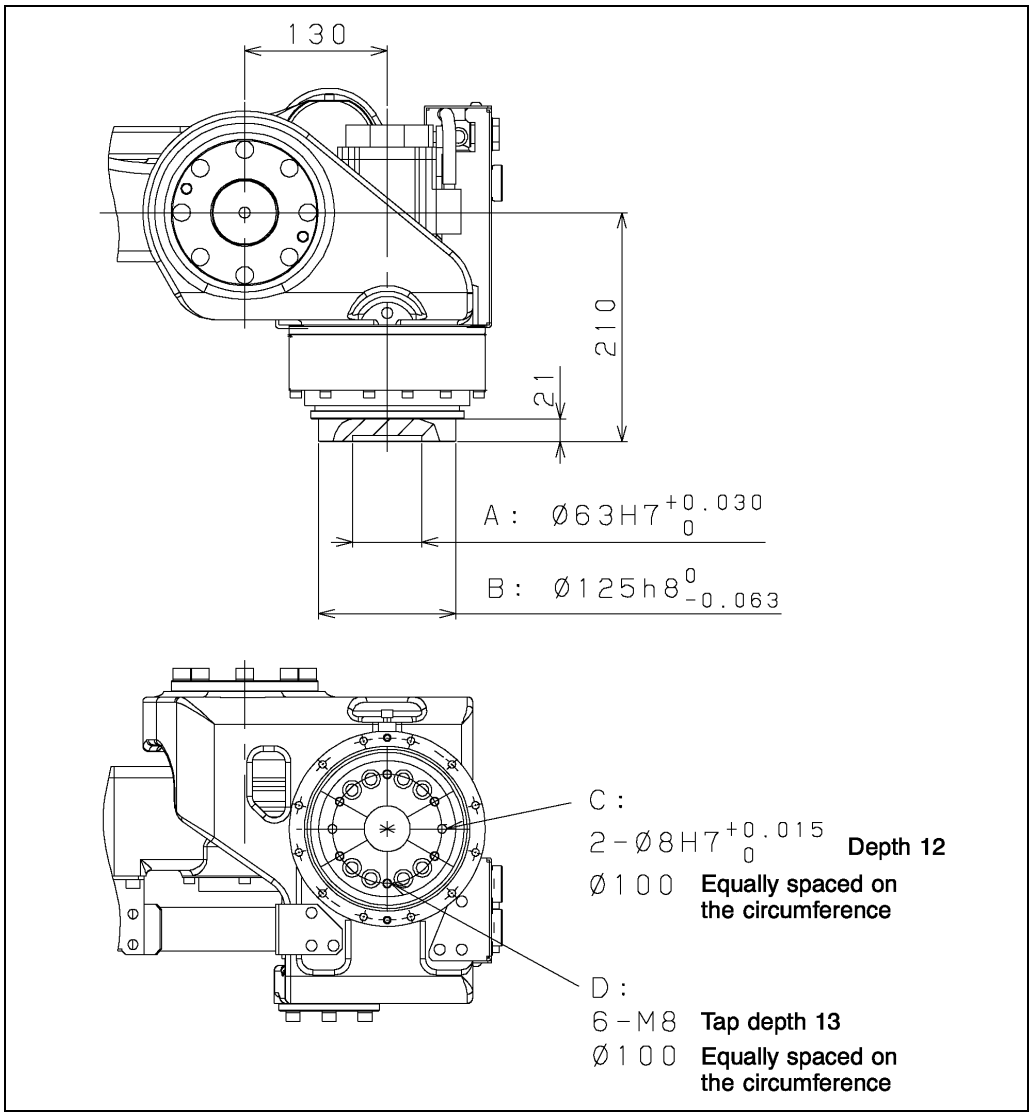


Fig. 8.3 (b) End effector mounting Face (M-420*i*A High-speed wrist)

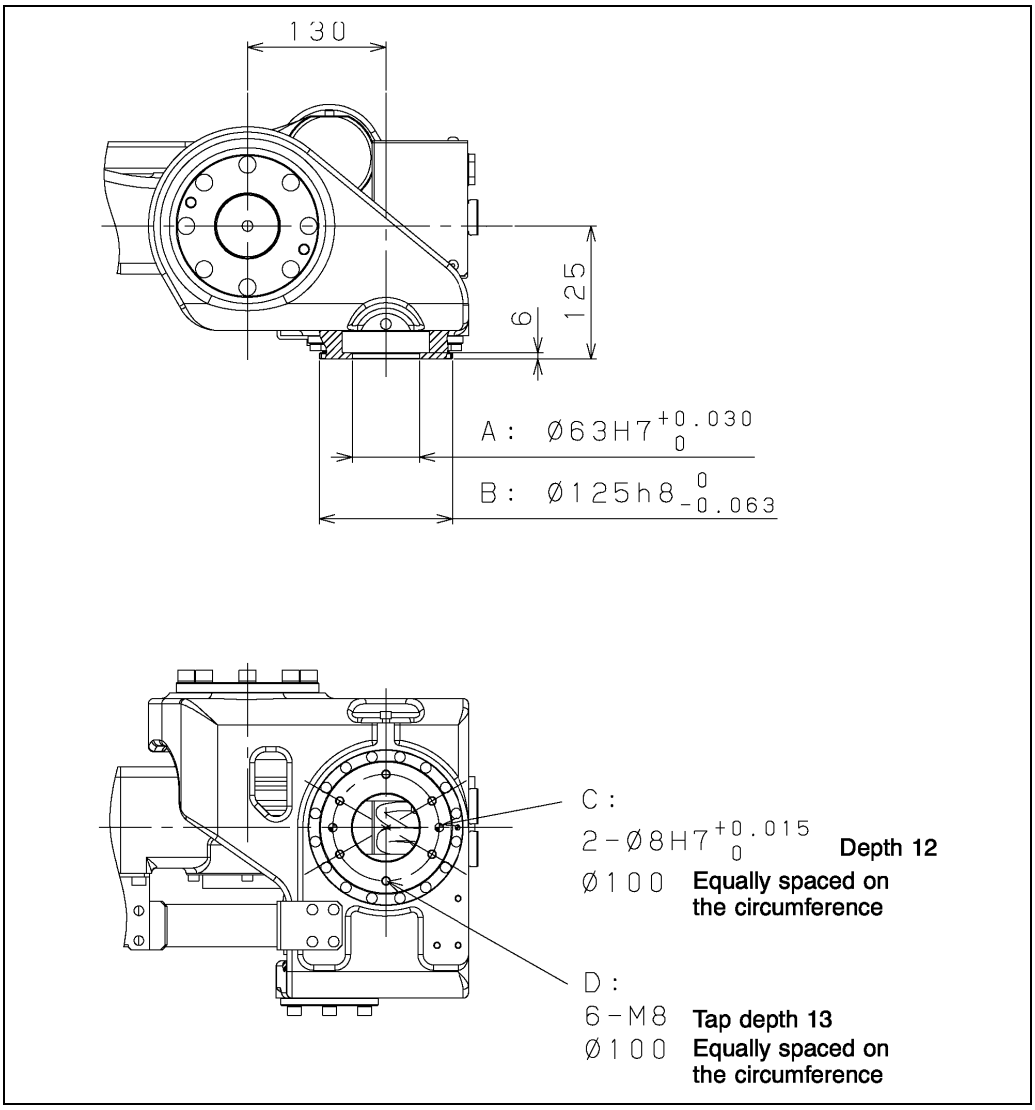


Fig. 8.3 (c) End effector mounting Face (M-421*i*A)

8.4 EQUIPMENT MOUNTING FACE

As shown in Fig.8.4 (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 Equipment's should be installed on robot in a way it does not interfere with the mechanical unit cables. If equipment's interfere, the mechanical unit cable might be disconnected, and unexpected troubles might occur.
> 3 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.

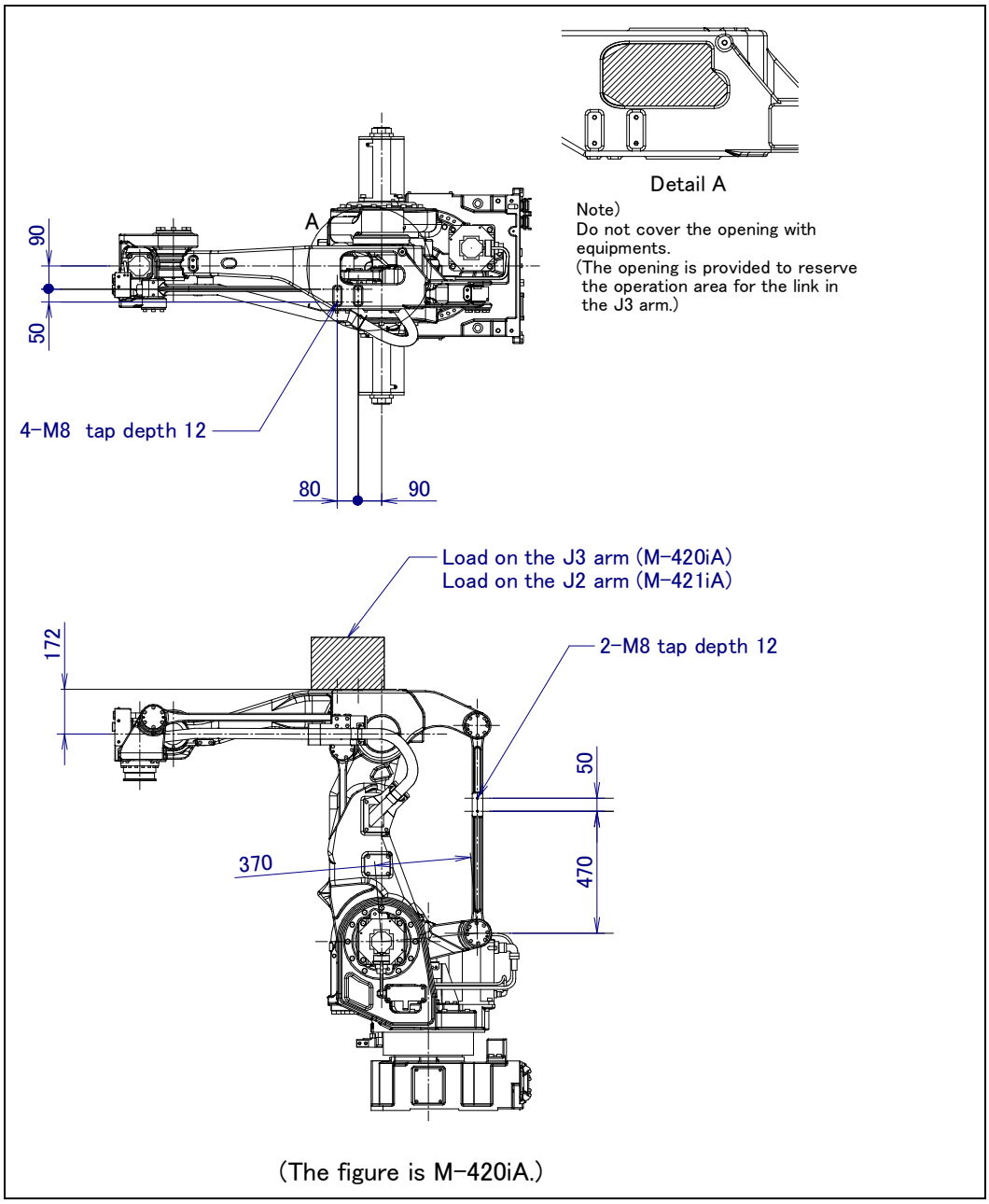
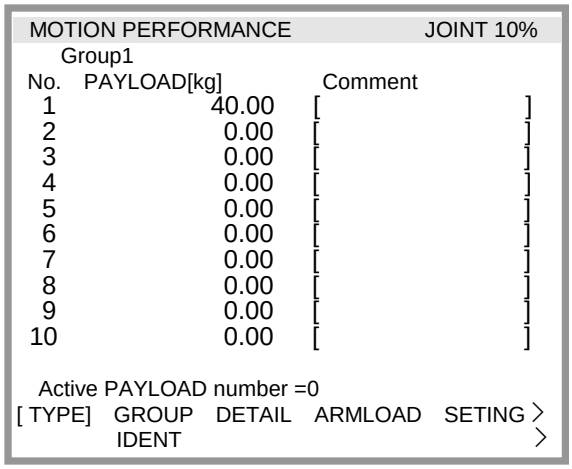


Fig. 8.4 (a) Equipment installation surface (Common to M-420*i*A and M-421*i*A)

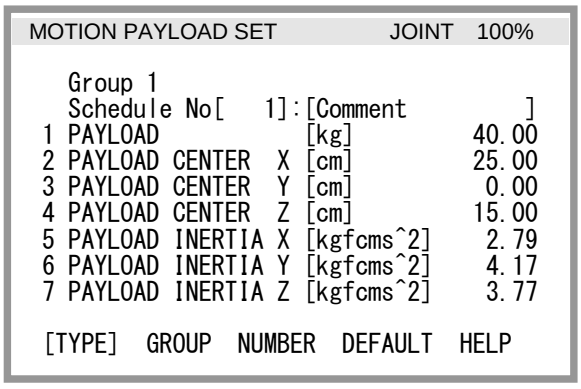
8.5 LOAD SETTING

The motion performance screens include the MOTION PERFORMANCE screen, MOTION PAYLOAD SET screen, and MOTION ARMLOAD SET screen. These screens are used to specify payload information and equipment information on the robot.

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



5 Ten different pieces of payload information can be set using condition Nos. 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.



