FANUC Robot M-710*i*C/50T/70T

MECHANICAL UNIT

OPERATOR'S MANUAL

B-82504EN/05

- **Original Instructions**

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

SAFETY PRECAUTIONS

This chapter must be read before using the robot.

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

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

1 DEFINITION OF USER

The 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 safety fence

Maintenance engineer:
- Operates the robot
- Teaches the robot inside the safety fence
- Maintenance (repair, adjustment, replacement)

- Operator is not allowed to work in the safety fence.
- Programmer and maintenance engineer is allowed to work in the safety fence. Works carried out in the safety fence include transportation, installation, teaching, adjustment, and maintenance.
- To work inside the safety fence, the person must be trained on proper robot operation.

Table 1 lists the work outside the safety fence. In this table, the symbol "○" means the work allowed to be carried out by the worker.

Table 1 List of work outside the fence

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

In the robot operating, programming and maintenance, the operator, programmer, teaching operator and maintenance engineer 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.

- Check this manual thoroughly, and keep it handy for the future reference.

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 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.

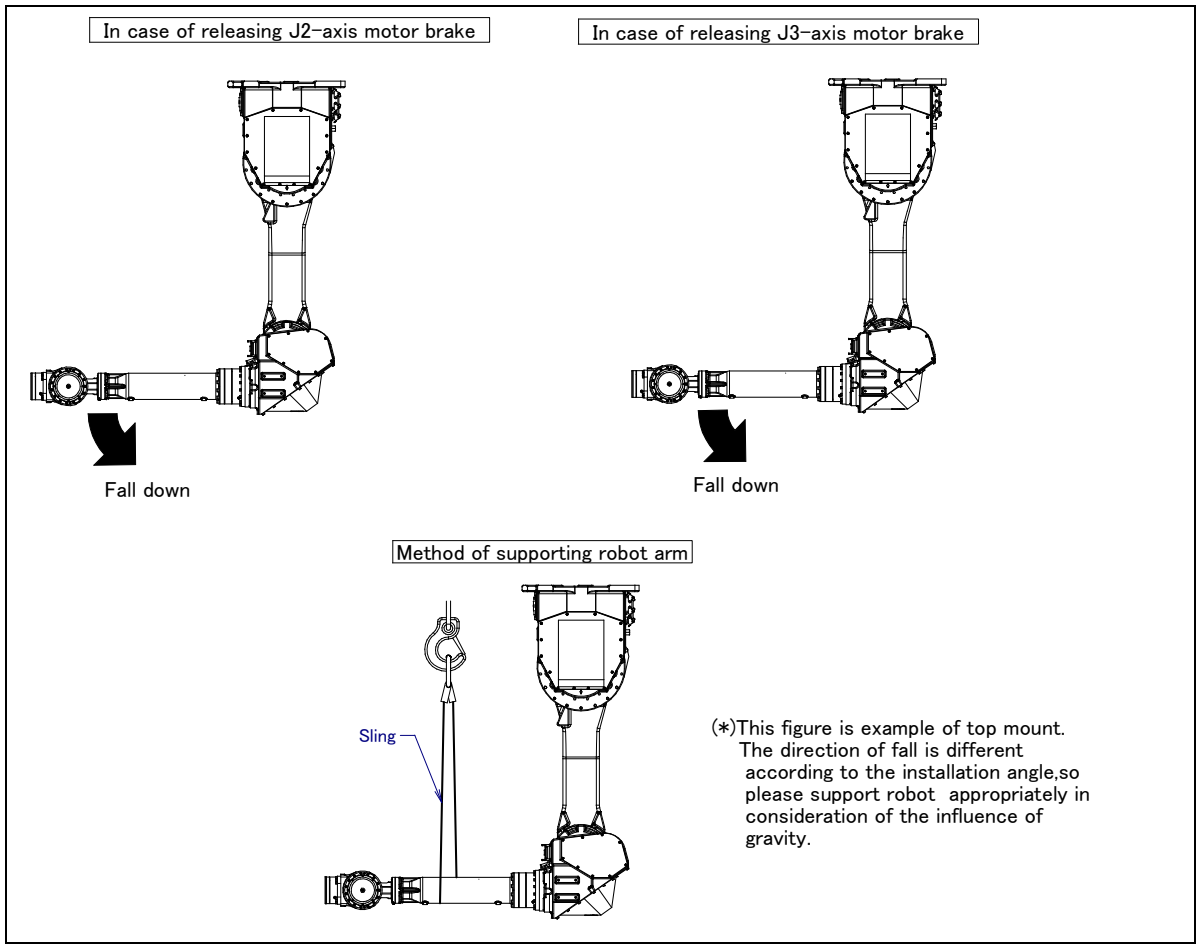


Fig. 3 Arm operation by the release of J2, J3-axis motor brake and measure

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 Chapter 7 CHECKS AND MAINTENANCE for explanations about specified grease, the grease amount, 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) Step-on prohibitive 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 tool such as heat-resistant gloves.

(4) Transportation label

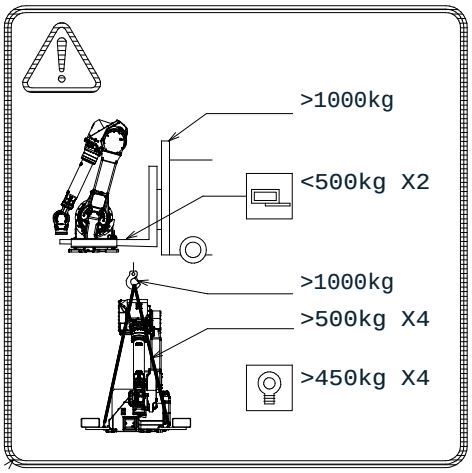


Fig. 4 (d) Step-on prohibitive label

Description

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

1) Using a forklift
- Use a forklift having a load capacity of 1000 kg or greater.
- Keep the total weight of the robot to be transported to within 1000 kg, because the allowable load of the forklift bracket (option) is 4900 N (500 kgf).

2) Using a crane
- Use a crane having a load capacity of 1000 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 4410 N (450 kgf) or greater.

> ⚠ **CAUTION**
> Transportation labels are model-specific. Before transporting the robot, see the transportation label affixed to the J2 base side.
> See Sub-section 1.1 TRANSPORTATION for explanations about the posture a specific model should take when it is transported.

(5) Operation space and payload label

Below label is added when CE specification is specified.

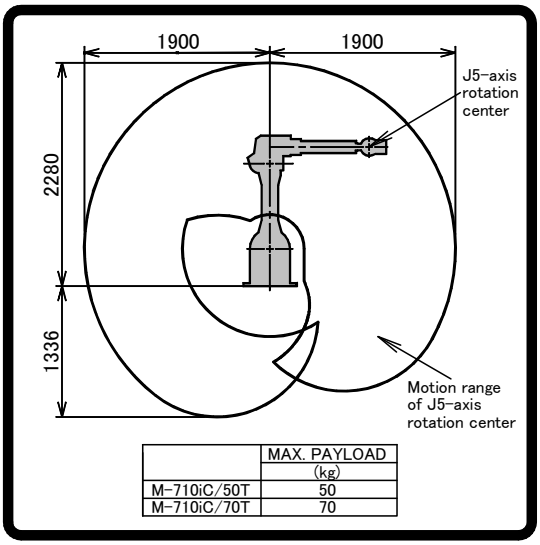


Fig. 4 (e) Operation space and payload label

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

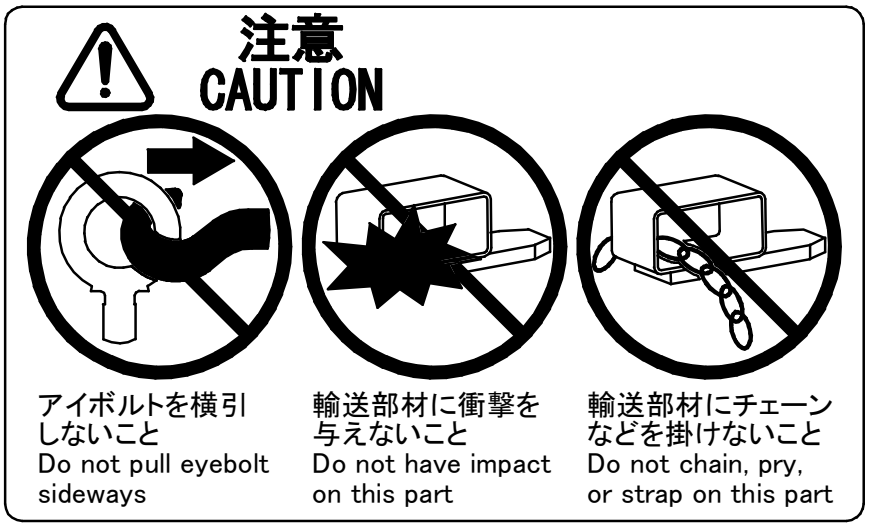


Fig. 4 (f) Transportation prohibitive label

Description

Keep the following in mind when transporting the robot.

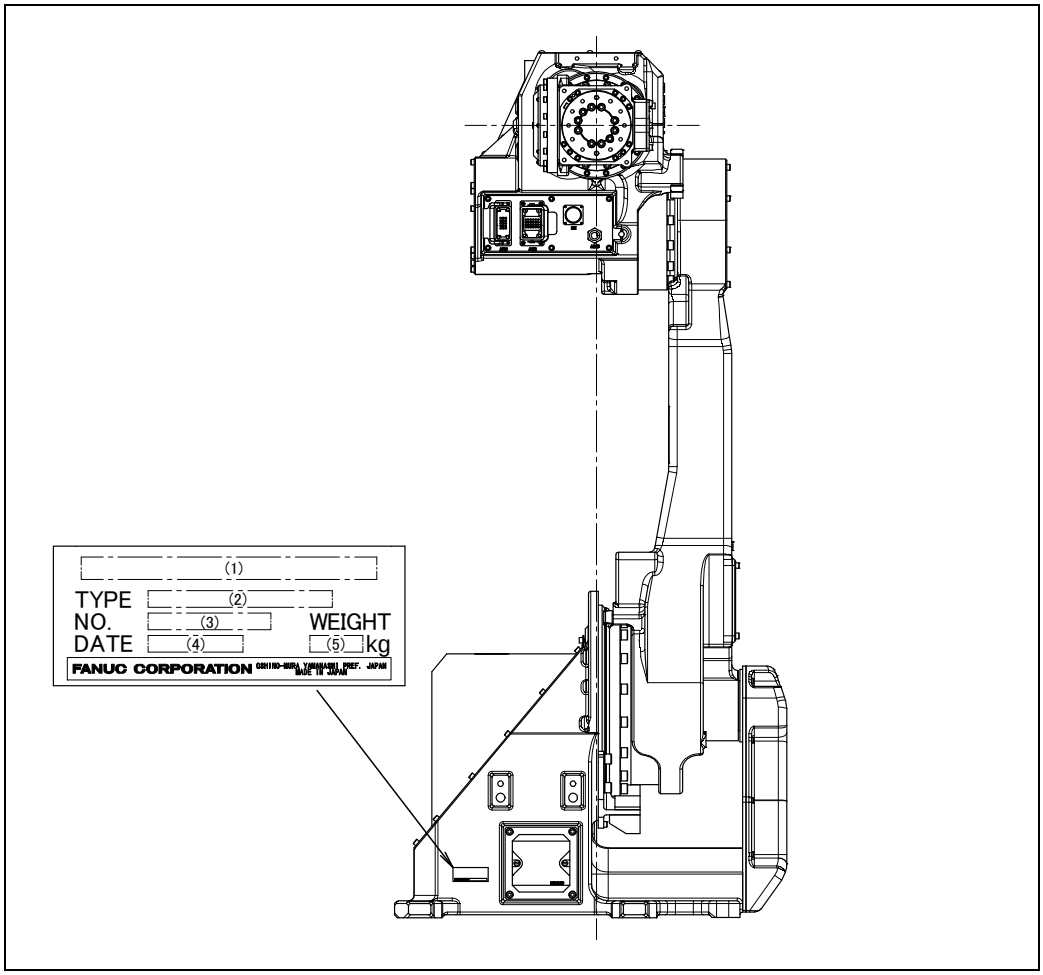
1) Do not pull eyebolts sideways
2) Prevent the forks of the forklift from having impact on a transport equipment.
3) Do not thread a chain or the like through a transport equipment.