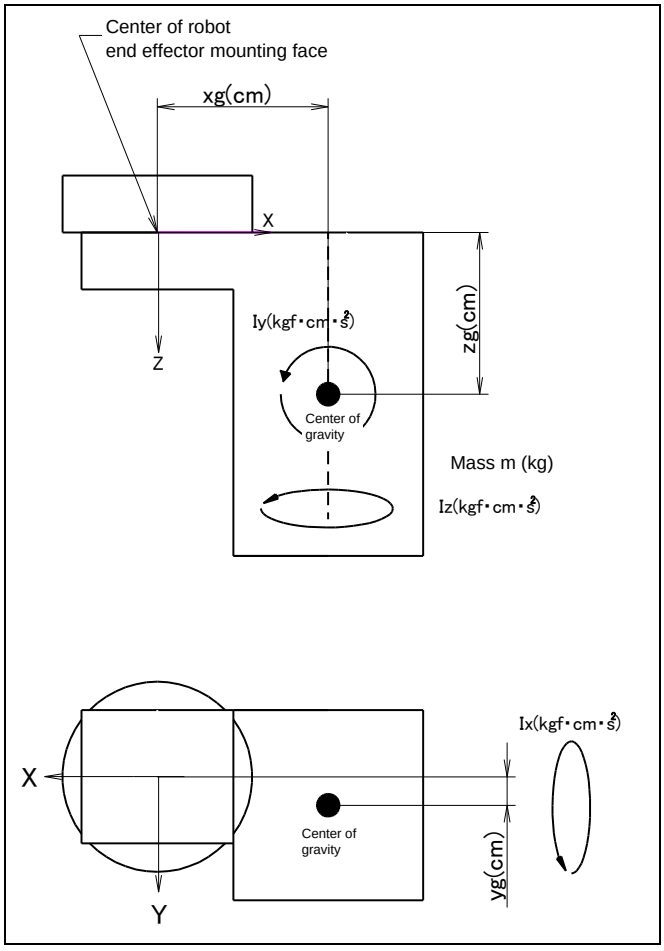


Fig. 8.5 (a) Standard tool coordinate

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 displayed: "Path and Cycletime will change. Set it?" Respond to the message with F4 ([YES]) or F5 ([NO]).

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

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

9 On the 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]              0.00
 2 ARM LOAD AXIS #3 [kg]             10.00