PREFACE

This manual explains the maintenance and connection procedures for the mechanical units of the following robots:

Model name	Mechanical unit specification No.	Maximum load
FANUC Robot M-710*i*C/50T	A05B-1125-B501	50kg
FANUC Robot M-710*i*C/70T	A05B-1125-B502	70kg

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



Position of label indicating mechanical unit specification number

	(1)	(2)	(3)	(4)	(5)
CONTENTS	-	TYPE	No.	DATE	WEIGHT kg (Without controller)
LETTERS	FANUC Robot M-710*i*C/50T	A05B-1125-B501	SERIAL NO IS PRINTED.	PRODUCTION YEAR AND MONTH ARE PRINTED	410
	FANUC Robot M-710*i*C/70T	A05B-1125-B502			410

RELATED MANUALS

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

SAFETY HANDBOOK **B-80687EN** All persons who use the FANUC Robot and system designer must read and understand thoroughly this handbook		Intended readers : Operator, system designer Topics : Safety items for robot system design, operation, maintenance
R-30*i*A controller	Setup and Operations manual SPOT TOOL **B-83124EN-1** HANDLING TOOL **B-83124EN-2** ARC TOOL **B-83124EN-3** DISPENSE TOOL **B-83124EN-4** SERVO GUN FUNCTION **B-82634EN** ALARM CODE LIST **B-83124EN-6**	Intended readers : Operator, programmer, maintenance engineer, system designer Topics : Robot functions, operations, programming, setup, interfaces, alarms Use : Robot operation, teaching, system design
	Maintenance manual **B-82595EN** **B-82595EN-1** (For Europe) **B-82595EN-2** (RIA)	Intended readers : Maintenance engineer, system designer Topics : Installation, start-up, connection, maintenance Use : Installation, start-up, connection, maintenance
R-30*i*B, **R-30*i*B Mate,** **R-30*i*B Plus,** **R-30*i*B Mate Plus,** **controller**	OPERATOR'S MANUAL (Basic Operation) **B-83284EN** OPERATOR'S MANUAL (Alarm Code List) **B-83284EN-1** Optional Function OPERATOR'S MANUAL **B-83284EN-2** SPOT FUNCTION OPERATOR'S MANUAL **B-83284EN-4** DISPENSE FUNCTION OPERATOR'S MANUAL **B-83284EN-5** Servo gun Function OPERATOR'S MANUAL **B-83264EN**	Intended readers : Operator, programmer, maintenance engineer, system designer Topics : Robot functions, operations, programming, setup, interfaces, alarms Use : Robot operation, teaching, system design
	MAINTENANCE MANUAL R-30*i*B, R-30*i*B Plus : **B-83195EN** R-30*i*B Mate, R-30*i*B Mate Plus : **B-83525EN**	Intended readers : Maintenance engineer, system designer Topics : Installation, start-up, connection, maintenance Use : Installation, start-up, connection, maintenance

AC servo motor (For J1-axis motor)	FANUC AC SERVO MOTOR αi-B/αi series DESCRIPTIONS **B-65262EN**	Intended readers: Maintenance engineer, system designer Topics: Specification, usage Use: Confirmation of specification and usage
	FANUC AC SERVO MOTOR αis series FANUC AC SERVO MOTOR αi series FANUC AC SPINDLE MOTOR αi series FANUC SERVO AMPLIFIER αi series Maintenance Manual **B-65285EN**	Intended readers: Maintenance engineer, system designer Topics: Setup, troubleshooting, maintenance Use: Setup, troubleshooting, maintenance

NOTE

This manual covers the five robot axes to be mounted on the J1-axis (traveling unit).
Information about the structure or handling of the traveling unit is not included.
The servo motor for the J1-axis is appended to this robot. “FANUC AC SERVO MOTOR αi-B/αi series DESCRIPTIONS” describe points of concern to use our servo motor safely. Read it before use the servo motor, and use the servo motor correctly after the each function is understood enough.

This manual uses following terms.

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

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1 TRANSPORTATION AND INSTALLATION

1.1 TRANSPORTATION

The robot can be transported by a crane or a forklift. When transporting the robot, be sure to change the posture of the robot to that shown below and lift by using the eyebolts and the transport equipment at their points.

⚠ WARNING

1 When hoisting or lowering the robot with a crane or forklift, move it slowly with great care. When placing the robot on the floor, exercise care to prevent the installation surface of the robot from striking the floor.
2 It is recommended to transport robot detaching the end effector and the incidental equipment from the robot because there is the following possibilities when transported with the end effector and the incidental equipment installed.
- It becomes unstable by the change in the position of the center of the gravity of the robot while transporting it.
- The end effector acts by the vibration when transported and an excessive load acts on far movement and the robot.

Please firmly fix the end effector referring to clause 1.1.1 when it is difficult to detach the end effector and transport it.
3 Use the forklift pockets only to transport the robot with a forklift. Do not use the forklift pockets to secure the robot.
4 Before moving the robot by using forklift pockets, check and tighten any loose bolts on the forklift pockets.

(1) Transportation using a crane (Fig. 1.1 (b))
In transportation with a crane, lift the robot with four slings passing through the M16 eyebolts attached to the special transport bracket.

⚠ CAUTION

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

(2) Transportation using a forklift (Fig. 1.1 (c))
The specific transport member must be attached.
Transport equipment are prepared as an option.

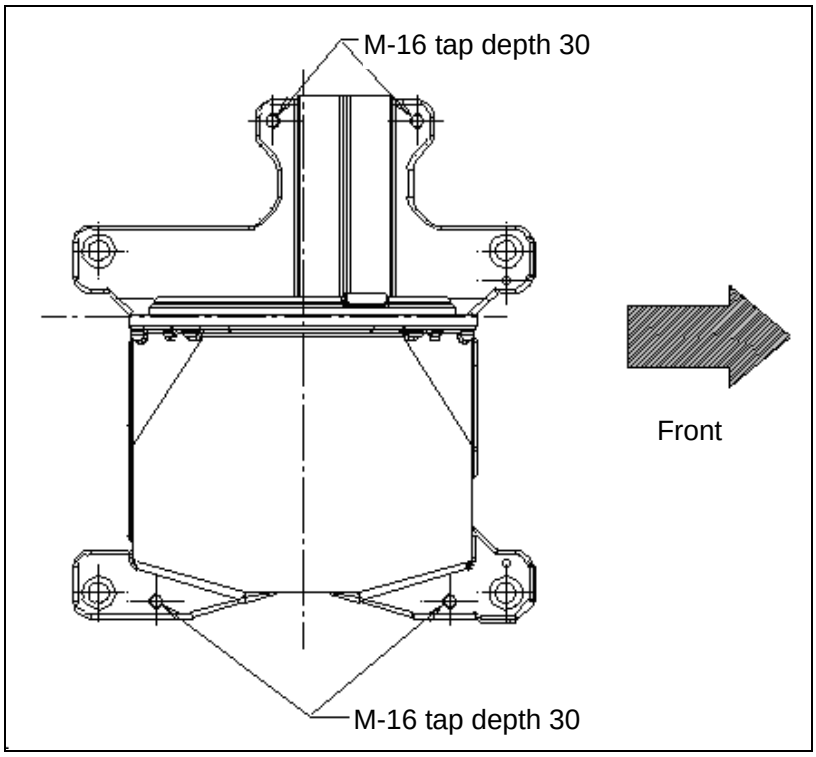


Fig. 1.1 (a) Position of the and transportation equipment

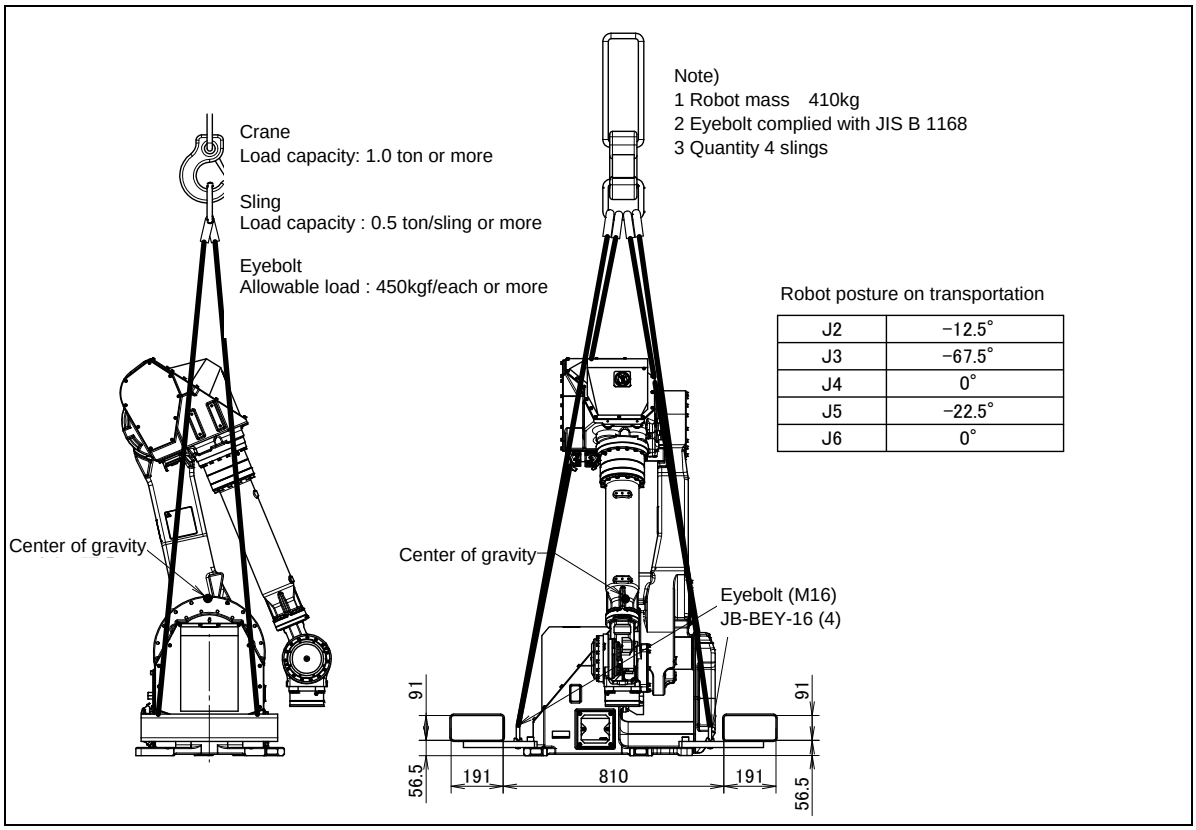


Fig. 1.1 (b) Transportation using a crane

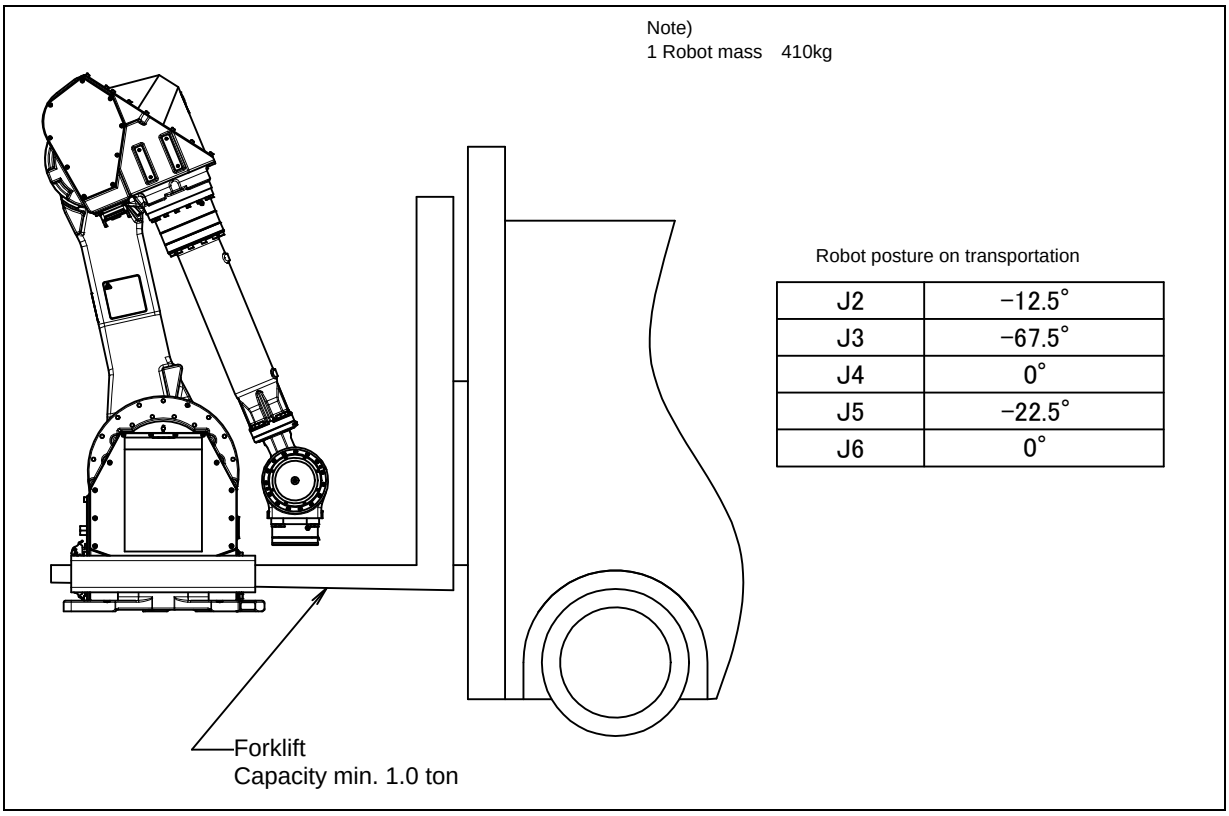


Fig. 1.1 (c) Transportation using a forklift

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

1.1.1 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.

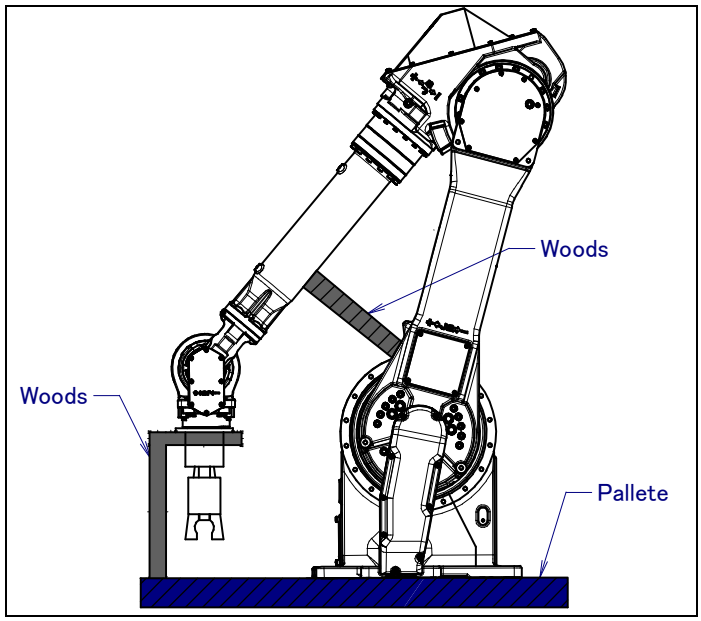


Fig. 1.1.1 Example of securing the arm during transportation when an end effector is attached

1.2 INSTALLATION

Fig. 1.2 (a) shows the robot base dimensions. Avoid placing any object in front of the robot on the mounting surface to facilitate the installation of the mastering fixture.

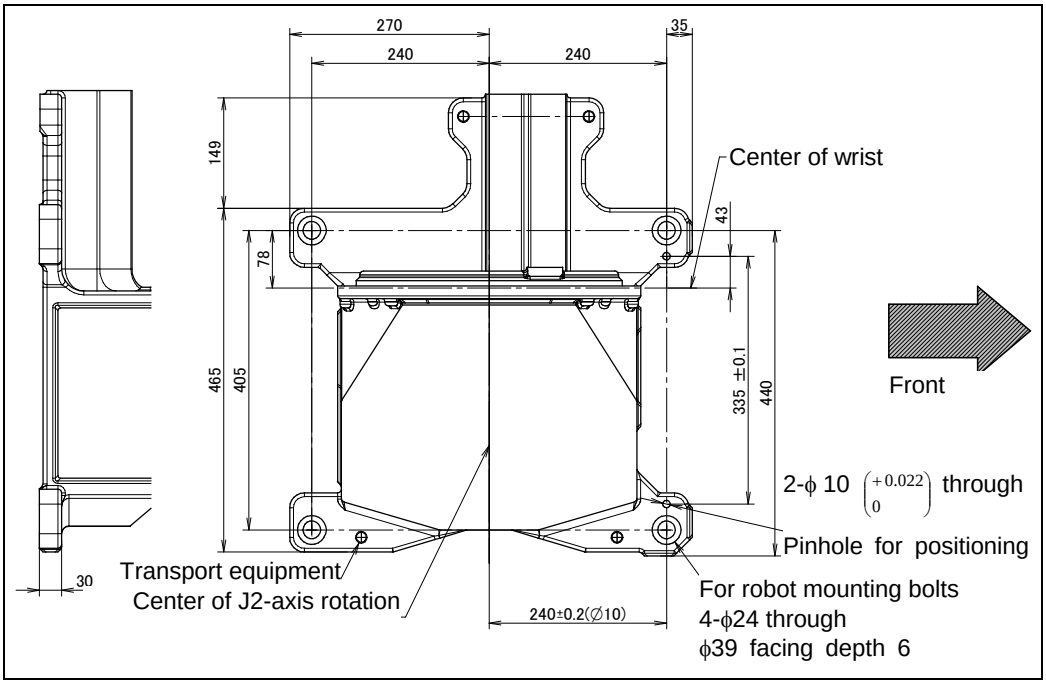


Fig. 1.2 (a) Dimensions of the robot base

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

Fig. 1.2 (b) and Table 1.2 (a) to (d) show the force and moment applied to the base plate at the time of Power-Off stop of the robot. Table 1.2 (c), (d) indicates the coasting time and distance of the J1 through J3 axes 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.1.2 (a) Force and moment during Power-Off stop (M-710*i*C/50T)

	Fx		Fy		Fz		Mx		My		Mz	
	N	kgf	N	kgf	N	kgf	N	kgf	N	kgf	N	kgf
Upside-down mount Robot only	4708	480	0	0	10194	1040	412	42	10938	1116	93	9
Upside-down mount Robot with traveling axis (NOTE)	4708	480	5976	610	10194	1040	5042	515	10938	1116	3169	323
Wall & angle mount Robot only	10194	1040	0	0	4708	480	93	9	12636	1289	412	42
Wall & angle mount Robot with traveling axis (NOTE)	10194	1040	5976	610	4708	480	4723	482	12636	1289	3488	356

Table.1.2 (b) Force and moment during Power-Off stop (M-710*i*C/70T)

	Fx		Fy		Fz		Mx		My		Mz	
	N	kgf	N	kgf	N	kgf	N	kgf	N	kgf	N	kgf
Upside-down mount Robot only	4708	480	0	0	10470	1068	412	42	11082	1131	93	9
Upside-down mount Robot with traveling axis (NOTE)	4708	480	6264	639	10470	1068	5639	575	11082	1131	3674	375
Wall & angle mount Robot only	10470	1068	0	0	4708	480	93	9	13326	1360	412	42
Wall & angle mount Robot with traveling axis (NOTE)	10470	1068	6264	639	4708	480	5320	543	13326	1360	3993	407

NOTE
The values indicate loads applied when the traveling axis is under the conditions below. Loads on the base vary if the traveling axis is under different conditions.
Maximum speed : 1.6 m/sec
Time constant : 480 msec (at acceleration), 150 msec (at Power-Off stop)

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

Model		J2-axis	J3-axis
M-710*i*C/50T	Stopping time [msec]	260	212
	Stopping distance [deg] (rad)	22.7 (0.40)	20.0 (0.35)
M-710*i*C/70T	Stopping time [msec]	204	180
	Stopping distance [deg] (rad)	10.5 (0.18)	11.0 (0.19)

* Max payload and max speed

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

Model		J2-axis	J3-axis
M-710*i*C/50T	Stopping time [msec]	644	288
	Stopping distance [deg] (rad)	62.5 (1.09)	60.4 (1.05)
M-710*i*C/70T	Stopping time [msec]	764	708
	Stopping distance [deg] (rad)	47.5 (0.83)	46.3 (0.81)

* Max payload and max speed

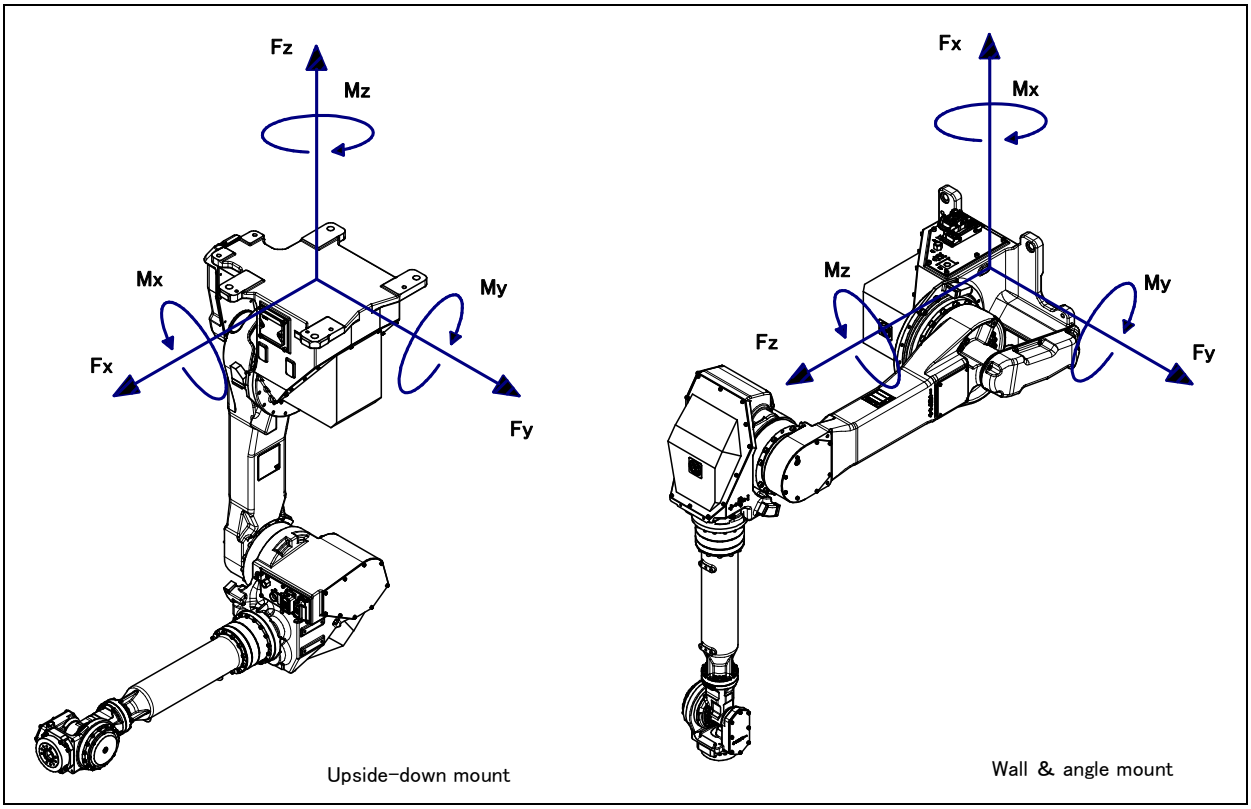


Fig.1.2 (b) Force during power-off stop

1.3 MAINTENANCE AREA

Fig. 1.3 shows the maintenance area of the mechanical unit. Be sure to leave enough room for the robot to be mastered. See Chapter 8 for mastering information.

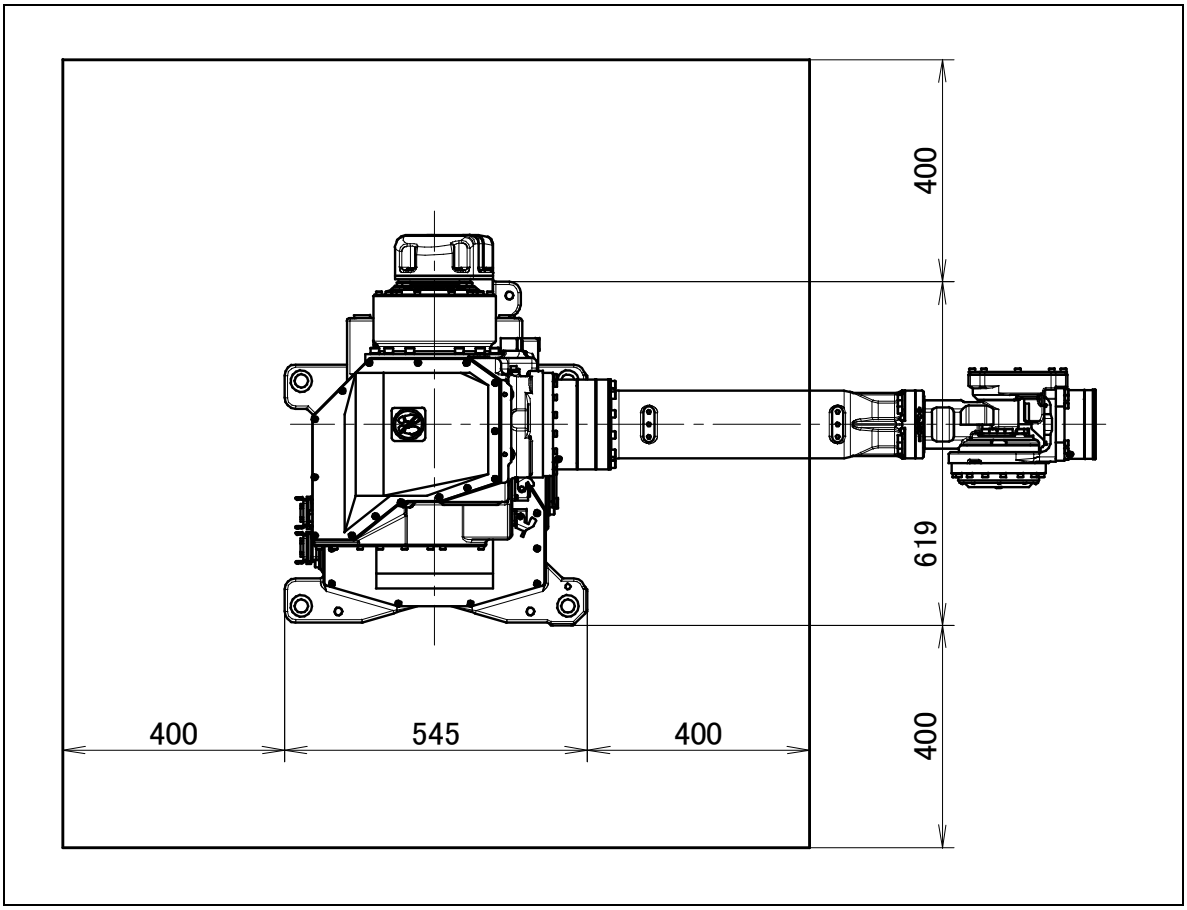


Fig. 1.3 Maintenance area

1.4 INSTALLATION CONDITIONS

Refer to specification of Section 3.1 about installation conditions.