[ TYPE ]    GROUP          DEFAULT   HELP
```

10 Specify the weight of the J3 arm (M-420*i*A) and load on the J2 arm (M-421*i*A) as follows:
ARM LOAD AXIS #1 [kg] : It can't be input.

ARM LOAD AXIS #3 [kg] : Weight of the load on the J2 /J3 arm
The following message will be displayed: "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 switching the power off and on again.

8.6 AIR SUPPLY

There are air-inlet and air outlet on the side of the J1 base and the front of wrist as following Fig.8.6(a) and (b). As couplings are not supplied, it will be necessary to prepare couplings, which suit to the hose size.

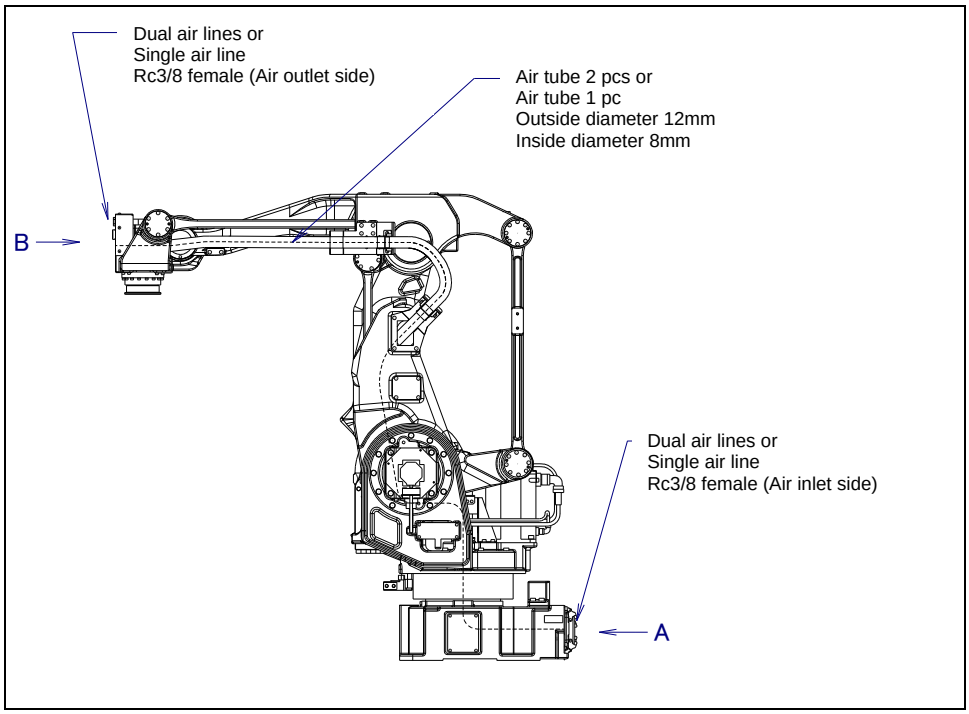


Fig. 8.6 (a) Air-pressure supply connection (M-420*i*A)

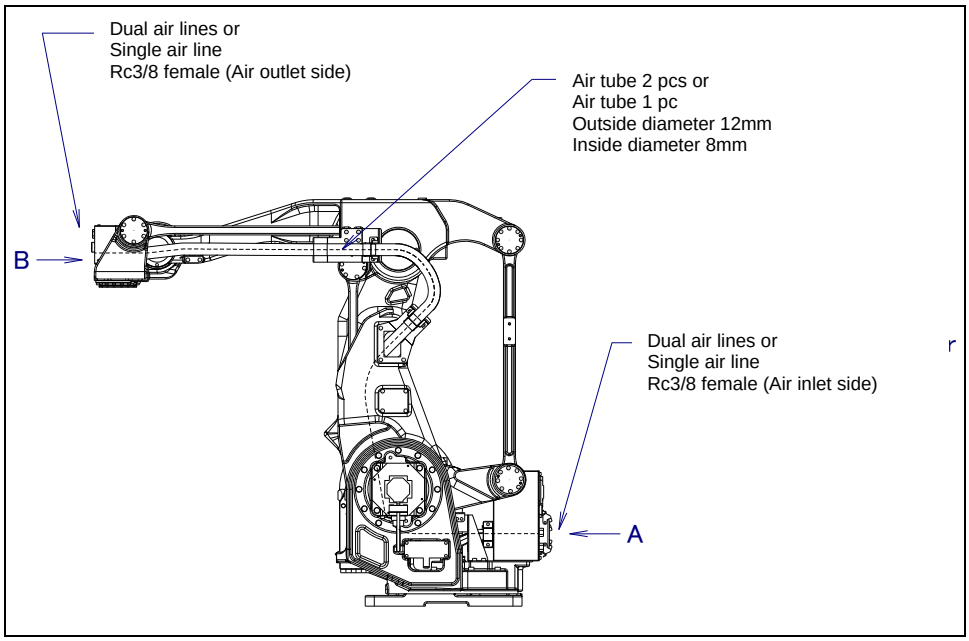


Fig. 8.6 (b) Air-pressure supply connection (M-421*i*A)

8.7 INTERFACE FOR OPTION CABLE (OPTION)

⚠ WARNING

- Only use appropriately-specified mechanical unit cables.
- Do not add user cables or hoses inside of the mechanical unit.
- Please do not obstruct the movement of the mechanical unit when cables are added to outside of mechanical unit.
- Please do not perform remodeling (adding a protective cover, or secure an additional outside cable) that obstructs the behavior of the outcrop of the cable.
- When external equipment is installed in the robot, make sure that it does not interfere with other parts of the robot.
- Cut and discard any unnecessary length of wire strand of the end effector (hand) cable. Insulate the cable with seal tape. (See Fig. 8.7 (a))
- If you have end effector wiring and a process that develops static electricity, keep the end effector wiring as far away from the process as possible. If the end effector and process must remain close, be sure to insulate the cable.
- Be sure to seal the connectors of the user cable and terminal parts of all cables to prevent water from entering the mechanical unit. Also, attach the cover to the unused connector.
- Frequently check that connectors are tight and cable jackets are not damaged.
- When precautions are not followed, damage to cables might occur. Cable failure may result in incorrect function of end effector, robot faults, or damage to robot electrical hardware. In addition, electric shock could occur when touching the power cables.

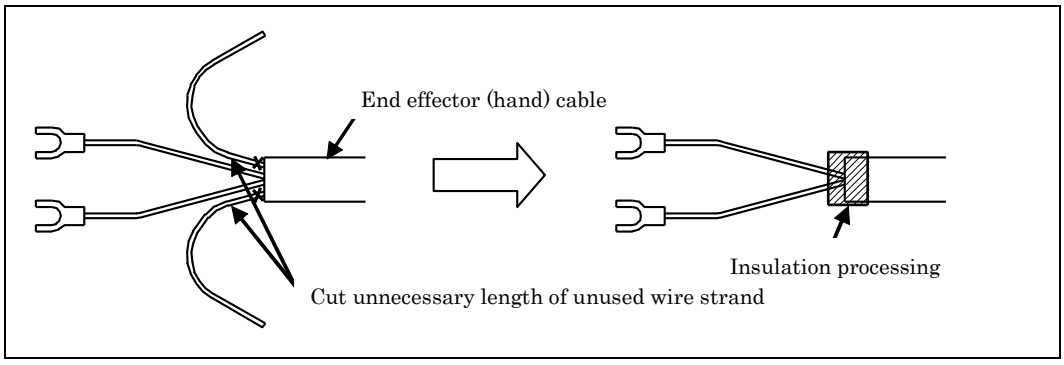


Fig. 8.7 (a) Treatment method of end effector (hand) cable

Fig.8.7 (b) to (e) show the position of the end effector interface. EE interface (RDI/RDO) or (RI/RO), user cable (signal lines), servo hand cable and camera cable are prepared as options.

NOTE

Each option cable is written like below on connector panel
EE(RI/RO) interface : EE
User cable (signal) : AS
Servo hand cable (Pulsecoder) : M3P,M4P,M5P,M6P
Servo hand cable (power, brake) : M3M,M4M,M5M,M6M
Camera cable : CAM

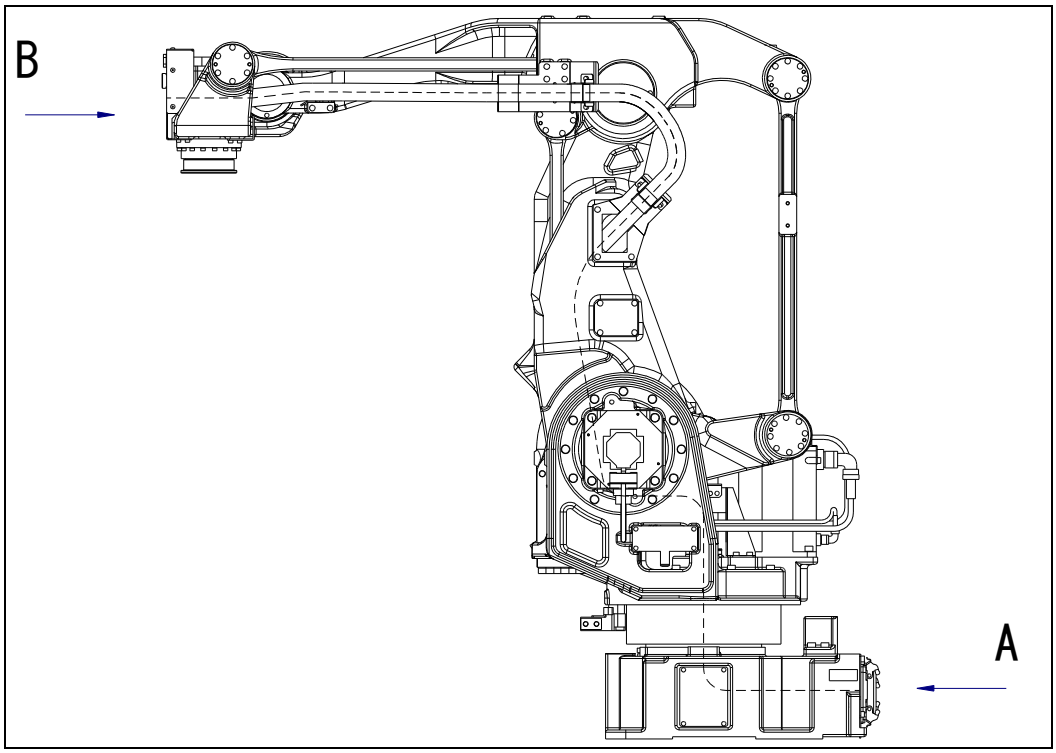


Fig. 8.7 (b) Interface for optional cable (Option) (M-420*i*A)

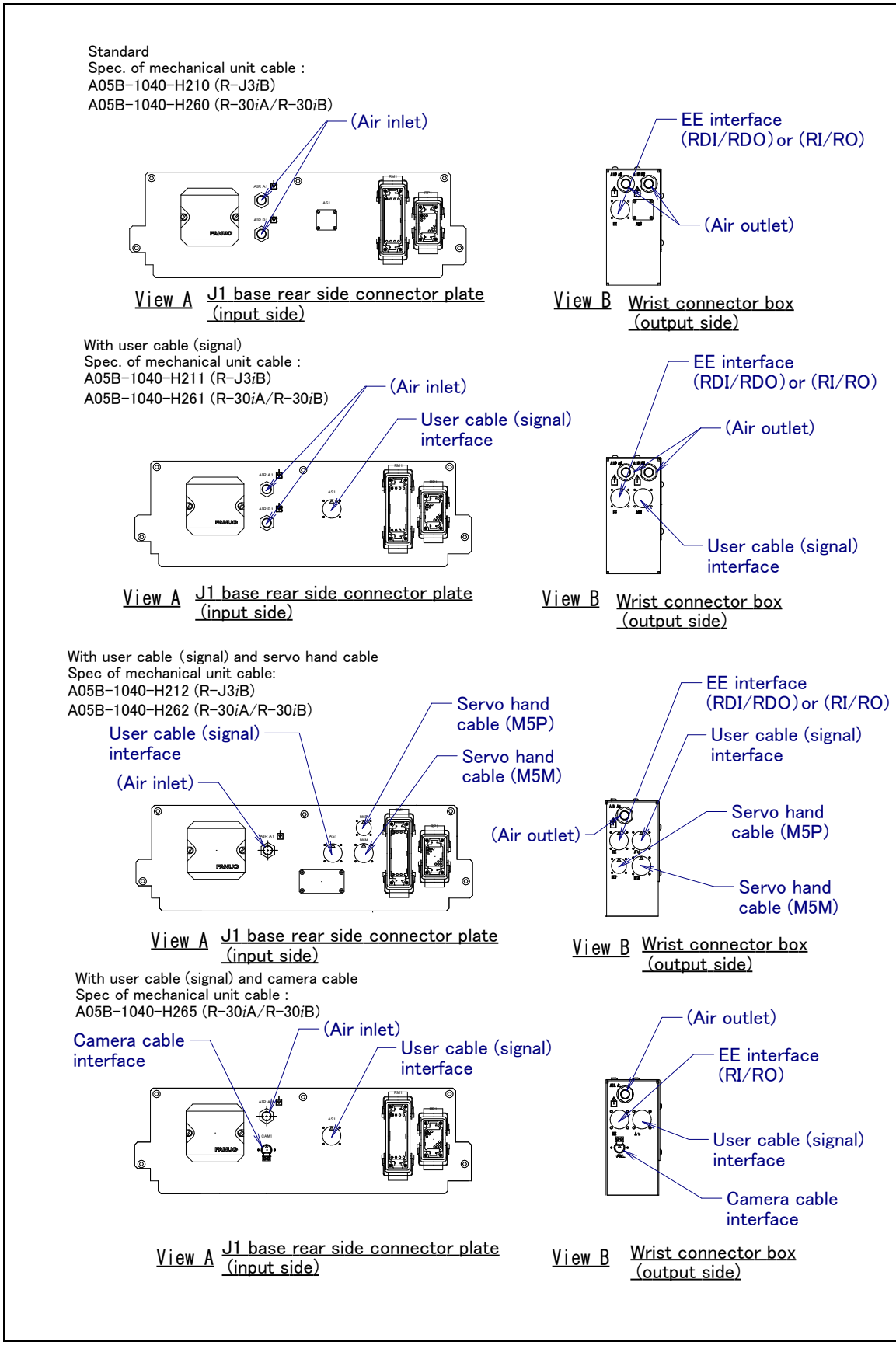


Fig. 8.7 (c) Interface for optional cable (Option) (M-420*i*A)

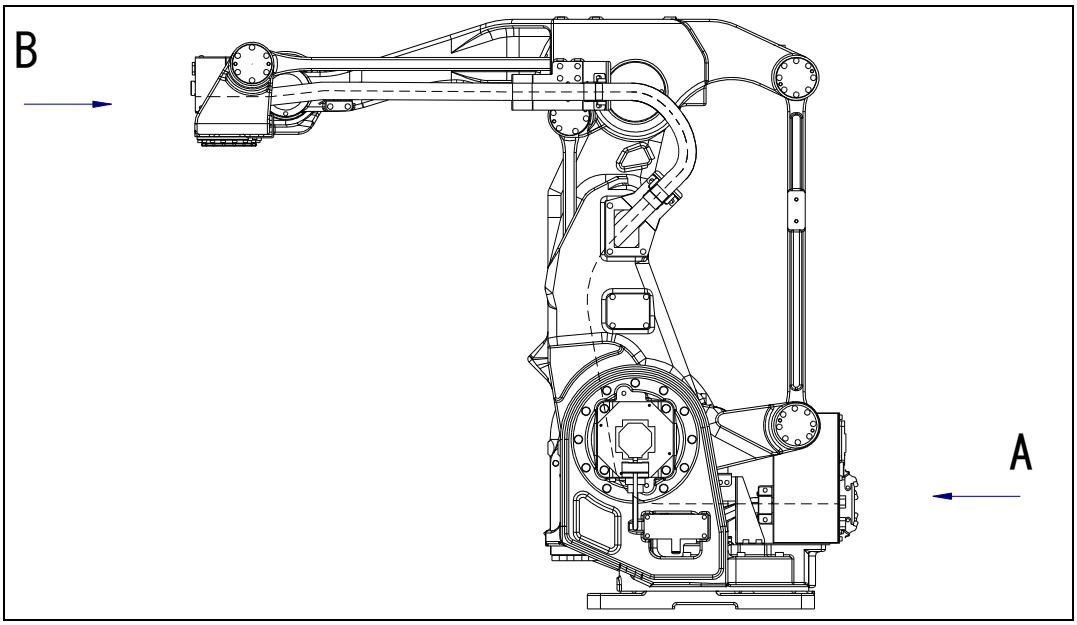
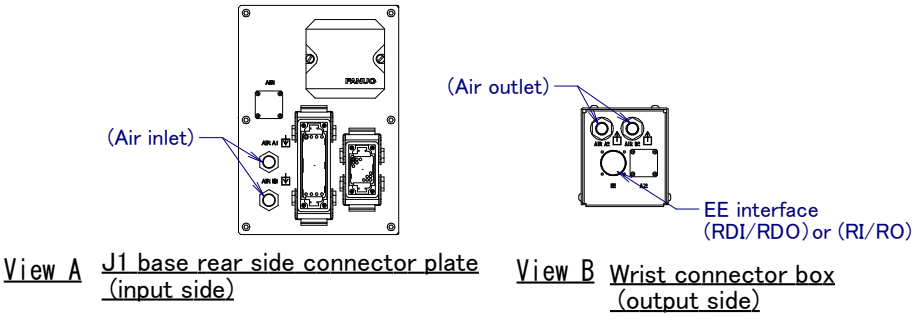
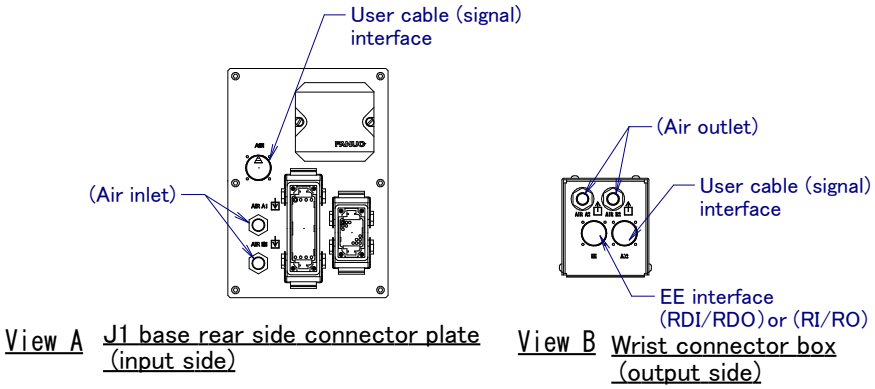


Fig. 8.7 (d) Interface for optional cable (Option) (M-421*i*A)

Standard
Spec. of mechanical unit cable :
A05B-1040-H220 (R-J3*i*B)
A05B-1040-H270 (R-30*i*A/R-30*i*B)



With user cable (signal)
Spec. of mechanical unit cable :
A05B-1040-H221 (R-J3*i*B)
A05B-1040-H271 (R-30*i*A/R-30*i*B)



With user cable (signal) and servo hand cable
Spec of mechanical unit cable:
A05B-1040-H222 (R-J3*i*B)
A05B-1040-H272 (R-30*i*A/R-30*i*B)

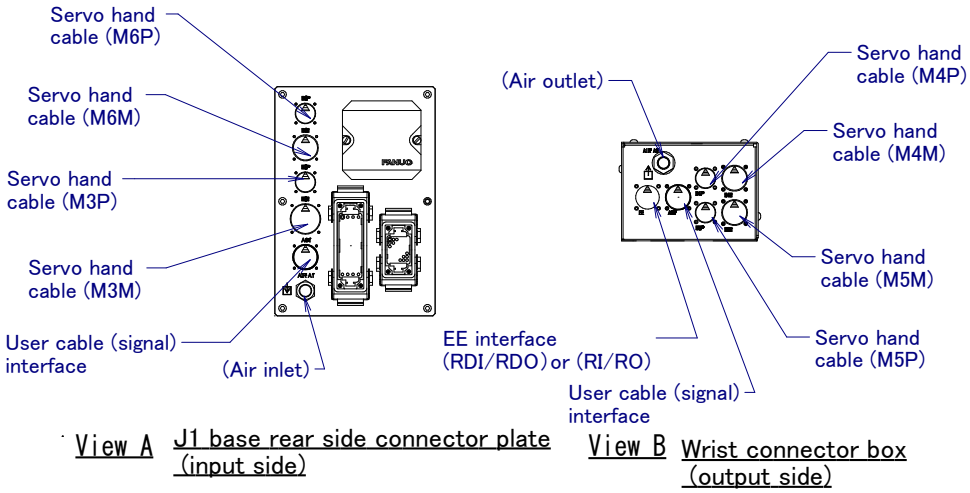