2 CONNECTION WITH THE CONTROLLER

2.1 CONNECTION WITH THE CONTROLLER

The robot is connected with the controller via the power cable and signal cable. Connect these cables to the connectors on the back of the base.

For details on air and option cables, see Chapter 5.

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

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

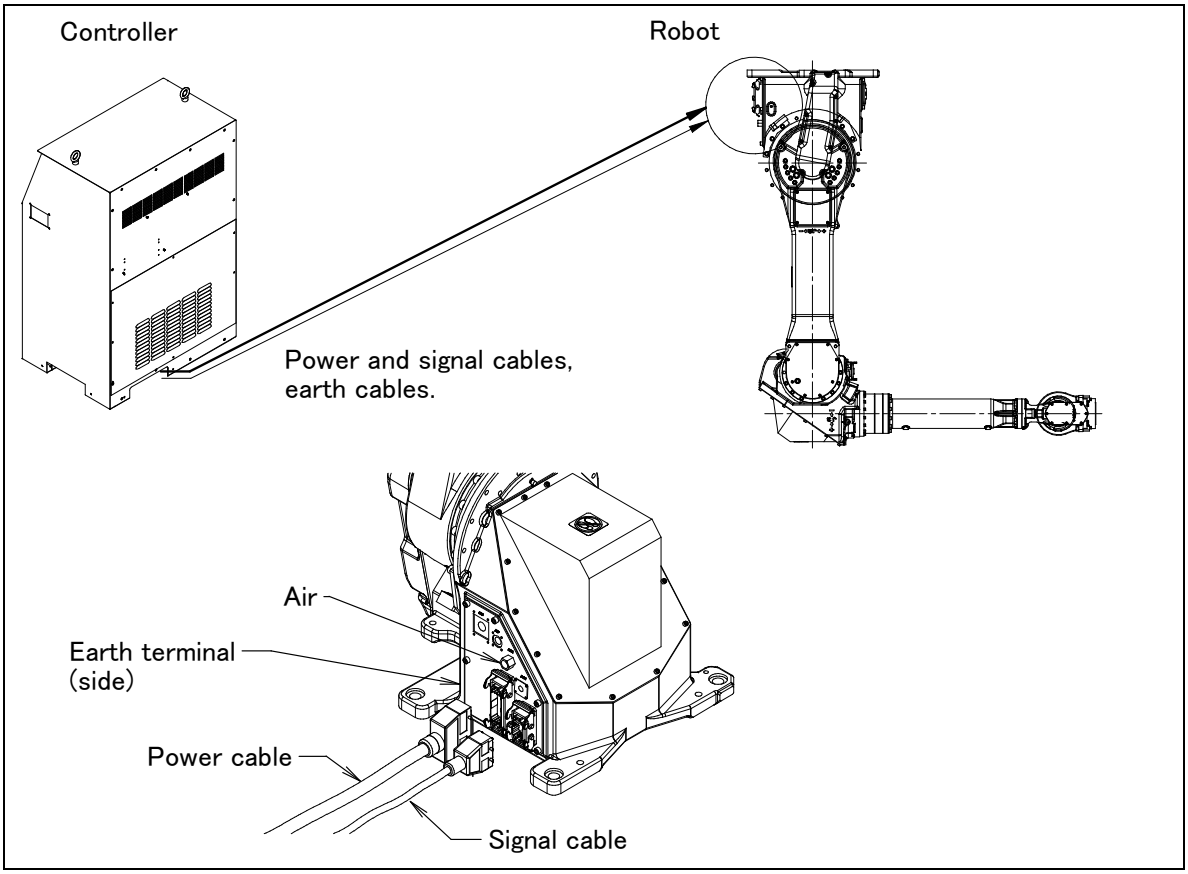


Fig. 2.1 Cable connection

3 BASIC SPECIFICATIONS

3.1 ROBOT CONFIGURATION

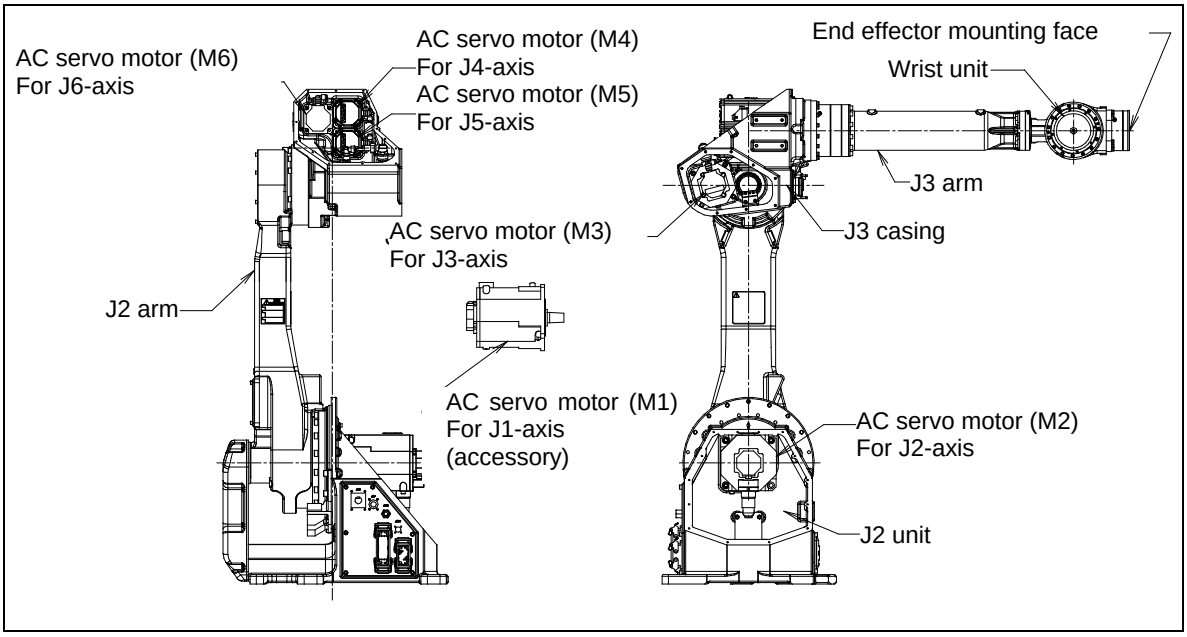


Fig. 3.1 (a) Mechanical unit configuration

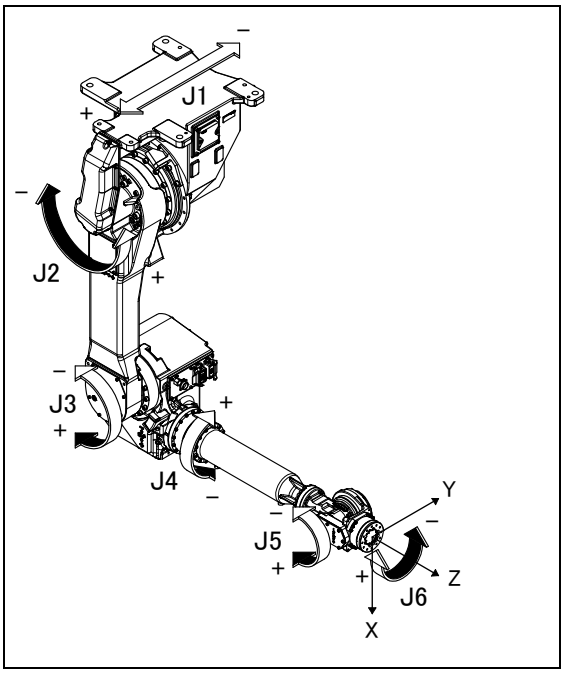


Fig. 3.1 (b) Each axis coordinates and mechanical interface coordinates

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

Specifications

Item		Specification		Remarks
Model		M-710*i*C/50T	M-710*i*C/70T	
Type		Articulated Type		
Controlled axes		6 axes (J1, J2, J3, J4, J5, J6)		
Reach		1900mm		
Installation (NOTE 1)		Floor, upside-down, wall & angle mount		
Motion range	J1-axis	-		(NOTE 1)
		-		
	J2-axis	119° (2.08rad)		
		-142° (-2.48rad)		
	J3-axis	347° (6.06rad)		
		-144° (2.51rad)		
	J4-axis	360° (6.28rad)		
		-360° (-6.28rad)		
	J5-axis	125° (2.18rad)		
		-125° (-2.18rad)		
	J6-axis	360° (6.28rad)		
		-360° (-6.28rad)		
Max motion speed (NOTE 2)	J1-axis	-		(NOTE 1)
	J2-axis	175° /s (3.05rad/s)	120° /s (2.09rad/s)	
	J3-axis	175° /s (3.05rad/s)	120° /s (2.09rad/s)	
	J4-axis	250° /s (4.36rad/s)	225° /s (3.93rad/s)	
	J5-axis	250° /s (4.36rad/s)	225° /s (3.93rad/s)	
	J6-axis	355° /s (6.20rad/s)	225° /s (3.93rad/s)	
Max. load capacity	At wrist	50kg	70kg	
	At J3 casing (NOTE 3)	15kg		
Allowable load moment at wrist	J4	206N·m (21kgf·m)	294N·m (30kgf·m)	
	J5	206N·m (21kgf·m)	294N·m (30kgf·m)	
	J6	127N·m (13kgf·m)	147N·m (15kgf·m)	
Allowable load inertia at wrist	J4	28kg·m^2 (286kgf·cm·s^2)		
	J5	28kg·m^2 (286kgf·cm·s^2)		
	J6	11kg·m^2 (112kgf·cm·s^2)		
Drive method		Electric servo drive by AC servo motor		
Repeatability		±0.07mm		(NOTE 4)
Mass (NOTE 5)		Approx. 410kg		(NOTE 5)
Acoustic noise level		71.3dB This value is an A load equivalent noise level measured in accordance with ISO11201 (EN31201). The measurement is made under the following condition. - Maximum load - Automatic operation (AUTO mode)		
Installation environment		Ambient temperature : 0 - 45°C (NOTE 6) Ambient humidity : Normally 75%RH or less No dew, nor frost allowed. Short time (within one month) Max 95%RH Height : Up to 1000 meters above the sea level required, no particular provision for posture. Vibration acceleration : 4.9m/s2 (0.5G) or less Free of corrosive gases (NOTE 7)		Non-condensing

NOTE

1 The drive motor αiF22/3000 or αiS30/3000 is provided as an accessory for the J1-axis.
2 During short distance motions, the axis speed may not reach the maximum value stated.
3 The Max. load capacity at J3 casing is restricted by the load weight at wrist. For details, see Section 3.5.
4 Repeatability of the arm unit (J2 to J6-axes)
5 The weight of the controller is not included.
6 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.
7 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.

The following table lists the IEC60529-based Severe dust/liquid protection characteristics of the M-710*i*C. Refer to Chapter 10 about severe dust/liquid protection package (option).

	Standard	Severe dust/liquid protection package
J3 arm and wrist section	IP67	IP67
Drive unit of the main body	IP66	IP67
Main body	IP54 (*)	IP67

(*) Except some connectors

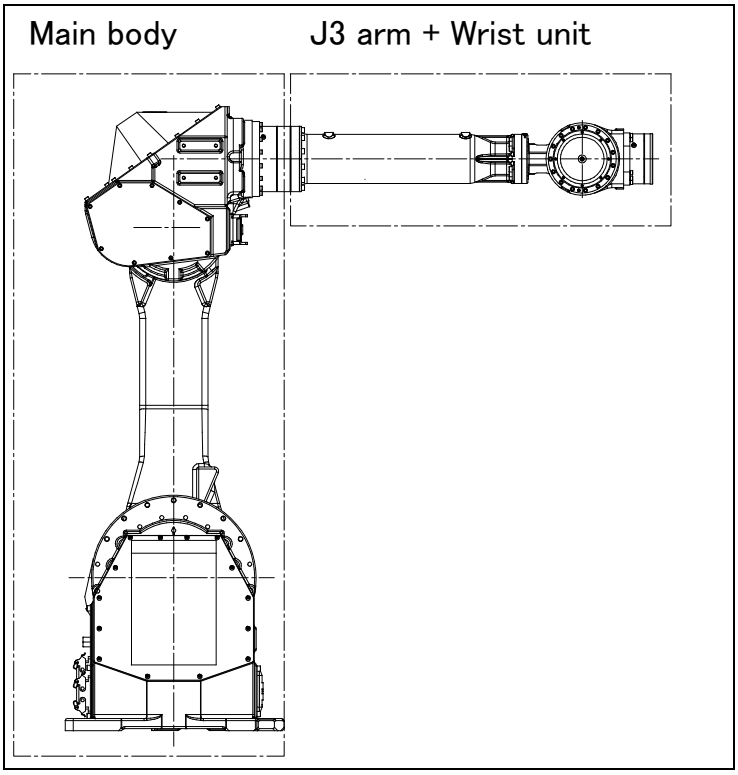


Fig. 3.1 (c) Characteristics of the M-710*i*C

NOTE

Definition of IP code
Definition of IP 67
6=Dust-tight: Complete protection against contact
7=Protection from water immersion: Ingress of water in harmful quantity shall not be possible when the enclosure is immersed in water under defined conditions of pressure and time.
Definition of IP 66
6=Dust-tight: Complete protection against contact
6=Protection from powerful water jets: Water projected in powerful jets against the enclosure from any direction shall have no harmful effects.
Definition of IP 54
5=Dust-tight: Ingress of dust is not entirely prevented, but it must not enter in sufficient quantity to interfere with the satisfactory of the equipment.
4=Protection from water immersion : Water splashing against the enclosure from any direction shall have no harmful effect.

Performance of resistant chemicals and resistant solvents

(1) The robot (including severe dust/liquid protection model) cannot be used with the following liquids. Potentially these liquids will cause irreversible damage to the rubber parts (such as: gaskets, oil seals, O-rings etc.). (As exception to this only liquids tested and approved by FANUC can be used with the robot.)
   (a) Organic solvents
   (b) Cutting fluid including chlorine / gasoline
   (c) Amine type detergent
   (d) Acid, alkali and liquid causing rust
   (e) Other liquids or solutions, that will harm NBR or CR rubber

(2) When the robots work in the environment, using water or liquid, complete draining of J1 base must be done. Incomplete draining of J1 base will make the robot break down.

(3) Don not use unconfirmed cutting fluid and cleaning fluid.

(4) Do not use the robot immersed in water, neither temporary nor permanent. Robot must not be wet permanently.
   *Example : in case motor surface is exposed to water for a long time, liquid may invade inside the motor and cause failure.

3.2 MECHANICAL UNIT EXTERNAL DIMENSIONS AND OPERATING SPACE

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

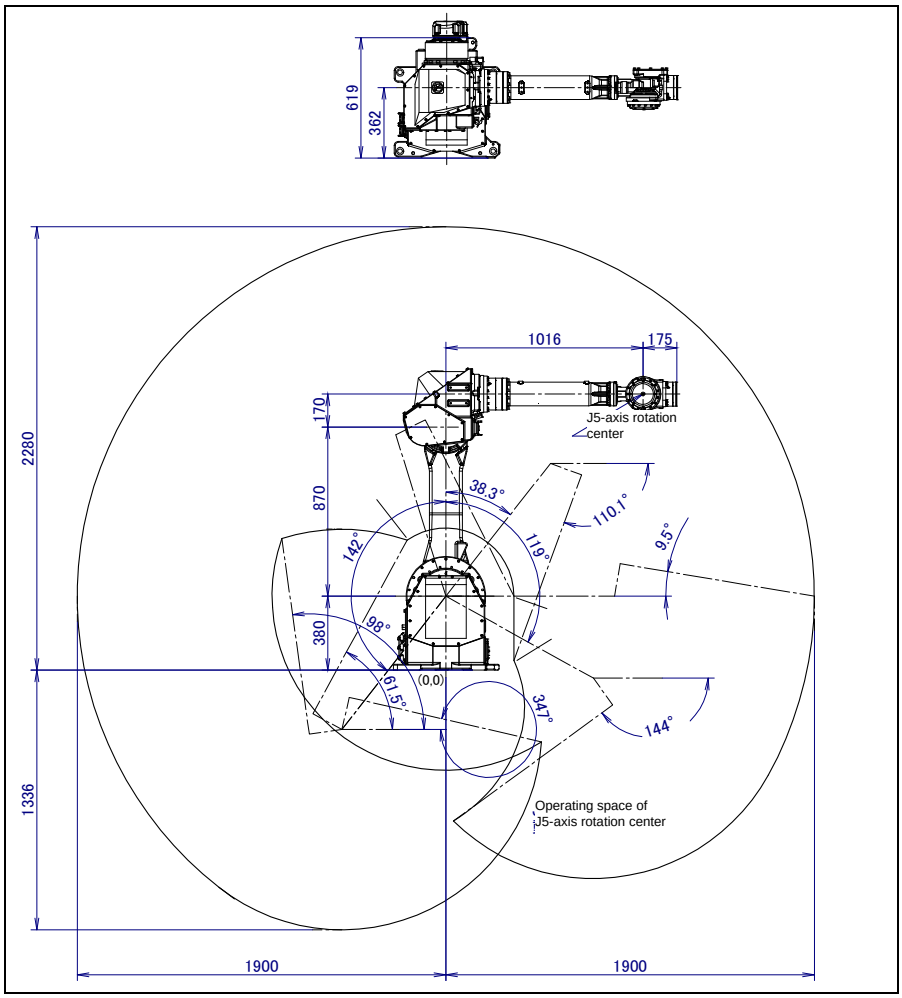


Fig. 3.2 Operating space

3.3 ZERO POINT POSITION AND MOTION LIMIT

Zero point and software motion limit are provided for each controlled axis. The robot cannot exceed the software motion limit unless there is a failure of the system causing loss of zero point position or there is a system error.

Exceeding the software motion limit of a controlled axis is called overtravel (OT). Overtravel is detected at both ends of the motion limit for each axis.
In addition, the motion range limit by a mechanical stopper or limit switch is also prepared to improve safety.

Fig. 3.3 (a) shows position of mechanical stopper.
Fig. 3.3 (b) shows the zero point of each axis. Fig. 3.3 (c) to Fig. 3.3 (f) show the motion limits and mechanical stopper positions of the individual axes.