Fig. 8.7 (e) Interface for optional cable (Option) (M-421*i*A)

(1) **EE interface (RDI/RDO) or (RI/RO)**

Fig.8.7 (f) to (i) show pin layout for EE interface (RDI/RDO) or (RI/RO). When M-420*i*A 2nd food 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.

> ⚠ **WARNING**
> The RDO signal for the R-J3*i*B controller and that for the R-30*i*A/R-30*i*B controller are incompatible with each other because different output formats are used. For details, refer to the maintenance manuals for the controllers.

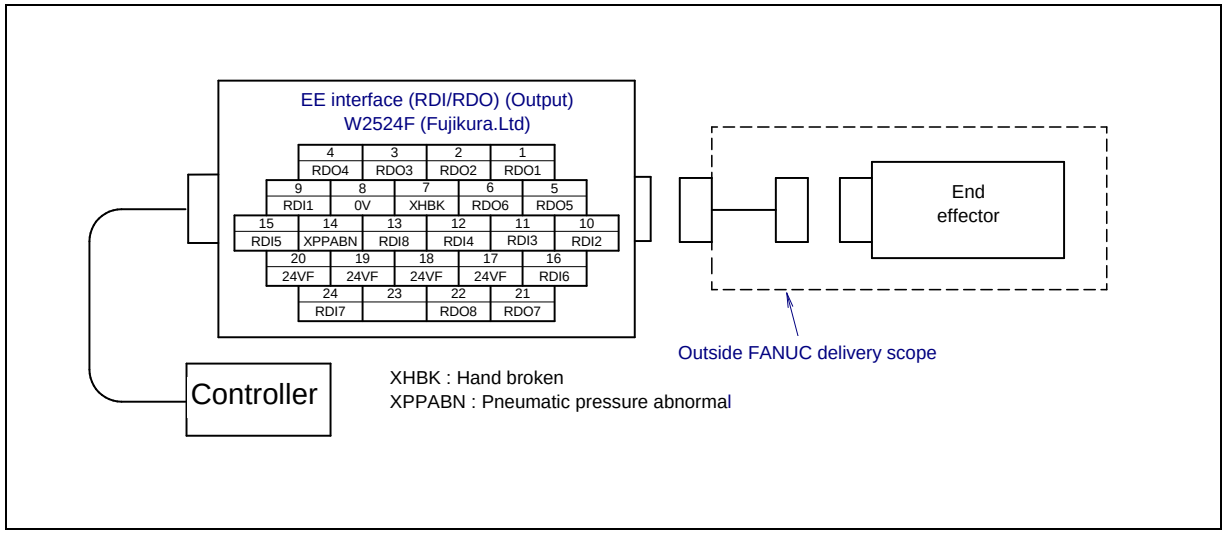


Fig. 8.7 (f) Pin layout for EE interface (RDI/RDO) (M-420*i*A standard/High speed wrist/M-421*i*A) (For R-J3*i*B controller)

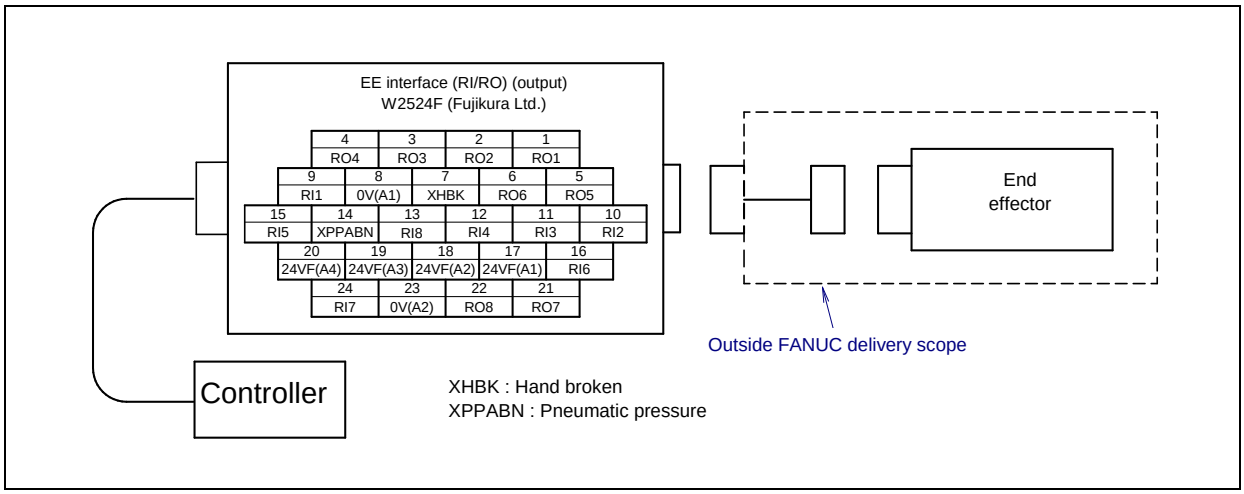


Fig. 8.7 (g) Pin layout for EE interface (RI/RO) (M-420*i*A Standard/High-speed wrist/M-421*i*A) (R-30*i*A/R-30*i*B Controller)

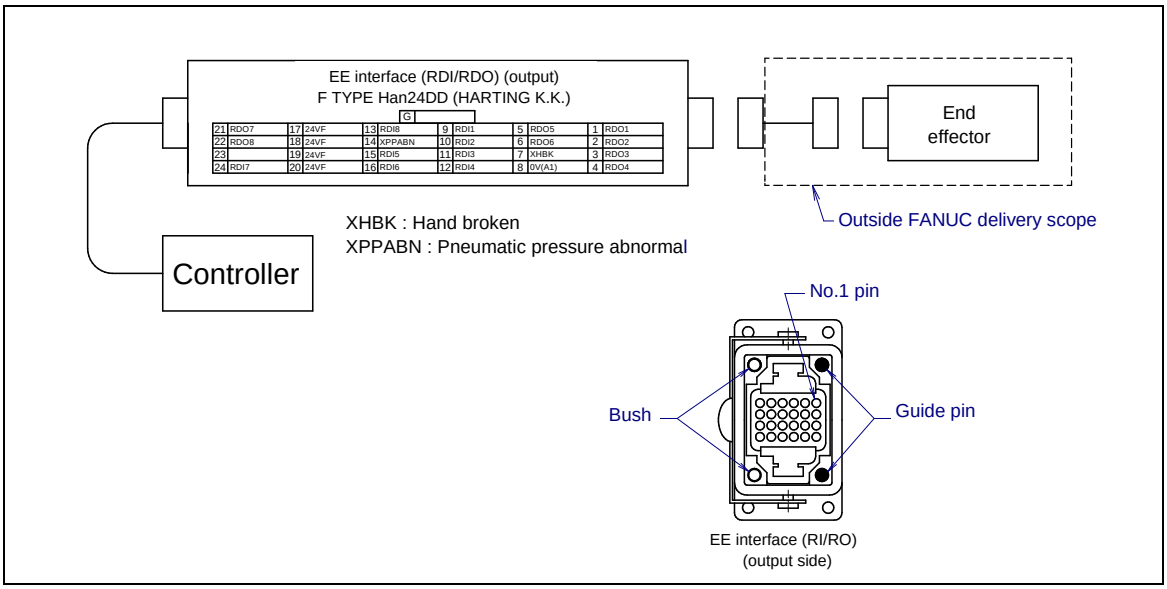


Fig. 8.7 (h) Pin layout for EE interface (RDI/RDO) (M-420*i*A 2nd Food) (R-J3*i*B Controller)

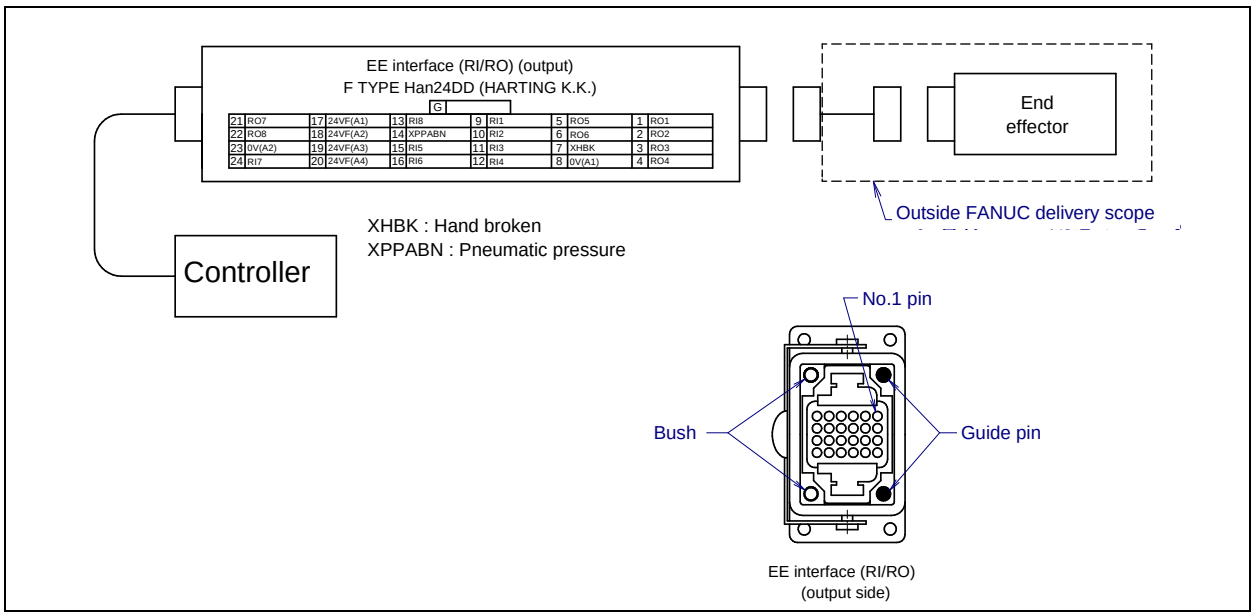


Fig. 8.7 (i) Pin layout for EE interface (RI/RO) (M-420*i*A 2nd Food) (R-30*i*A/R-30*i*B Controller)

(2) User cable (signal line) interface (Option)
Fig. 8.7 (j) shows pin layout for user cable (signal line) (AS) interface (option).

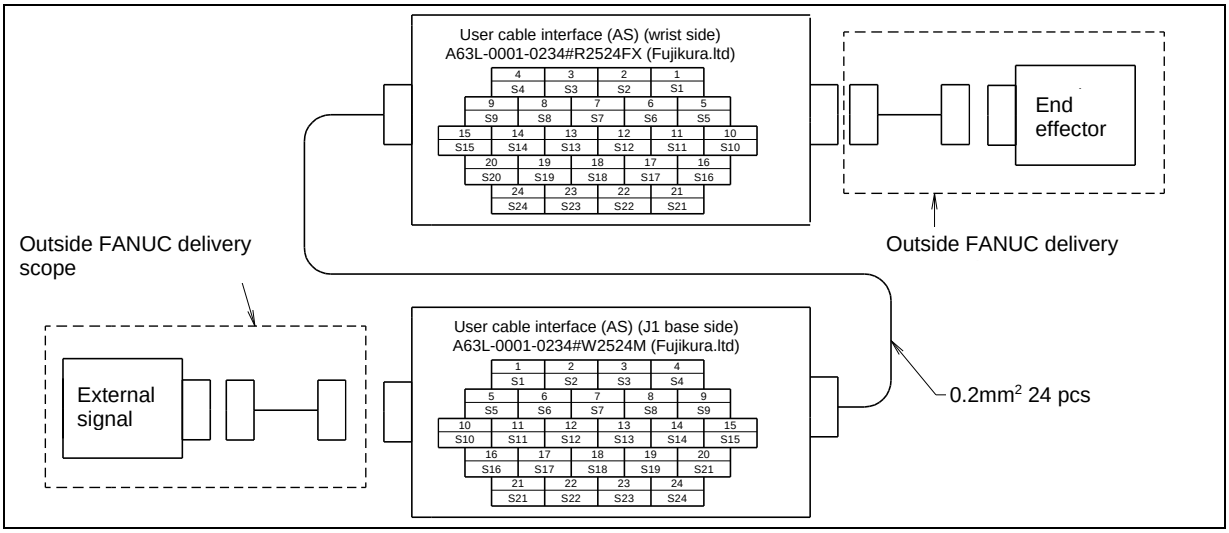


Fig. 8.7 (j) Pin layout for the user cable (Signal Line) (AS) Interface (Option)

Connector specifications

Table 8.7 (a) Connector specifications (M-420*i*A Standard/High-speed wrist machine side)

Cable	Input side (J1 base)	Output side (J3 casing)	Maker/ Dealer
RDI/RDO or RI/RO	-	JMR2524F	Fujikura.Ltd
AS (Signal)	JMWR2524M	JMR2524FX	

Table 8.7 (b) Connector specifications (M-420*i*A Standard/High-speed wrist user side)

Cable	Input side (J1 base)	Output side (J3 casing)	Maker/ Dealer
RDI/RDO or RI/RO	-	JMSP2524M Straight (Appendix) (FANUC specification: A63L-0001-0234#S2524M) JMLP2524M Angle	Fujikura.Ltd
AS (Signal)	JMSP2524F Straight JMLP2524F Angle	JMSP2524MX Straight JMLP2524MX Angle	

Table 8.7 (c) Connector specifications (M-420*i*A 2nd food machine side)

Cable	Output side (J3 casing)		Maker/ Dealer
RDI/RDO or RI/RO	Housing Insert Contacts Guide pin Bushing	09 30 006 0301 09 16 024 3101 (Han 24DD F) 09 15 000 6204 09 33 000 9908 09 33 000 9909	HARTING

Table 8.7 (d) Connector specifications (M-420*i*A 2nd food user side)

Cable	Output side (J3 casing)		Maker/ Dealer
RDI/RDO or RI/RO	Foods Select one.	09 30 006 1540 Side entry 1541 ↓ 0542 0543 (Attached) 1440 Top entry 1441 ↓ 0442 0443	HARTING
	Insert	09 16 024 3001 (Han 24DD M) (Attached)	
	Contacts Select one.	09 15 000 6104 AWG 26-22 6103 AWG 20 6105 AWG 18 (Attached) 6102 AWG 18 6101 AWG 16 6106 AWG 14	
	Clumps Select one.	09 00 000 5083 5085 5086 (Attached) 5090 5094 Besides these, there are many.	
	Guide pin Bushing	09 33 000 9908 09 33 000 9909	

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

9 TRANSPORTATION AND INSTALLATION

9.1 TRANSPORTATION

(1) **Transportation using a crane**

The robot can be transported by lifting it. When transporting the robot, be sure to change the posture of the robot to that shown in Fig.9.1 (a) and (b) and lift by attaching slings to the four M16 eyebolts.

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

(2) **Transportation using a forklift**

The robots can also be transported using a forklift (Refer to Fig.9.1 (c) and (d)). Transport materials are available as an option.
Fig. 9.1 (e) and (f) shows the transport materials and eyebolt location.

> ⚠ **CAUTION**
> Remove the end effector and base plate when you transport robot,