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

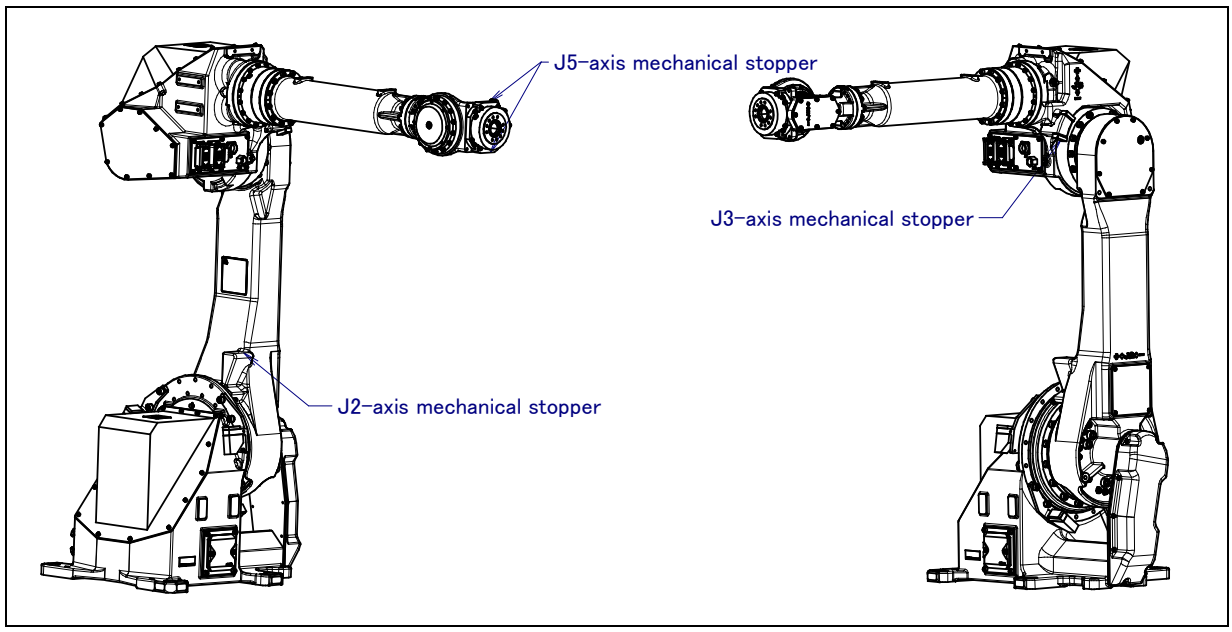


Fig. 3.3 (a) Position of mechanical stopper

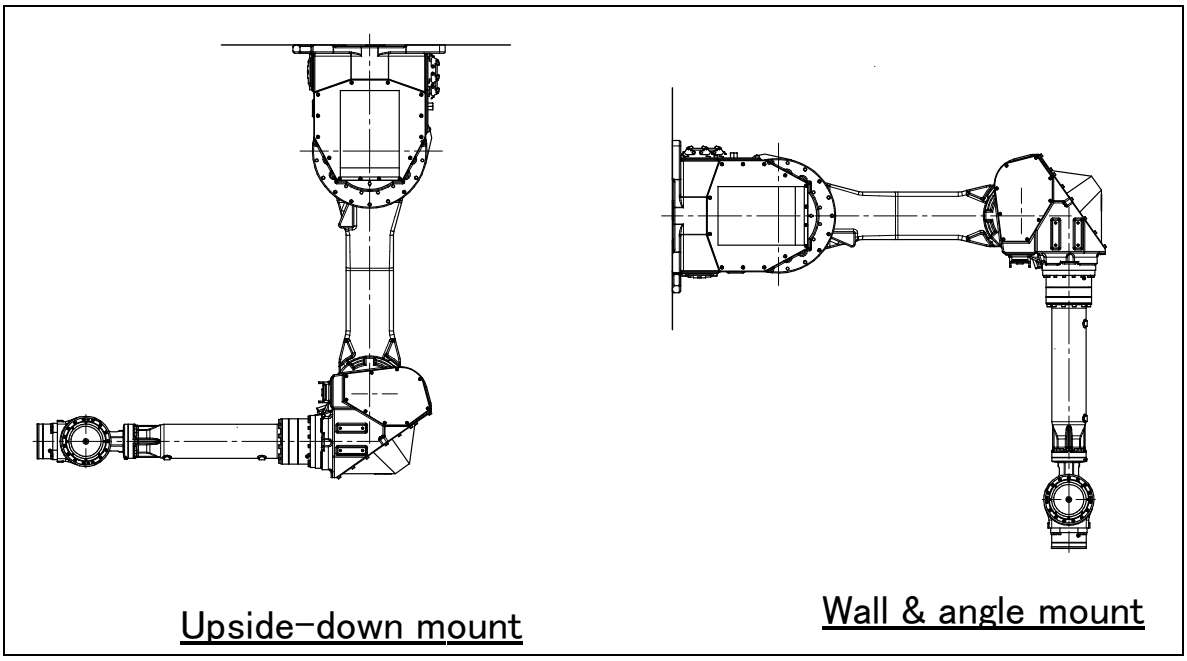


Fig.3.3 (b) Zero point position for each installation type

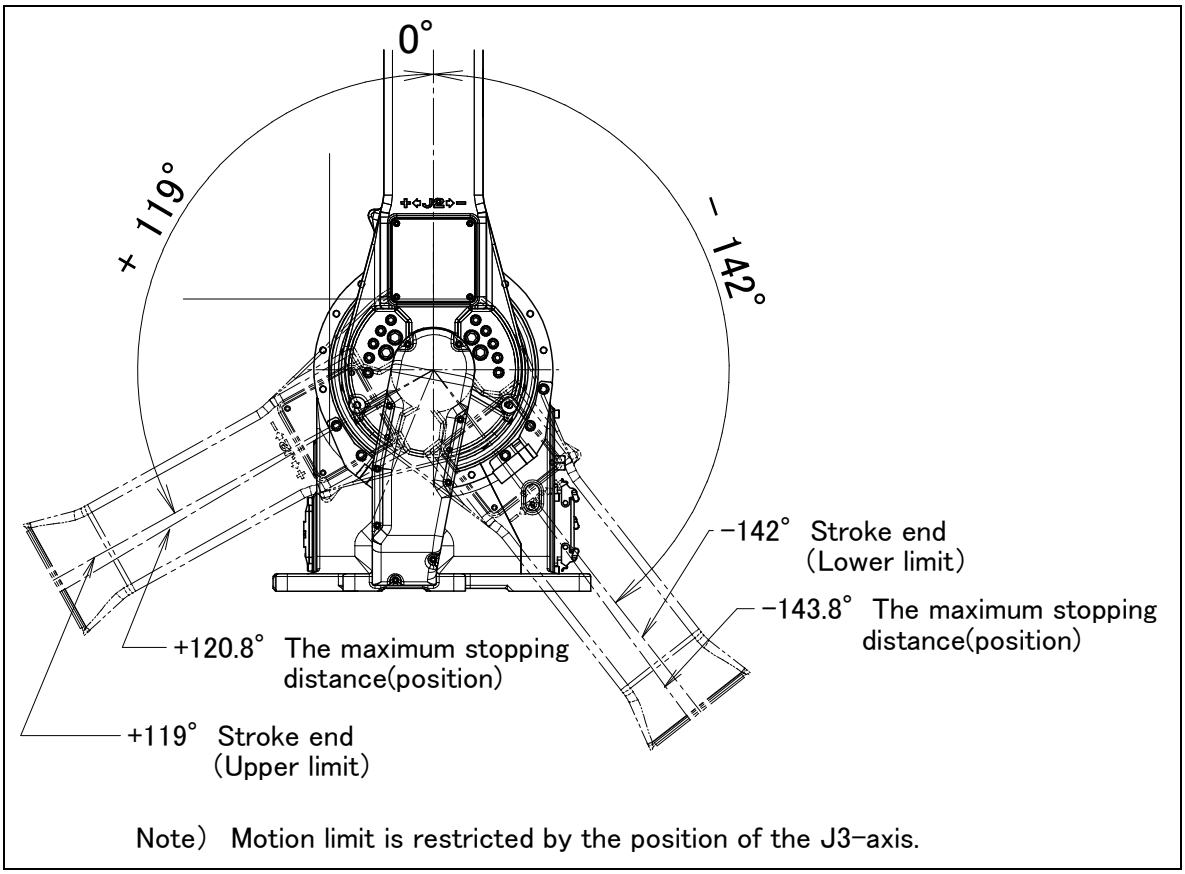


Fig. 3.3 (c) J2-axis motion limit

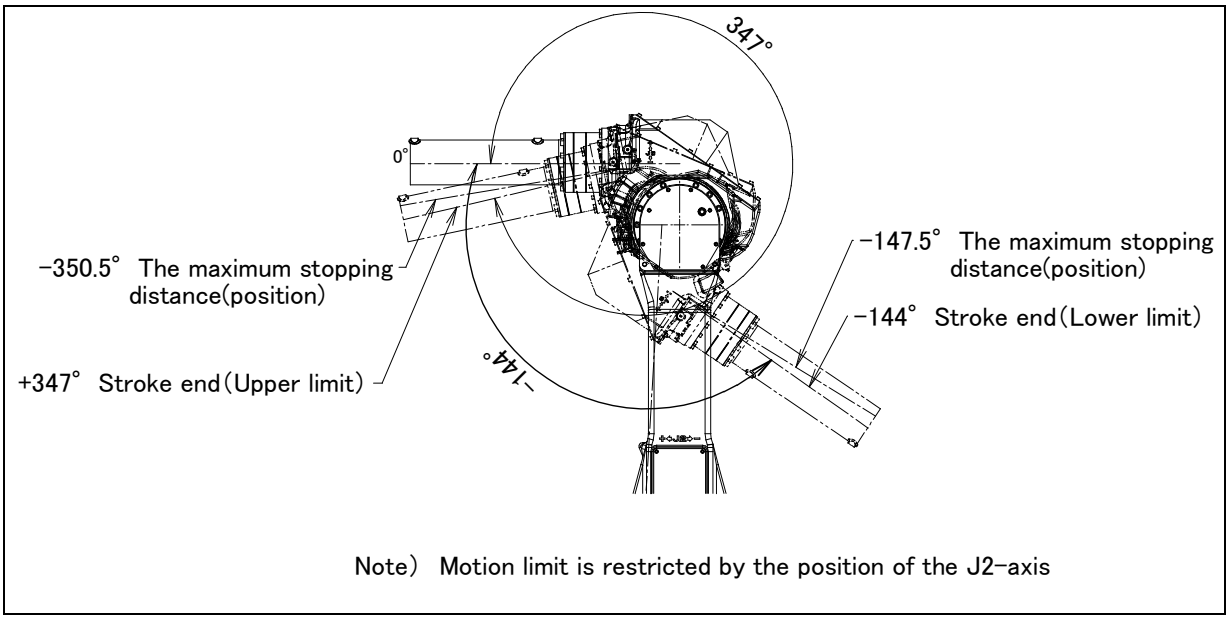


Fig. 3.3 (d) J3-axis motion limit

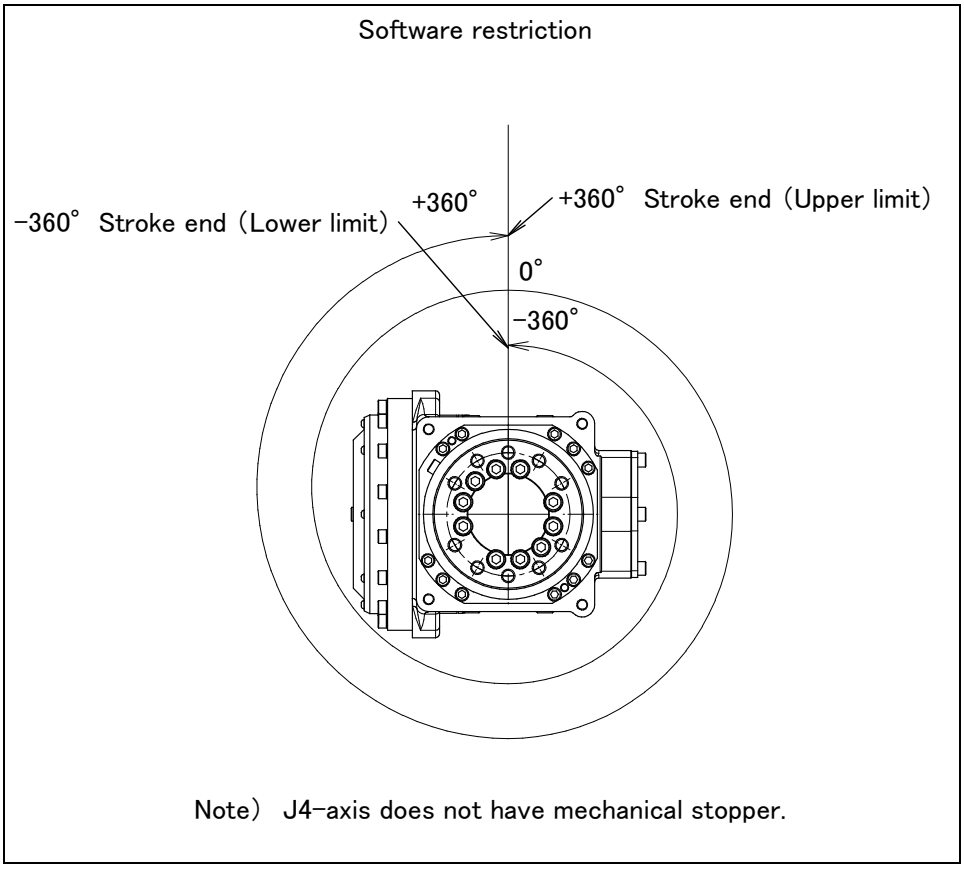


Fig. 3.3 (e) J4-axis motion limit

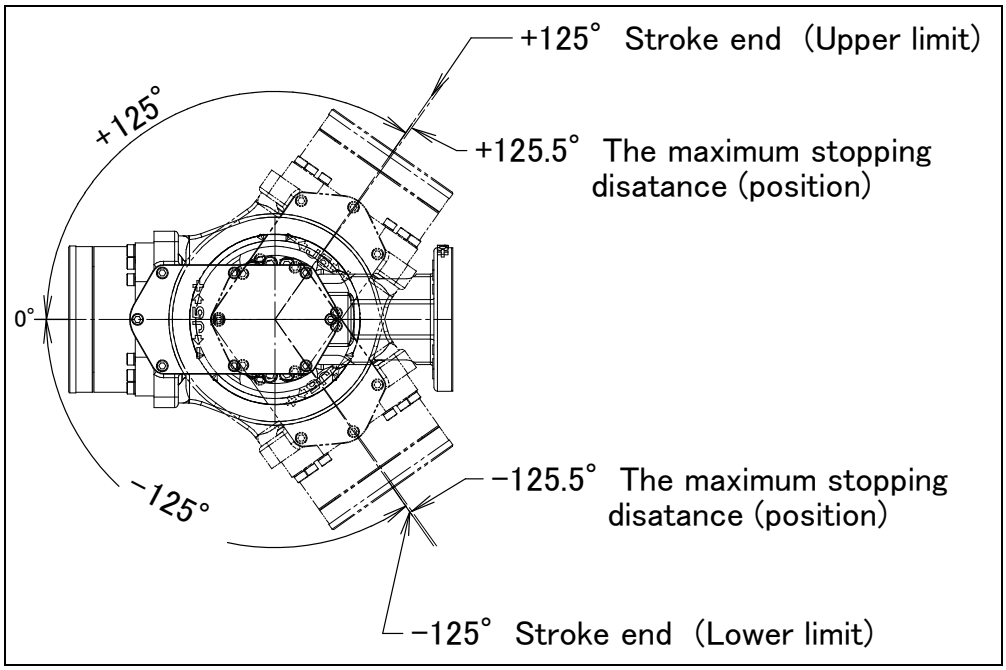


Fig. 3.3 (f) J5-axis motion limit

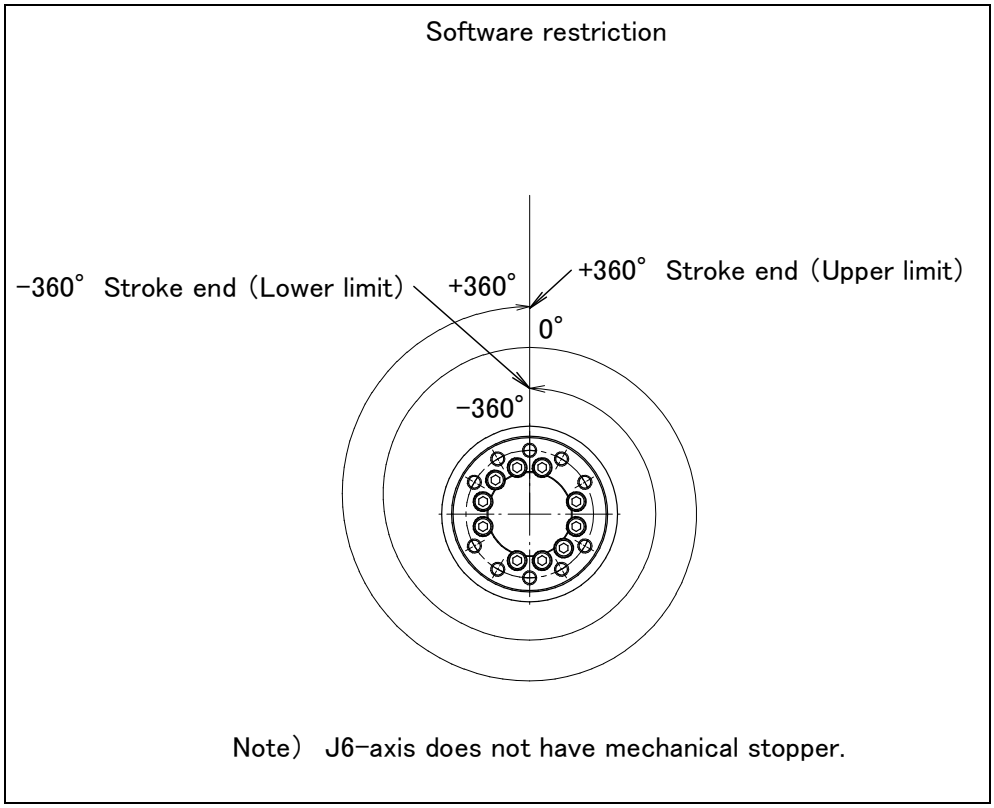


Fig. 3.3 (g) J6-axis motion limit

3.4 WRIST LOAD CONDITIONS

Fig. 3.4 (a), (b) is diagrams to limit loads applied to the wrist. Apply a load within the region indicated in the graph.

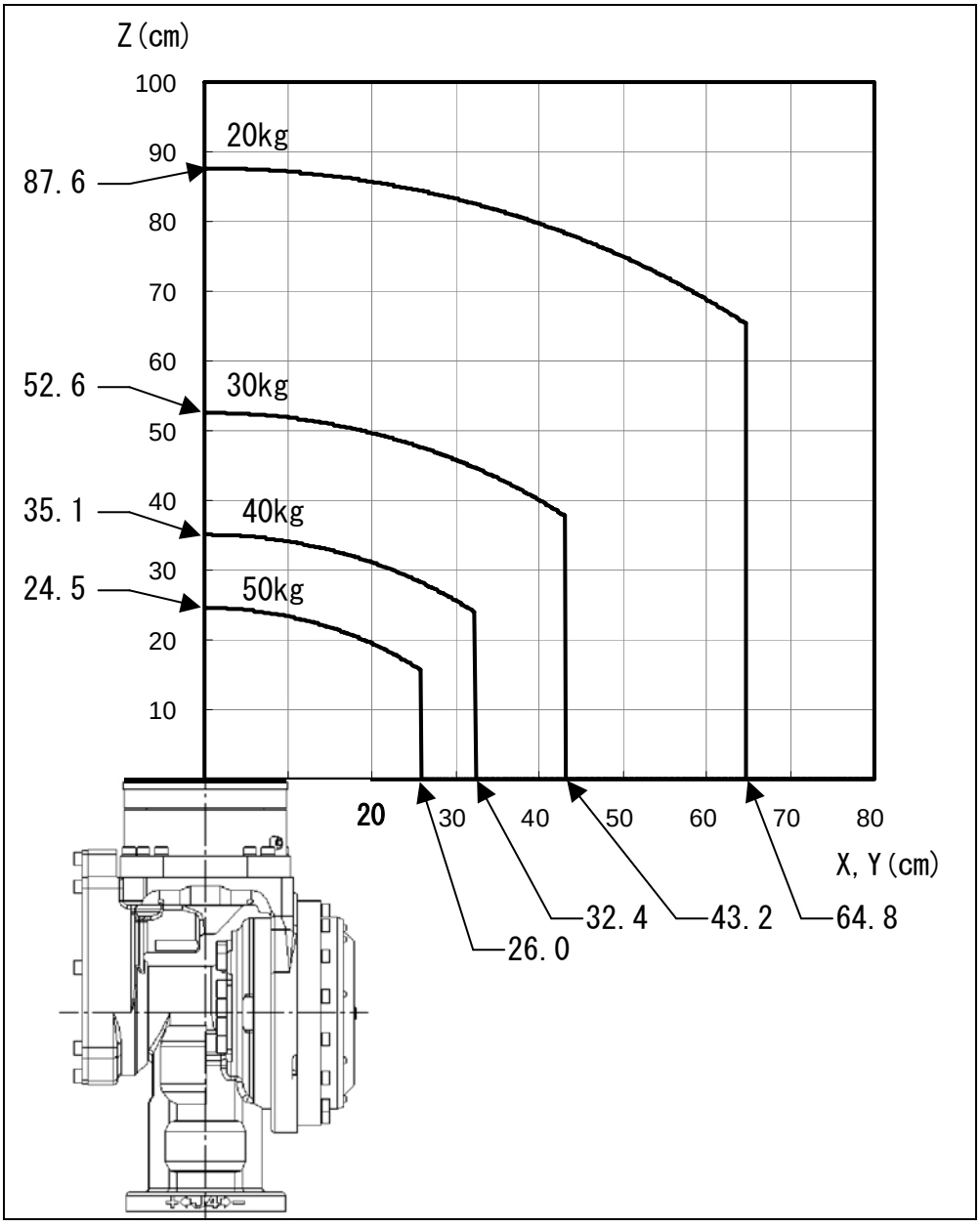


Fig. 3.4 (a) Wrist load diagram (M-710*i*C/50T)

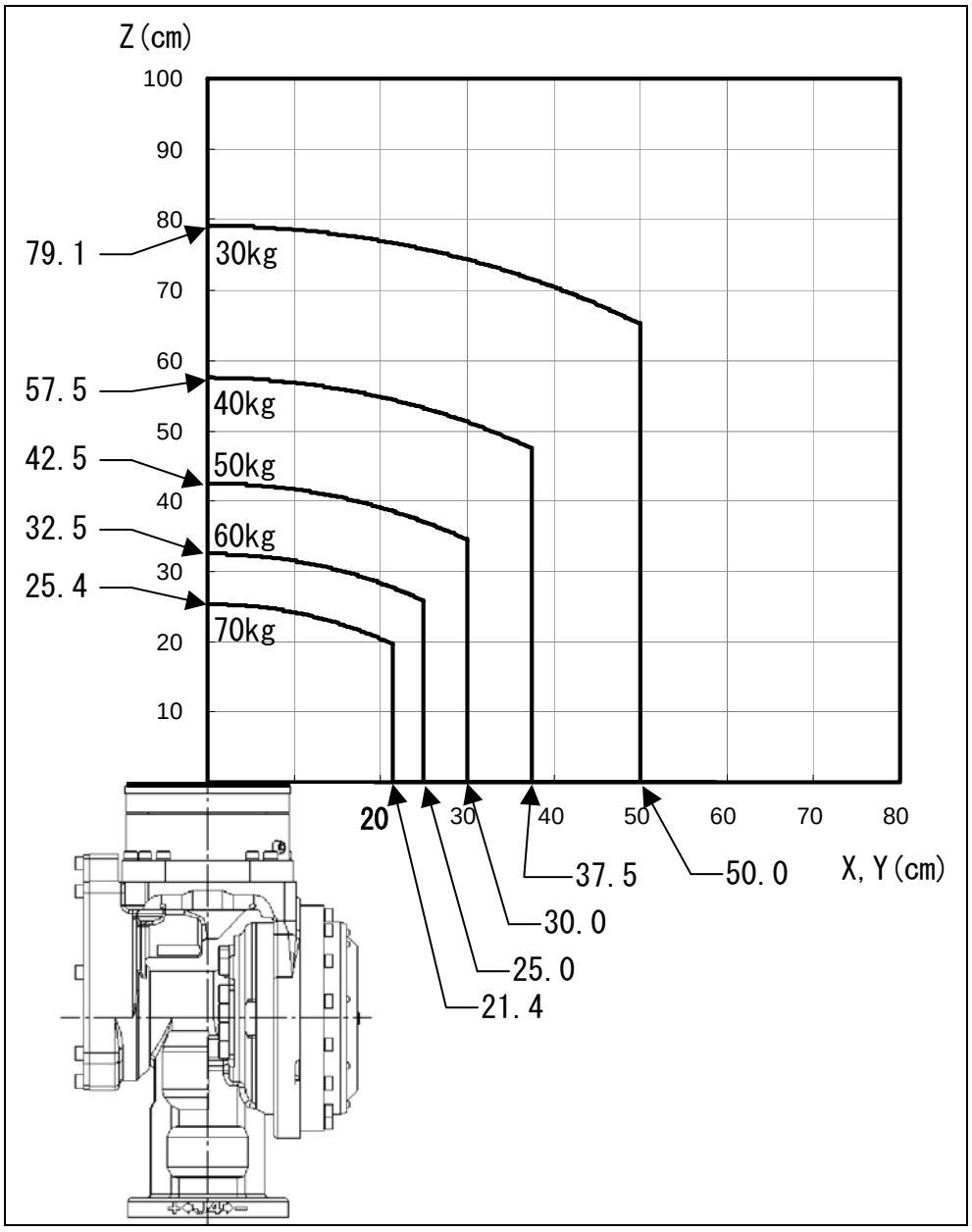


Fig. 3.4 (b) Wrist load diagram (M-710*i*C/70T)

3.5 LOAD CONDITION ON J3 CASING

Table 3.5 (a), (b) and Fig. 3.5 shows J3 casing load condition.
(The J3 casing load weight is limited according to the wrist load weight.)

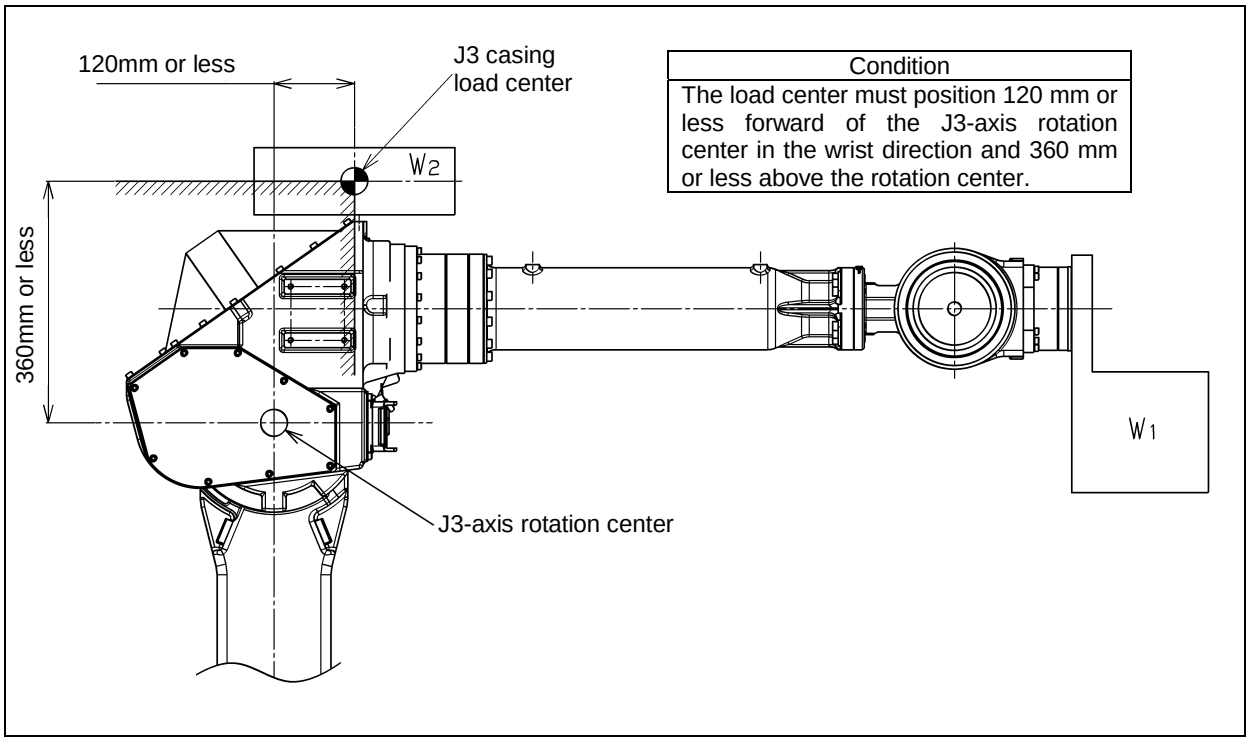


Fig. 3.5 J3 casing load condition (M-710*i*C/50T/70T)

Table 3.5 (a) J3 casing load condition (M-710*i*C/50T)

Wrist load weight W_1	**J3 casing load weight** W_2
43 kg or less	15 kg or less
Equal to or more than 43 kg and equal to or less than 50 kg	$W_2 \le -\frac{15}{7} \times (50 - W_1[kg])$

Table 3.5 (b) J3 casing load condition (M-710*i*C/70T)

Wrist load weight W_1	**J3 casing load weight** W_2
63 kg or less	15 kg or less
Equal to or more than 63 kg and equal to or less than 70 kg	$W_2 \le \frac{15}{7} \times (70 - W_1[kg])$

⚠ CAUTION
- Do not put load on J3 arm. (There is no problem for putting load on J3 casing.)
- If equipment is installed to J3 arm, it is dangerous because it rotate with J3 arm.
- If you put load on J3 arm, unavoidably, treat it as wrist load.

4 EQUIPMENT INSTALLATION TO THE ROBOT

4.1 END EFFECTOR INSTALLATION TO WRIST

Fig. 4.1 (a) to (c) are the diagrams for installing end effectors on the wrist. Select screws and positioning pins of a length that matches the depth of the tapped holes and pin holes. Fasten the bolt for fixing the end effector with following torque.

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

Table 4.1 Hexagon socket head bolt (Steel: strength rating of 12.9)

Nominal diameter	Tightening torque N·m (kgf·cm)	
	Upper limit	Lower limit
M8	32 (330)	23 (230)
M10	66 (670)	46 (470)