> Please follow notes when it is necessary to transport robot with the end effector or the base plate installed.
>
> - The entire position of center of gravity is changed by installing the end effector or the base plate. Please note the balance enough.
> - The end effector swings by the vibration etc when transported, and there is a possibility that an excessive load acts on the robot. Please fix the end effector firmly. (Refer to Subsection 9.1.1)
> - When you lift robot with the base plate installed, please lift up not the robot but the base plate.
> - Do not pull eyebolts sideways.
> - Prevent the forks of the forklift from having impact on transport equipment.
> - Do not thread a chain or the like through transport equipment.

> ⚠ **WARNING**
> 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.

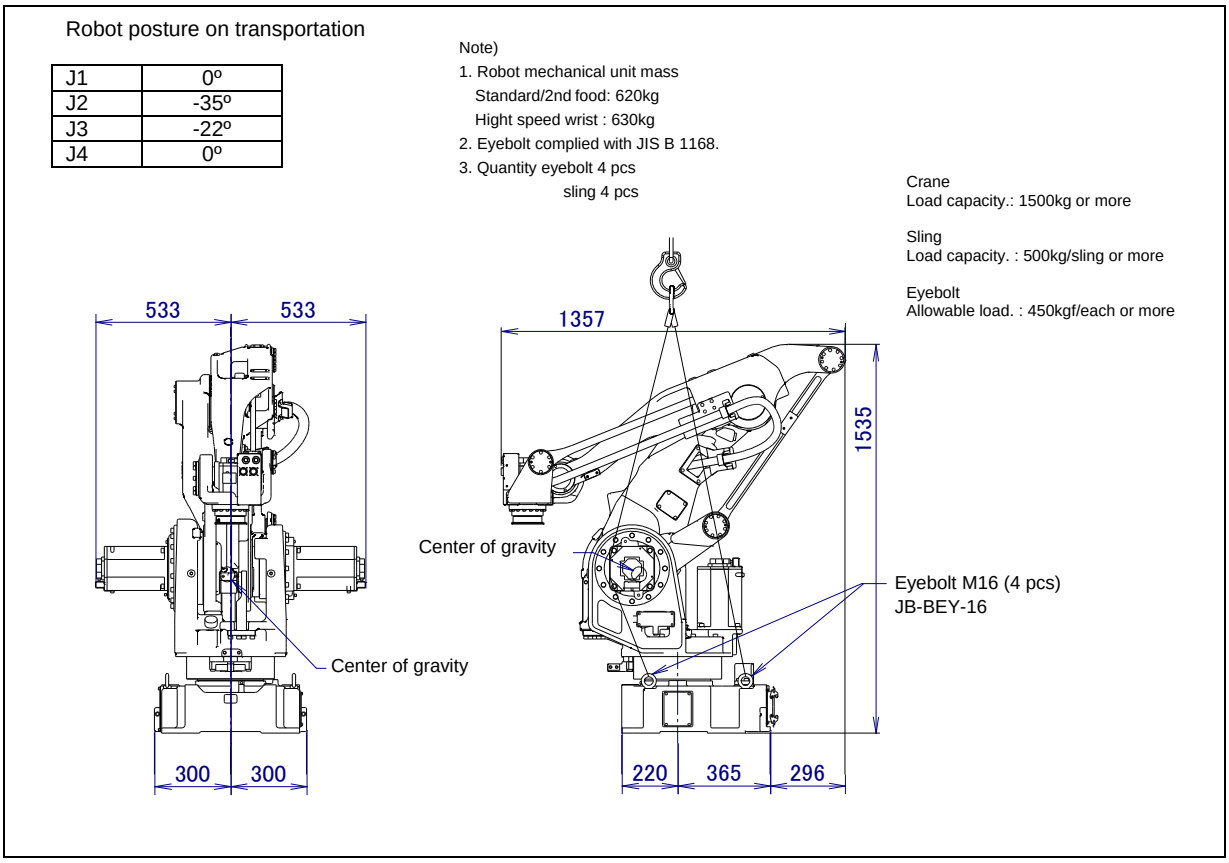


Fig. 9.1 (a) Transportation using a crane (M-420*i*A)

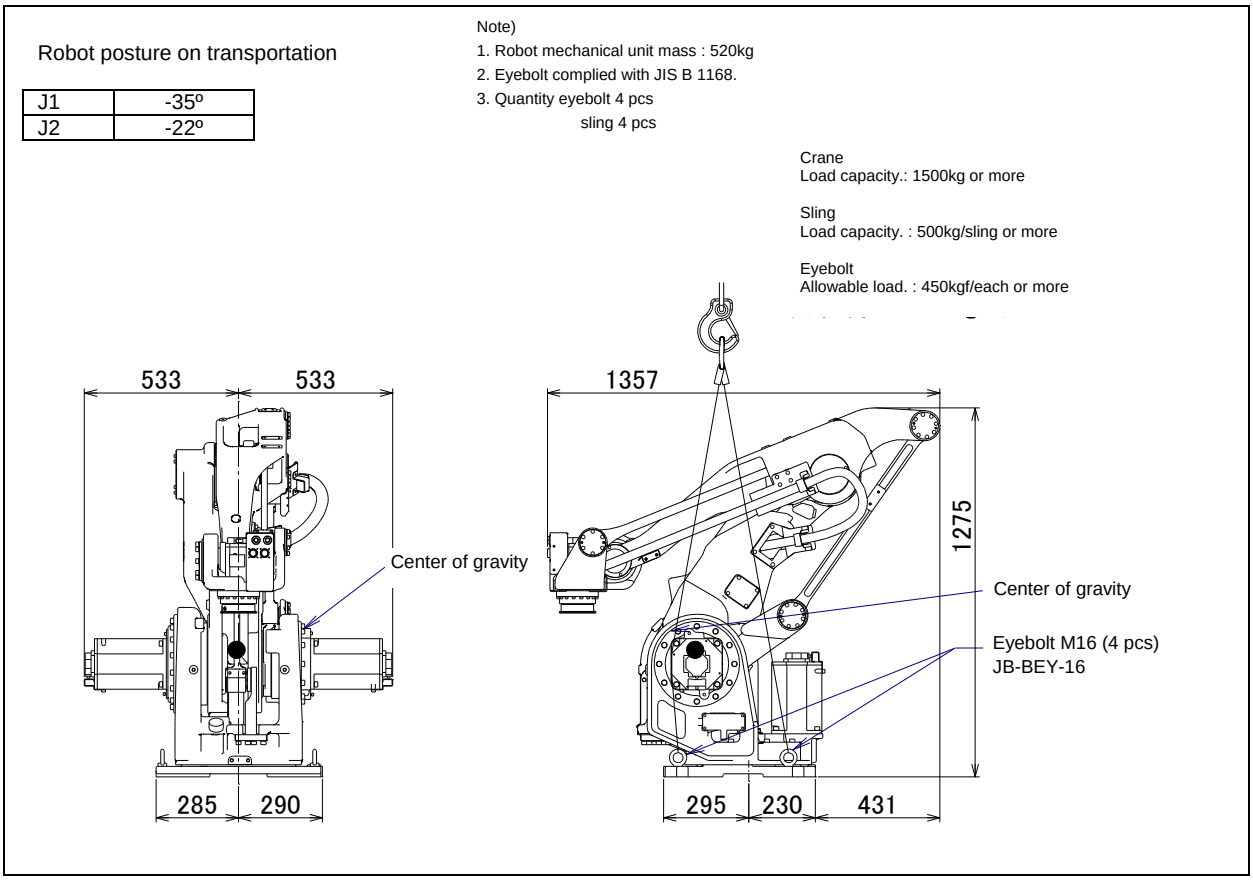


Fig. 9.1 (b) Transportation using a crane (M-421*i*A)

Robot posture on transportation

J1	0º
J2	-35º
J3	-22º
J4	0º

Note)
1. Robot mechanical unit mass
Standard/2nd food: 620kg
Hight speed wrist : 630kg

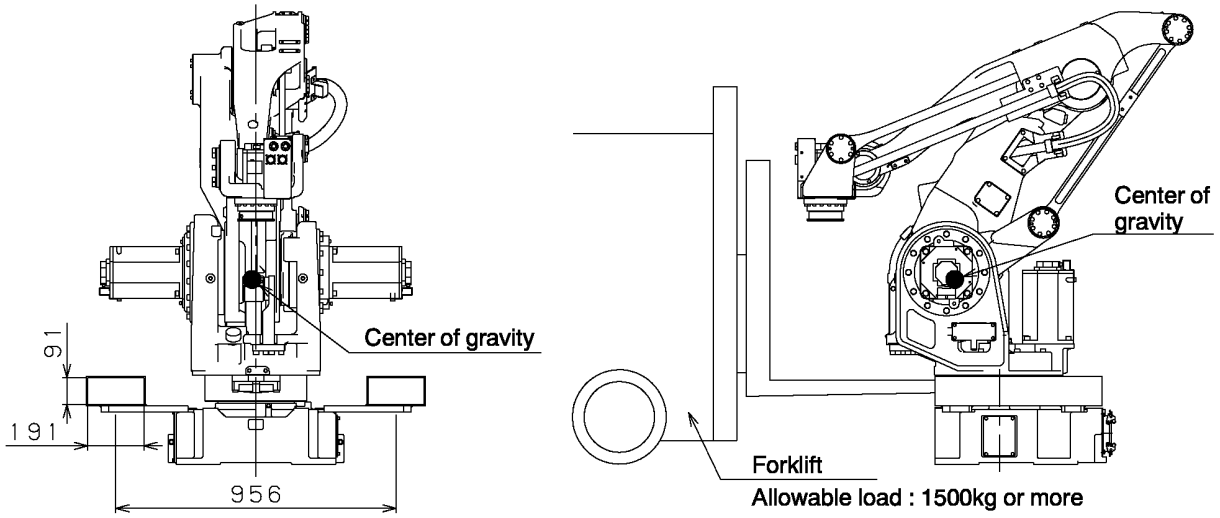


Fig. 9.1 (c) Transportation using a forklift (M-420*i*A)

Robot posture on transportation

J1	-35º
J2	-22º

Note)
1. Robot mechanical unit mass : 520kg

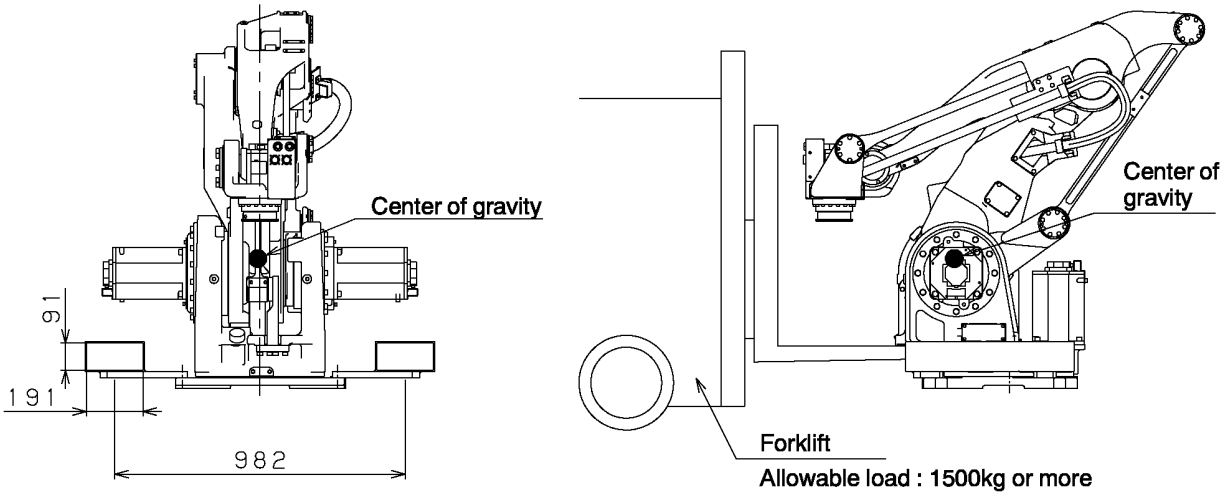


Fig. 9.1 (d) Transportation using a forklift (M-421*i*A)

NOTE
Prevent the forks of the forklift from having impact on transport equipment.

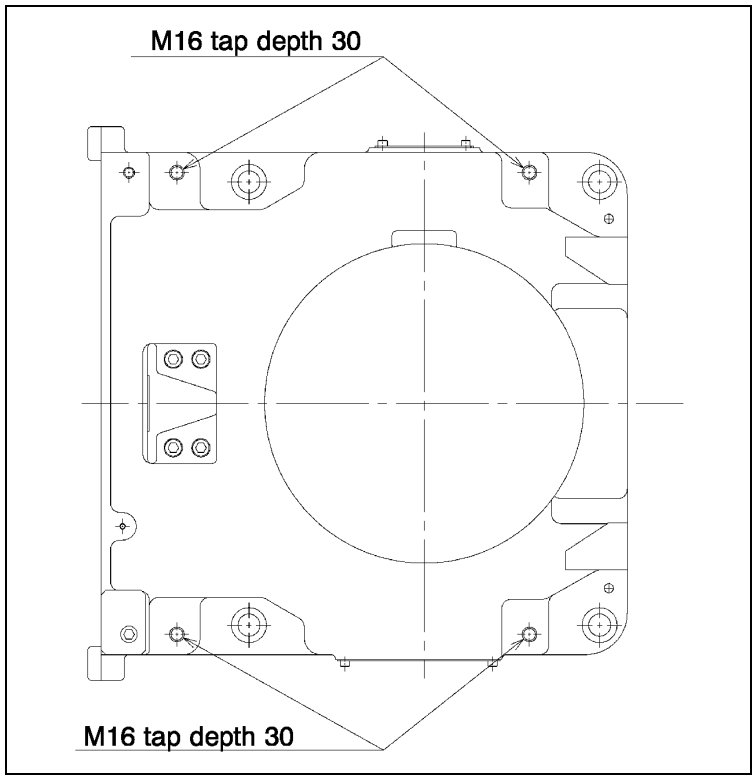


Fig.9.1 (e) Transport materials and eyebolt location (M-420*i*A)

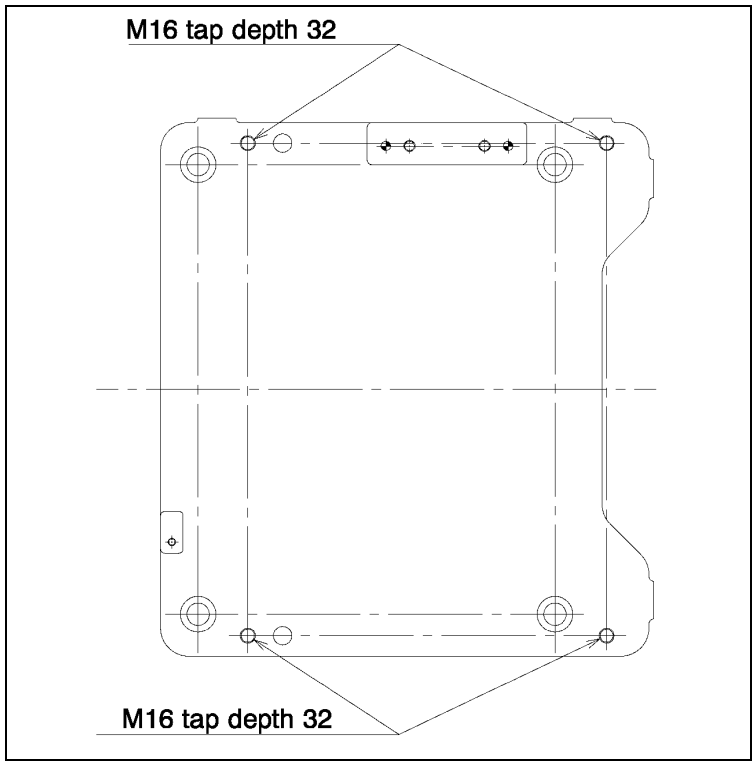


Fig.9.1 (f) Transport materials and eyebolt location (M-421*i*A)

9.1.1 Transportation with an End Effector Attached

When transporting a robot with an end effector such as a welding gun or hand attached, secure the arm with wood. If the arm is not secured, the end effector may oscillate for a cause such as vibration during transportation, thus imposing a large impact load on the reducer of the robot and damaging the reducer at an earlier stage.

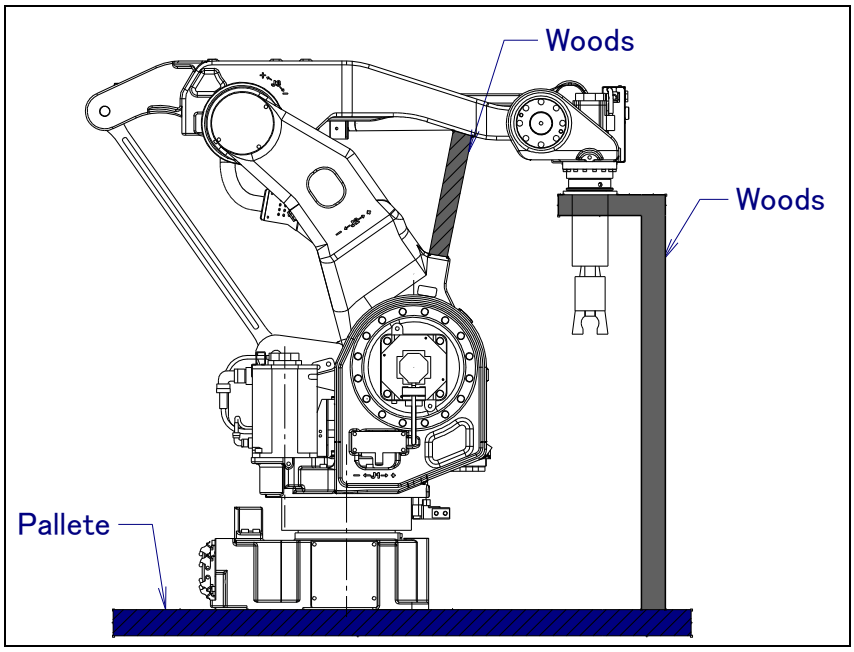


Fig. 9.1.1 (a) Example of securing the arm during transportation when an end effector is attached

9.2 INSTALLATION

Fig.9.2 (a) and (b) show the robot base dimensions. Fig.9.2 (c) and (d) show actual examples of robot installations.
In Fig.9.2 (c), the floor plate is imbedded in concrete and fastened with four M20 (tensile strength 400N/mm^2 or more) chemical anchors. Also, fasten the base plate to the robot base using four M20 x 45 bolts (tensile strength 1200N/mm^2 or more). Next, position the robot, and weld the base plate to the floor plate. (Foot length is 10 to 15mm.) (The base plate is prepared as an option.)
In Fig.9.2 (d), the floor plate is not imbedded in concrete. It is fastened with four M20 (tensile strength 400N/mm^2 or more) chemical anchors, and the inclination of the floor plate is adjusted by four set screws. The robot base is brought against three 20mm diameter. Straight pins inserted into the base to position the robot base, and the robot base is fastened to the floor plate using four M20 x 45 bolts (tensile strength 1200N/mm^2 or more).
For the M-421*i*A robot, use M20 x 70 bolts to fasten it.
If you want to install the robot on a level higher than the floor, use a pedestal having an approximate height and strength instead of the floor plate.
Avoid placing any object in front of the robot on the mounting face to facilitate the installation of the mastering fixture, as shown in Fig.9.2 (a) and (b).

> ⚠ **CAUTION**
> For the M-421*i*A, the mastering fixture is below the J1 base mounting face.

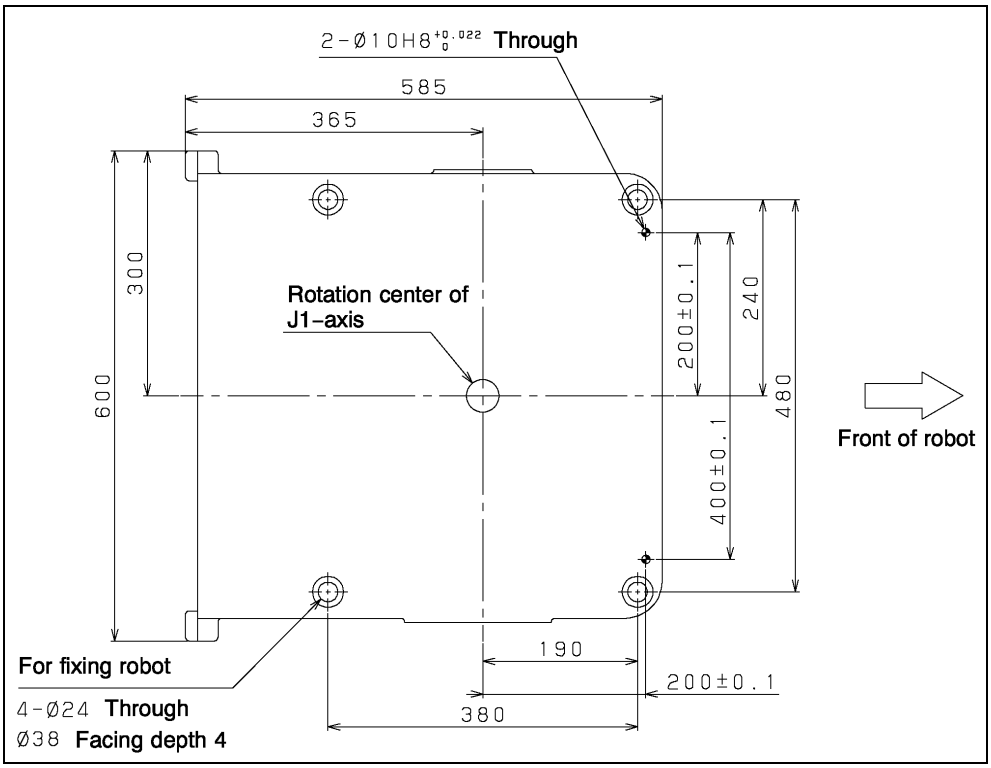


Fig. 9.2 (a) Dimensions of the robot base (M-420*i*A)

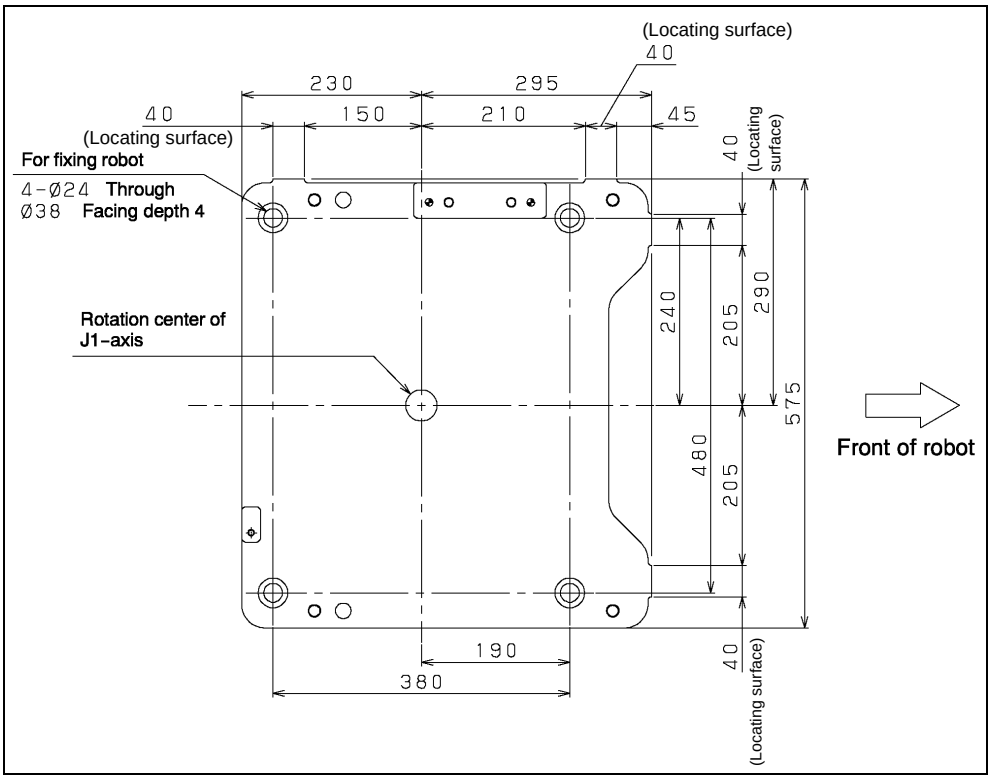


Fig. 9.2 (b) Dimensions of the robot base (M-421*i*A)

Parts to be provided by the customer:

Robot mounting bolts	M20 x 45 (tensile strength 1200N/mm^2 or more)	4 pcs
Chemical anchors	M20 (tensile strength 400N/mm^2 or more)	4 pcs
Base plates	Thickness 32	4 sheets
Floor plate	Thickness 32	1 sheets

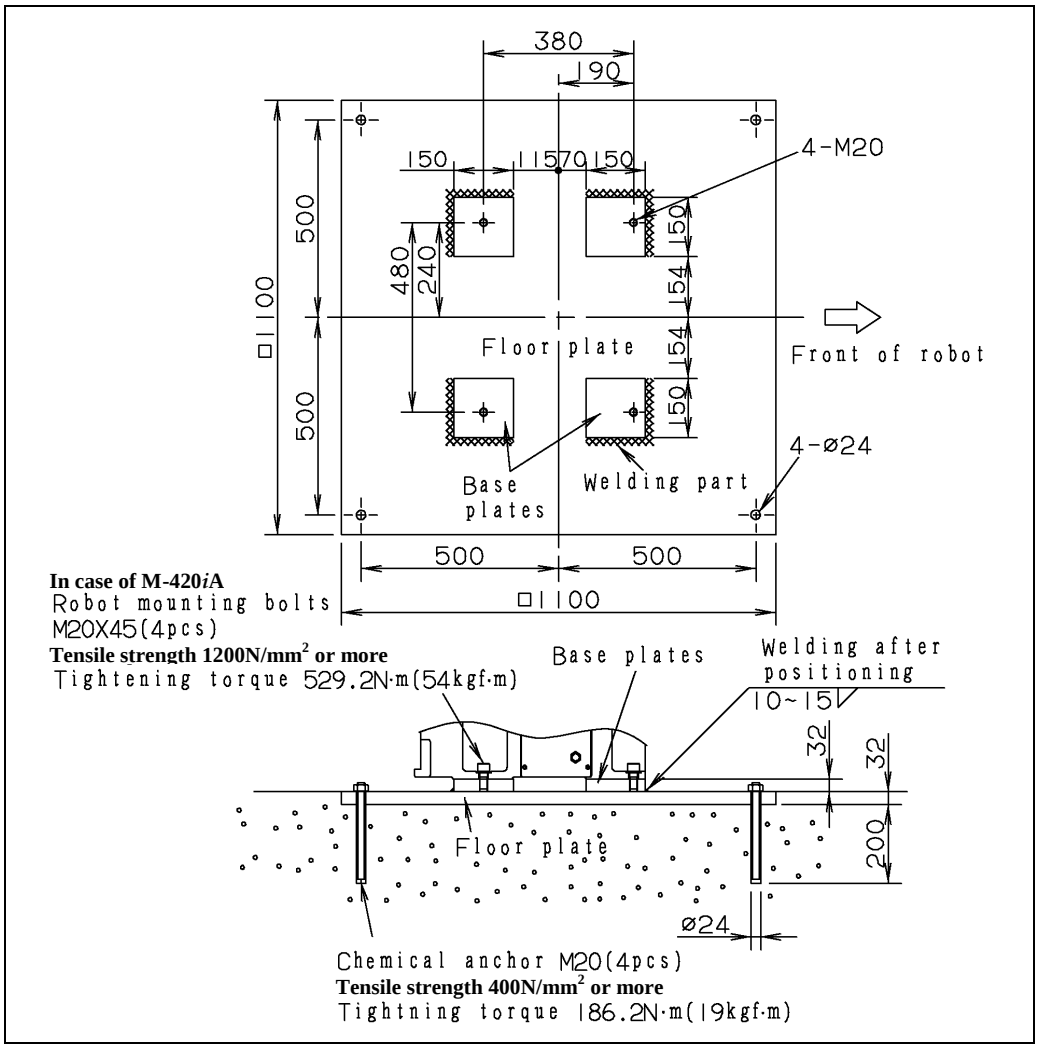


Fig. 9.2 (c) Actual installation example (Part 1)

NOTE
1 The customer is responsible for preparation of the above foundation, including welding and anchoring.
2 Anchor the floor plate in concrete

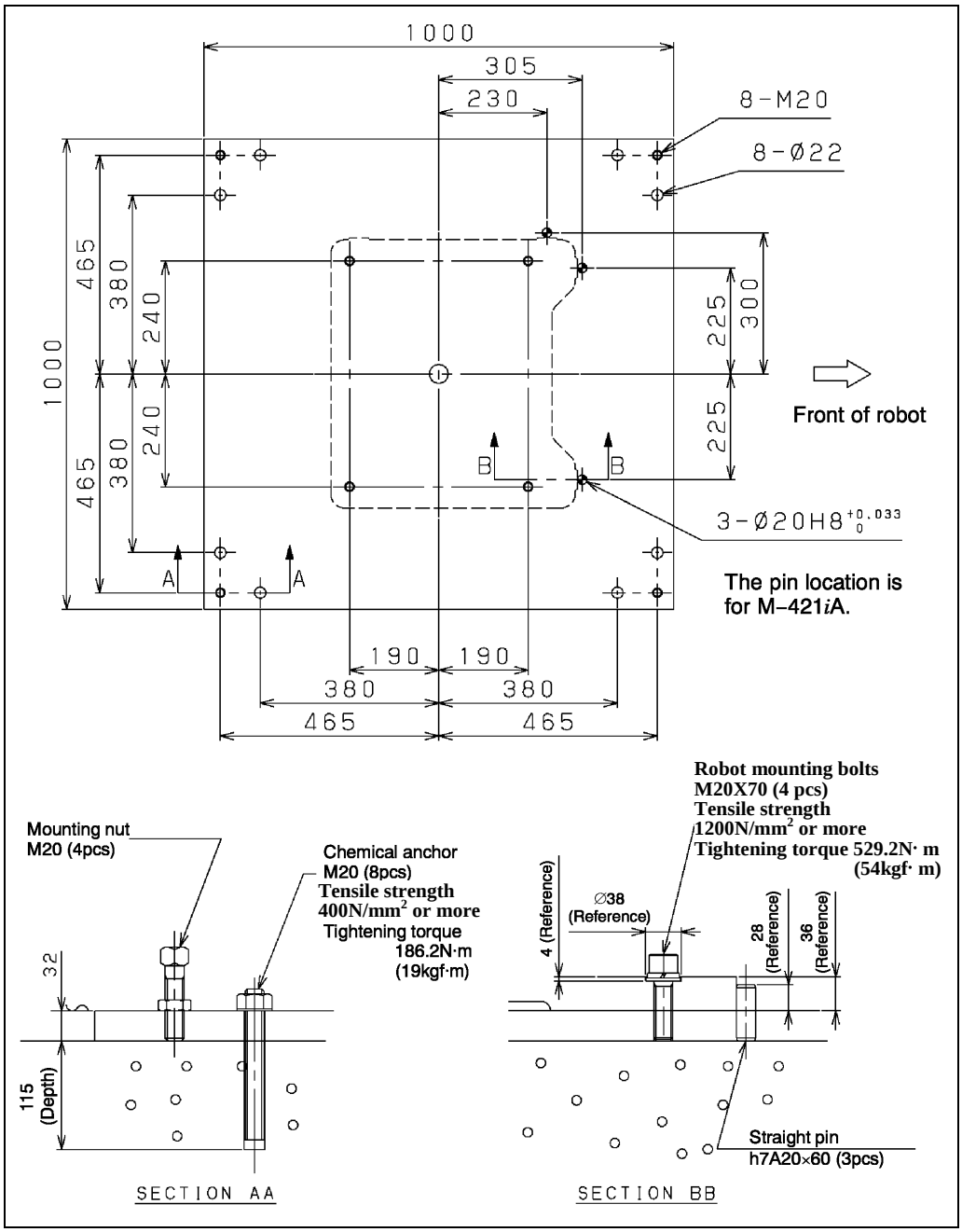


Fig. 9.2 (d) Actual installation example (Part 2)

Fig.9.2 (e), (f) and Table 9.2 (a) show the force and moment applied to the robot base at the time of emergency stop. Table 9.2 (b), (c) indicate the coasting time and distance 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.

Table 9.2 (a) Force and moment during Power-Off stop

Robot model	Vertical moment MV [kN·m (kgf·m)]	Force in vertical direction FV [kN (kgf)]	Horizontal moment MH [kN·m (kgf·m)]	Force in horizontal direction FH [kN (kgf)]
M-420*i*A	17.8 (1816)	17 (1736)	8.0 (815)	8.3 (848)
M-421*i*A	17.8 (1816)	16.3 (1659)	0 (0)	0 (0)

Table 9.2 (b) Stopping time and distance until the robot stopping by Power-Off stop after input of stop signal

Model		J1-axis	J2-axis	J3-axis
M-420*i*A	Coasting time [ms]	254	190	110
	Coasting distance [deg] (rad)	24.0 (0.42)	24.3 (0.42)	11.1 (0.19)
M-421*i*A	Coasting time [ms]	190	110	
	Coasting distance [deg] (rad)	24.3 (0.42)	11.1 (0.19)	

Table 9.2 (c) Stopping time and distance until the robot stopping by Controlled stop after input of stop signal

Model		J1-axis	J2-axis	J3-axis
M-420*i*A	Coasting time [ms]	734	726	710
	Coasting distance [deg] (rad)	58.6 (1.02)	73.1 (1.28)	55.8 (0.97)
M-421*i*A	Coasting time [ms]	726	710	
	Coasting distance [deg] (rad)	73.1 (1.28)	55.8 (0.97)	

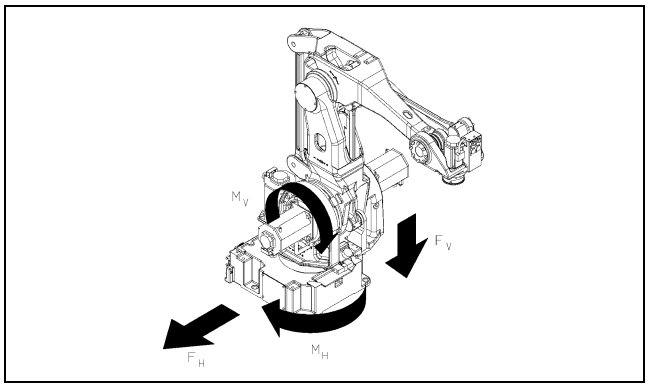


Fig. 9.2 (e) Force and moment during power-off stop (M-420*i*A)

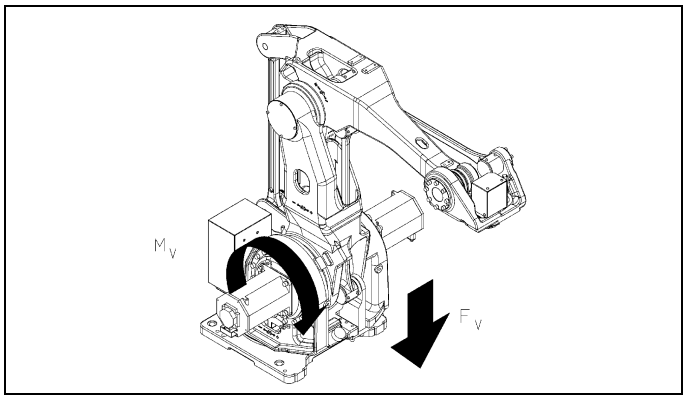


Fig. 9.2 (f) Force and moment during power-off stop (M-421*i*A)

9.3 MAINTENANCE AREA

Fig. 9.3 (a) and (b) show the maintenance area of the mechanical unit. Be sure to leave enough room for the robot to be mastered. See Chapter 5 for mastering information.

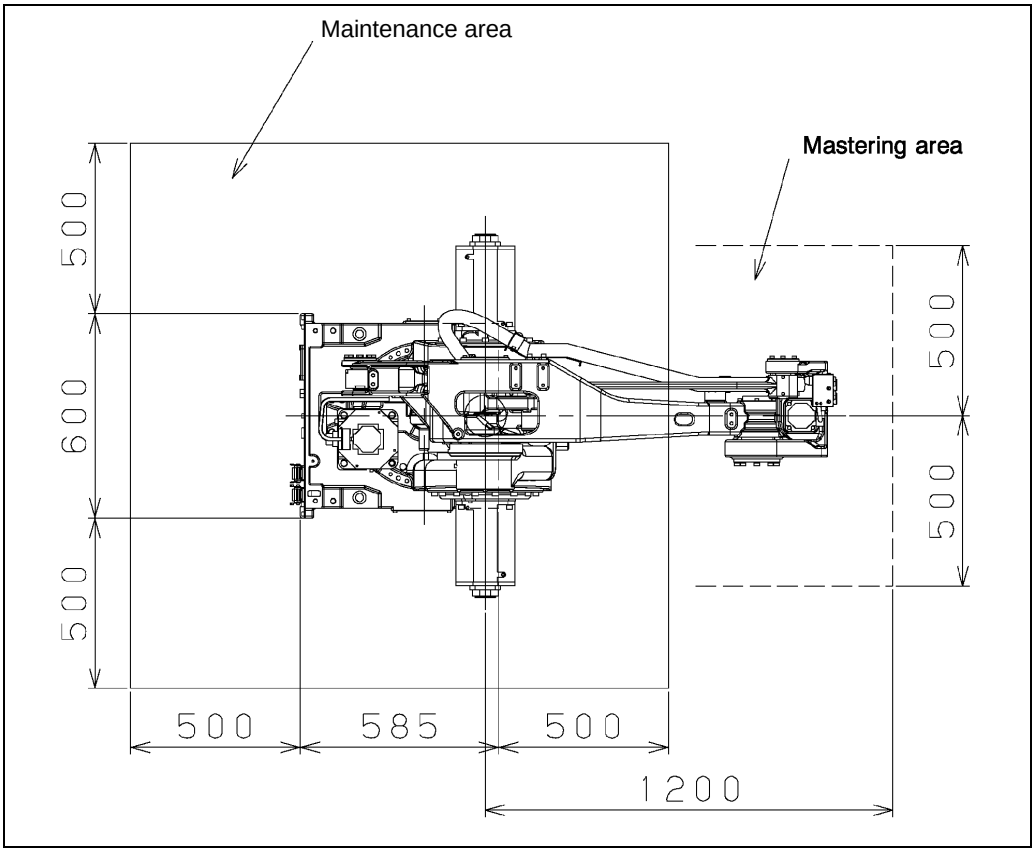


Fig. 9.3 (a) Maintenance area (M-420*i*A)

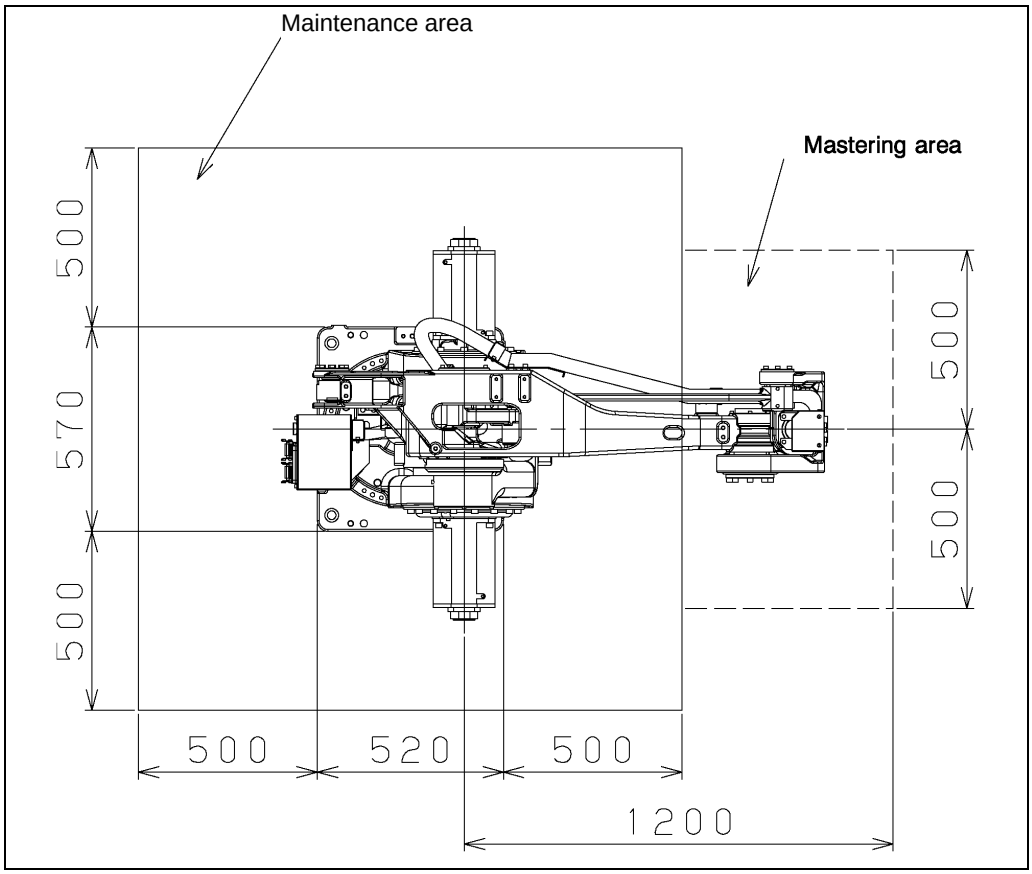


Fig. 9.3 (b) Maintenance area (M-421*i*A)

9.4 AIR PIPING (OPTION)

Fig.9.4 (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.9.4 (b).

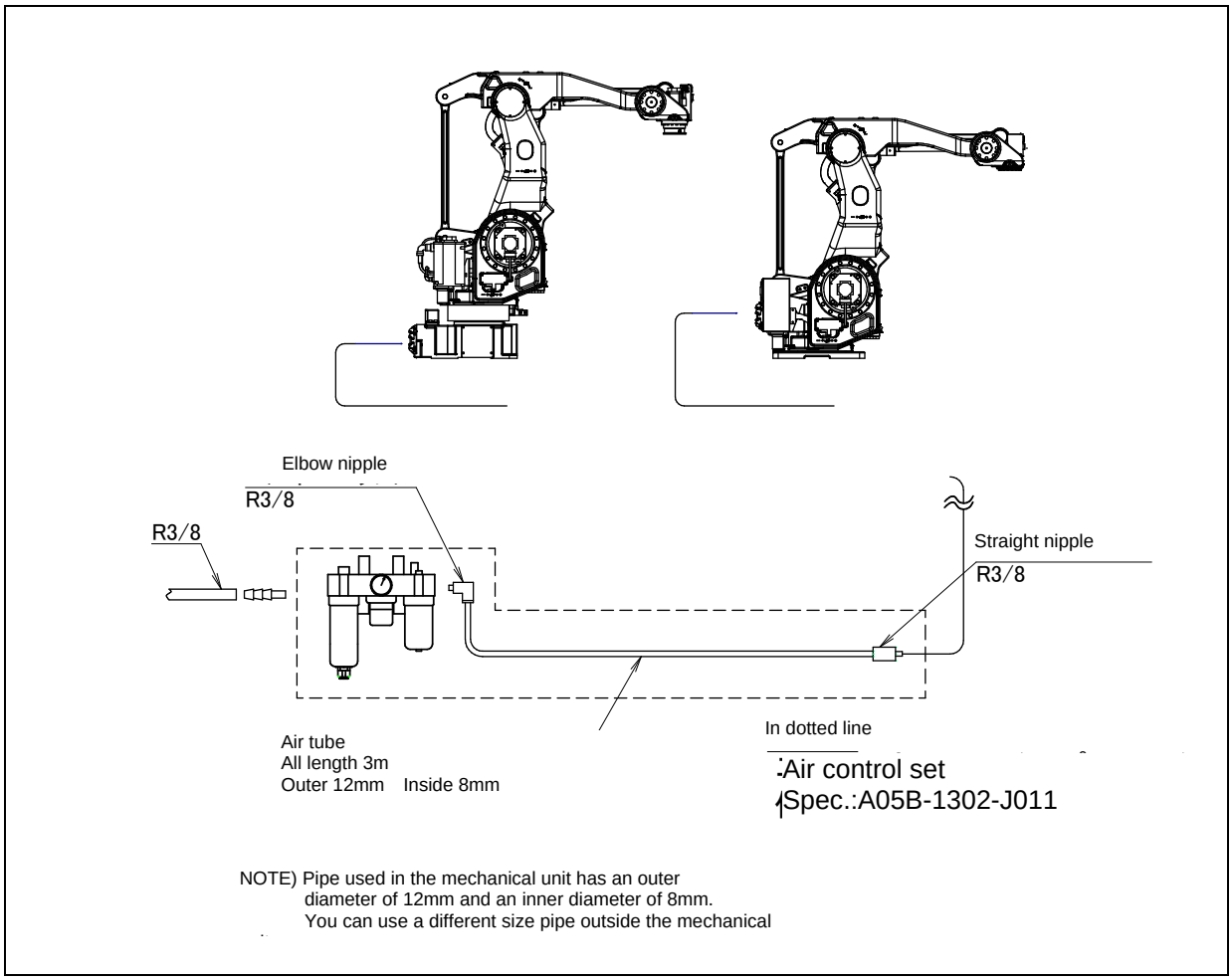


Fig. 9.4 (a) Air piping option

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.

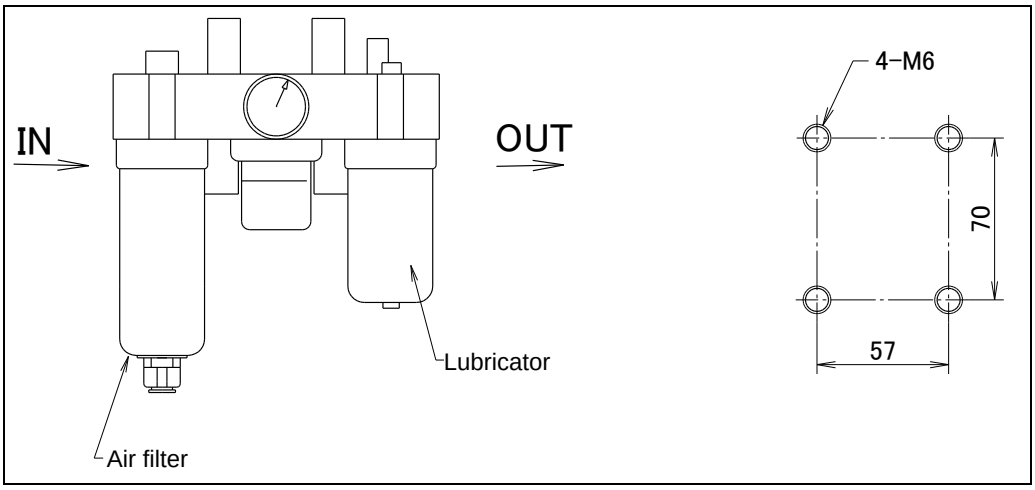


Fig. 9.4 (b) Air control set option (option)

9.5 INSTALLATION CONDITIONS

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

⚠ CAUTION

Contact the service representative, if the robot is to be used in an environment or a place subjected to severe vibrations, heavy dust, cutting oil splash and or other foreign materials.

If the robot is used especially in an adverse environment stated below, grease the bearing as required.

- Dusty environment; for example, an application in which the robot is used to handle tiles or bricks.
  In addition, if the robot is used in a special environment stated below, use a robot jacket or some other means to protect robot.
- Environment where glass abrasive powders and others are used; for example, an application in which the robot is subjected to splashes of powders in handling and other operations during glass abrasion.
- Environment where metal powders are used; for example, an application in which the robot is subjected to splashes of powders in handling and other operations during metal working.

9.6 STORAGE

To store the robot, set it to the same posture as that used for transportation. (See 9.1)

10 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 8.

> ⚠ **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.

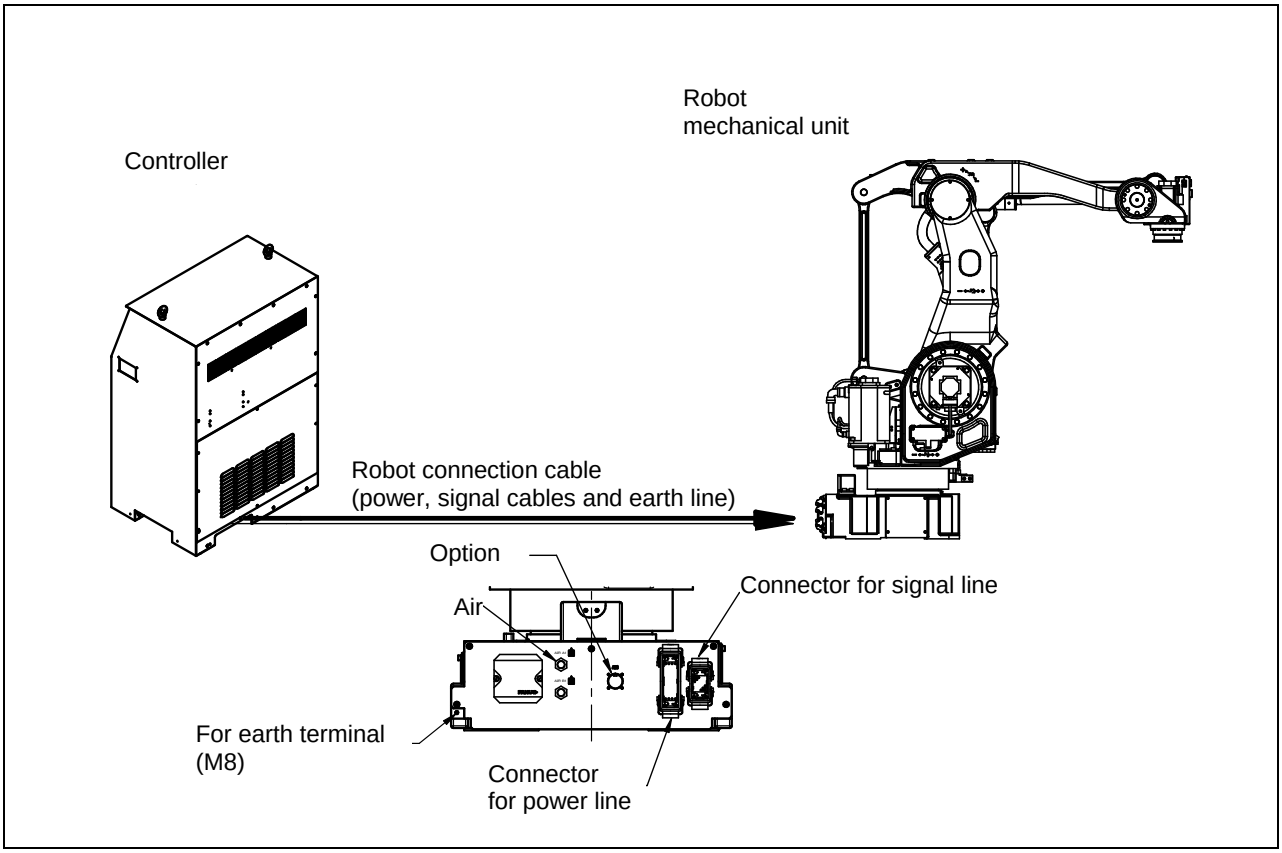


Fig. 10 (a) Cable connection

APPENDIX

A PERIODIC MAINTENANCE

FANUC Robot M-420*i*A STANDARD, HIGH SPEED WRIST Periodic Maintenance Table

Items			Working time (H) 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
Mechanical unit	1	Check for external damage or peeling paint	0.1H	—	○	○	○	○	○	○	○	○	○	○	○	○
	2	Check damages of the cable protective sleeves	0.1H	—	○	○	○	○	○	○	○	○	○	○	○	○
	3	Check wear debris of J1-axis swing stopper	0.1H	—	○	○	○	○	○	○	○	○	○	○	○	○
	4	Check for water	0.1H	—	○	○	○	○	○	○	○	○	○	○	○	○
	5	Check the mechanical cable. (Damaged or twisted)	0.2H	-		○			○				○			
	6	Check the end effector (hand) cable	0.2H	-		○			○				○			
	7	Check the motor connector and exposed connector. (Loosening) Tighten the end effector bolt.	0.2H	-		○			○				○			
	8	Retightening the end effector mounting bolts	0.2H	-		○			○				○			
	9	Tighten the cover and main bolt.	2.0H	-		○			○				○			
	10	Check the mechanical stopper and adjustable mechanical stopper	0.1H	-		○			○				○			
	11	Clean spatters, sawdust and dust	1.0H	-		○			○				○			
	12	Replacing batteries	0.1H	-							●					
	13	Replacing grease of J1 axis reducer	0.7H	4100ml												
	14	Replacing grease of J2 axis reducer	0.5H	1140ml												
	15	Replacing grease of J3 axis reducer	0.5H	1060ml												
	16	Replacing grease of J4 axis reducer	0.5H	180ml												
	17	Grease to bearing of connecting port of J3 arm (2 parts)	0.5H	20ml												
	18	Grease to bearing of connecting port of wrist (2 parts)	0.5.H	10ml												
	19	Replacing cable of mechanical unit	4.0H	-												
Controller	20	Check the teach pendant cable ,operation box connection cable and robot connection cable	0.2H	-		○			○				○			
	21	Cleaning the ventilator	0.2H	-	○	○	○	○	○	○	○	○	○	○	○	○
	22	Replacing batteries *1	0.1H	-												

*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 Europe) (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 Europe) (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 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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○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○		21
				●																	22

Overhaul

Overhaul

FANUC Robot M-420*i*A 2nd food Periodic Maintenance Table

Items		Working time (H)	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
Mechanical unit	1	Check for external damage or peeling paint	0.1H	—	○	○	○	○	○	○	○	○	○	○	○	○
	2	Check damages of the cable protective	0.1H	—	○	○	○	○	○	○	○	○	○	○	○	○
	3	Check wear debris of J1-axis swing stopper	0.1H	—	○	○	○	○	○	○	○	○	○	○	○	○
	4	Check for water	0.1H	—	○	○	○	○	○	○	○	○	○	○	○	○
	5	Check the mechanical cable. (damaged or twisted)	0.2H	-		○			○				○			
	6	Check the end effector (hand) cable	0.2H	-		○			○				○			
	7	Check the motor connector and exposed connector.	0.2H	-		○			○				○			
	8	Retightening the end effector mounting bolts	0.2H	-		○			○				○			
	9	Tighten the cover and main bolt.	2.0H	-		○			○				○			
	10	Check the mechanical stopper and adjustable	0.1H	-		○			○				○			
	11	Clean spatters, sawdust and dust	1.0H	-		○			○				○			
	12	Replacing batteries	0.1H	-							●					
	13	Replacing grease of J1 axis reducer	0.7H	4100ml					●				●			
	14	Replacing grease of J2 axis reducer	0.5H	1140ml					●				●			
	15	Replacing grease of J3 axis reducer	0.5H	1060ml					●				●			
	16	Replacing grease of J4 axis reducer	0.5H	180ml					●				●			
	17	Grease to bearing of connecting port of J3 arm (2 parts)	0.5H	20ml					●				●			
	18	Grease to bearing of connecting port of wrist (2 parts)	0.5H	10ml					●				●			
	19	Replacing cable of mechanical unit	4.0H	-												
Controller	20	Check the robot cable, teach pendant cable and robot connecting cable	0.2H	-		○			○				○			
	21	Cleaning the ventilator	0.2H	-	○	○	○	○	○	○	○	○	○	○	○	○
	22	Replacing batteries *1	0.1H	-												

*1 Refer to “REPLACING UNITS Chapter of MAINTENANCE ” of the following manuals.
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R-J3*i*B CONTROLLER MAINTENANCE MANUAL (For Europe) (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 Europe) (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 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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FANUC Robot M-421*i*A **Periodic Maintenance Table**

Items		Working time (H)	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
Mechanical unit	1	Check for external damage or peeling paint	0.1H	—	○	○	○	○	○	○	○	○	○	○	○	○
	2	Check damages of the cable protective	0.1H	—	○	○	○	○	○	○	○	○	○	○	○	○
	3	Check wear debris of J1-axis swing stopper	0.1H	—	○	○	○	○	○	○	○	○	○	○	○	○
	4	Check for water	0.1H	—	○	○	○	○	○	○	○	○	○	○	○	○
	5	Check the mechanical cable. (Damaged or twisted)	0.2H	-		○			○				○			
	6	Check the end effector (hand) cable	0.2H	-		○			○				○			
	7	Check the motor connector and exposed connector.	0.2H	-		○			○				○			
	8	Retightening the end effector mounting bolts	0.2H	-		○			○				○			
	9	Tighten the cover and main bolt.	2.0H	-		○			○				○			
	10	Check the mechanical stopper and adjustable	0.1H	-		○			○				○			
	11	Clean spatters, sawdust and dust	1.0H	-		○			○				○			
	12	Replacing batteries.	0.1H	-							●					
	13	Replacing grease of J1 axis reducer	0.5H	1140ml												
	14	Replacing grease of J2 axis reducer	0.5H	1060ml												
	17	Grease to bearing of connecting port of J3 arm (2 parts)	0.5H	20ml												
	18	Grease to bearing of connecting port of wrist (2 parts)	0.5H	10ml												
	19	Replacing cable of mechanical unit	4.0H	-												
Controller	20	Check the robot cable, teach pendant cable and robot connecting cable	0.2H	-		○			○				○			
	21	Cleaning the ventilator	0.2H	-	○	○	○	○	○	○	○	○	○	○	○	○
	22	Replacing batteries *1	0.1H	-												

*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 Europe) (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 Europe) (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 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
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Overhaul

Overhaul

B STRENGTH OF BOLT AND BOLT TORQUE LIST

NOTE

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

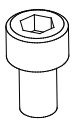
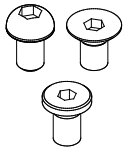
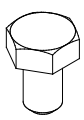
Use the following strength bolts. Comply with any bolt specification instructions.
Hexagon socket head bolt made of steel:

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

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