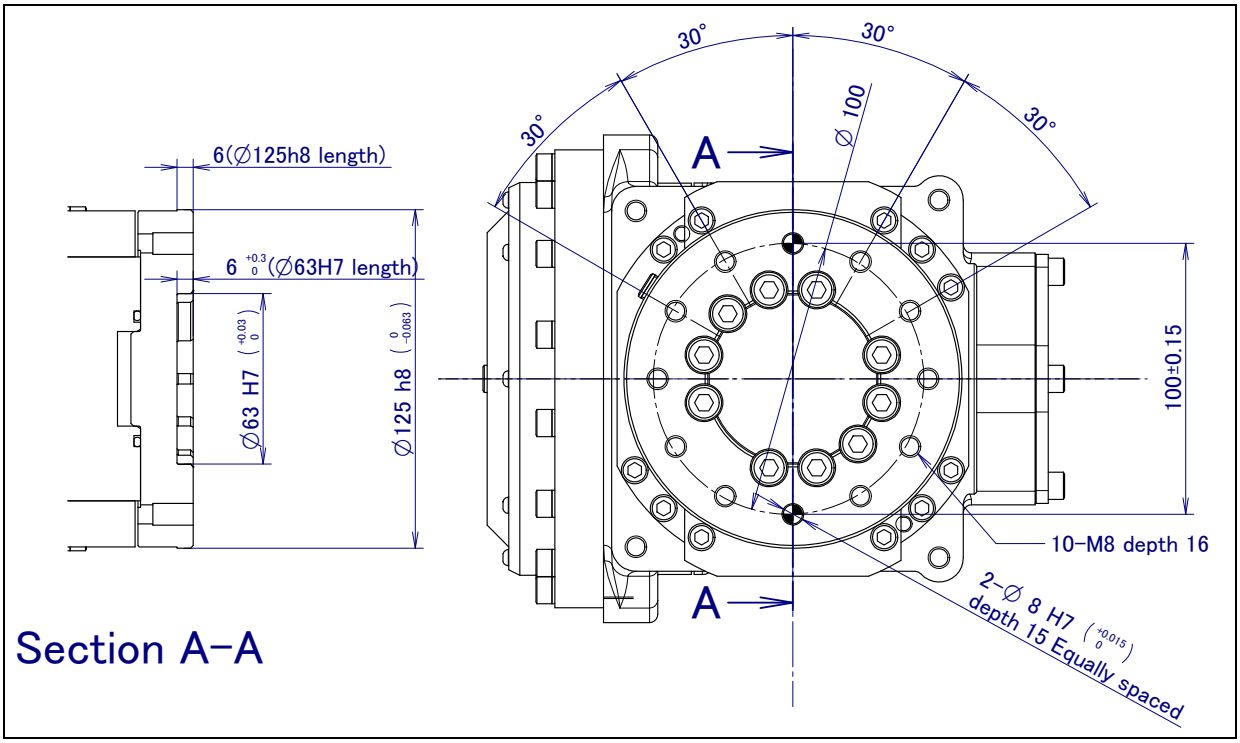


Fig. 4.1 (a) ISO flange, ISO rust protection flange

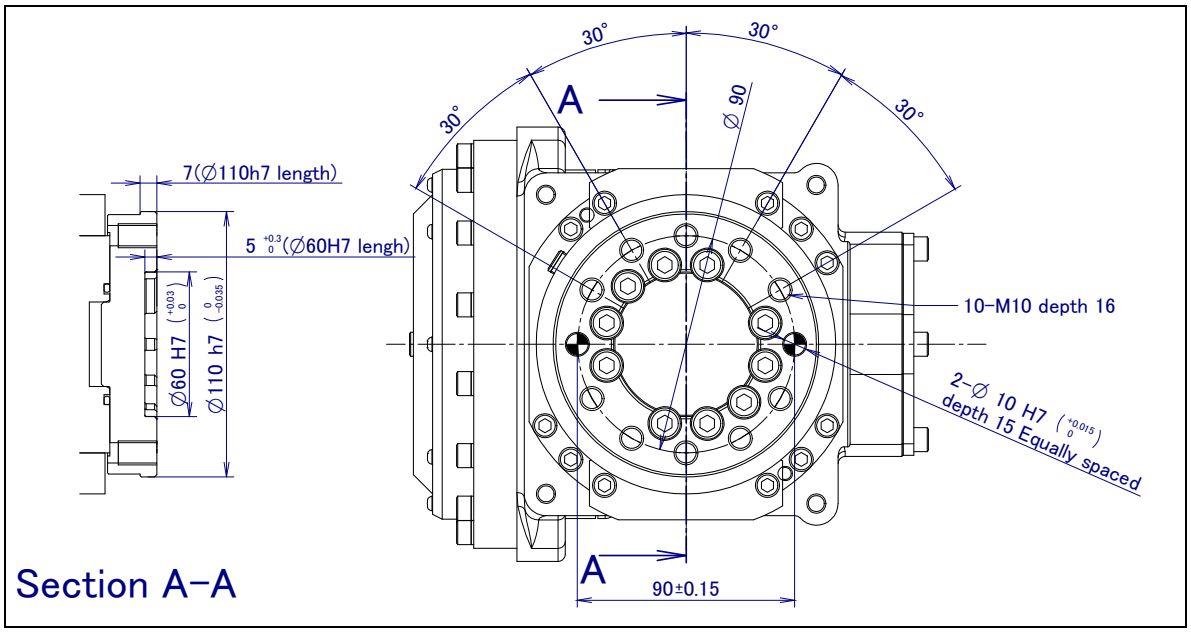


Fig. 4.1 (b) FANUC flange

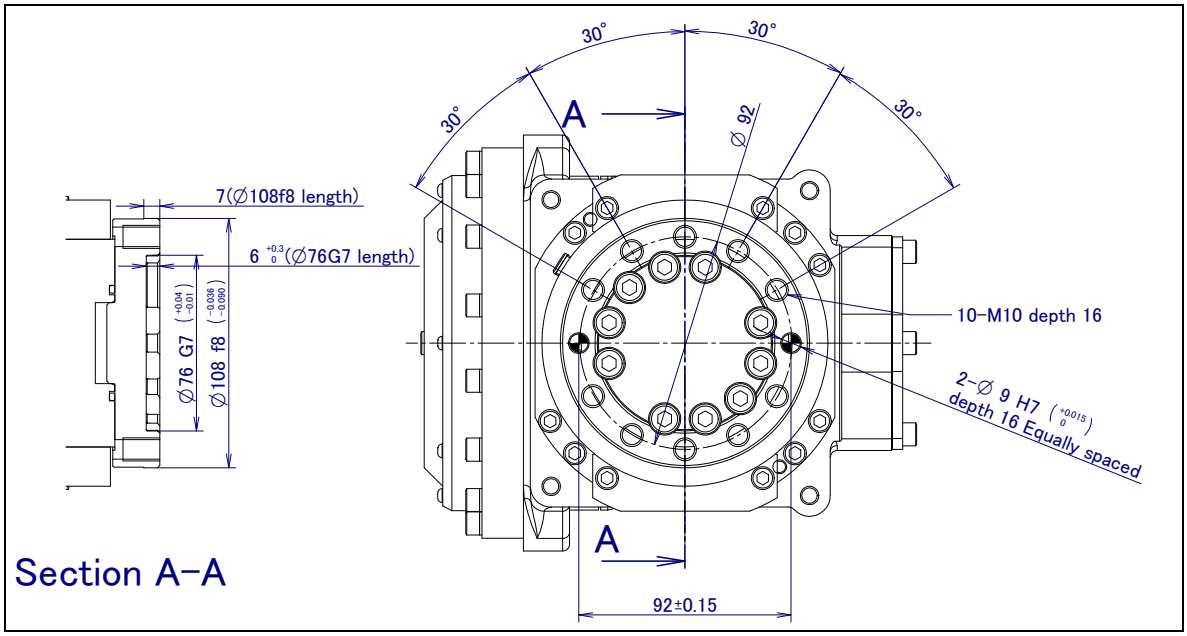


Fig. 4.1 (c) Special flange

4.2 EQUIPMENT MOUNTING FACE

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

⚠ CAUTION

1 Never perform additional machining operations such as drilling or tapping on the robot body. This can seriously affect the safety and functions of the robot.
2 Note that the use of a tapped hole not shown in the following figure is not assured. Please do not tighten both with the tightening bolts used for mechanical unit.
3 Equipment should be installed so that mechanical unit cable does not interfere. If equipment interfere, the mechanical unit cable might be disconnected, and unexpected troubles might occur.
4 ・ Do not put load on J3 arm. (There is no problem for putting load on J3 casing.)
・ If equipment is installed to J3 arm, it is dangerous because it rotate with J3 arm.
・ If you put load on J3 arm, unavoidably, treat it as wrist load.

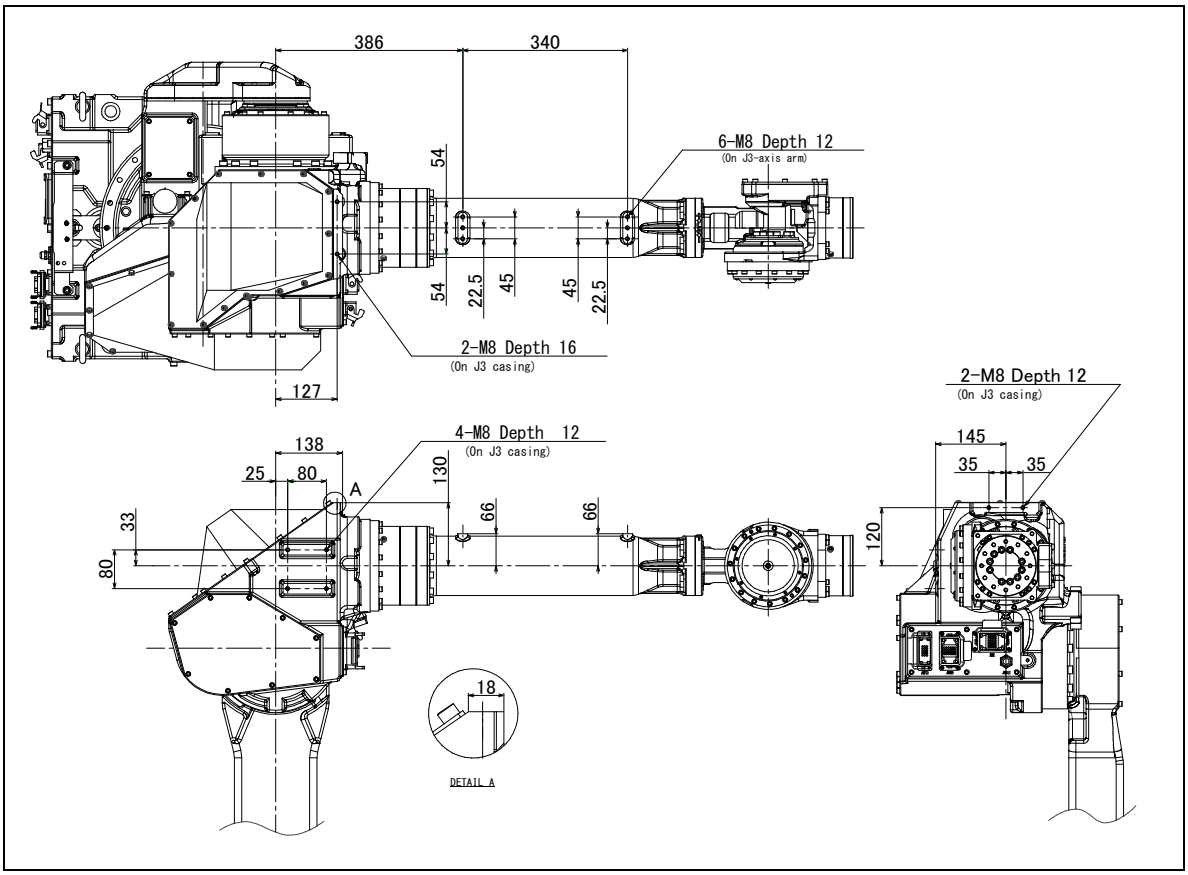


Fig. 4.2 Equipment mounting surfaces

4.3 LOAD SETTING

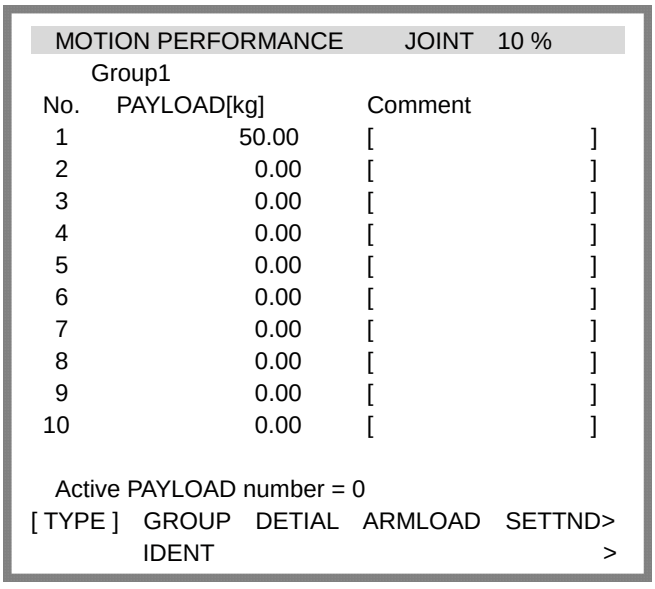
⚠ CAUTION

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

2 WHEN PERFORMING LOAD ESTIMATION AFTER PARTS REPLACEMENT
If wrist axes (J5/J6-axis) motors or reducers are replaced, estimation accuracy may go down. Perform the calibration for load estimation before performing load estimation. Refer to below.
- Section 9.15 "LOAD ESTIMATION" in R-30*i*A Controller Spot tool+ OPERATOR'S MANUAL (B-83124EN-1).
- Section 9.15 "LOAD ESTIMATION" in R-30*i*A Controller Handling tool OPERATOR'S MANUAL (B-83124EN-2).
- Section 9.15 "LOAD ESTIMATION" in R-30*i*A Controller Arc tool OPERATOR'S MANUAL (B-83124EN-3).
- Section 9.15 "LOAD ESTIMATION" in R-30*i*A Controller Dispense tool OPERATOR'S MANUAL (B-83124EN-4).
- Chapter 9 "LOAD ESTIMATION" in R-30*i*B/R-30*i*B Mate/R-30*i*B Plus/R-30*i*B Mate Plus Controller Optional Function OPERATOR'S MANUAL (B-83284EN-2).

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



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

```
MOTION PAYLOAD SET        JOINT          100 %

      Group1
1     Schedule No [     1]:     [ Comment          ]
2     PAYLOAD                   [ kg ]          50.00
3     PAYLOAD  CENTER  X        [ cm ]         -26.00
4     PAYLOAD  CENTER  Y        [ cm ]           0.00
5     PAYLOAD  CENTER  Z        [ cm ]          15.00
6     PAYLOAD  INERTIA X        [kgfcmsˆ2]       4.307
7     PAYLOAD  INERTIA Y        [kgfcmsˆ2]       6.699
8     PAYLOAD  INERTIA Z        [kgfcmsˆ2]       4.318

 [ TYPE ]  GROUP  NUMBER  DEFAULT  HELP
```

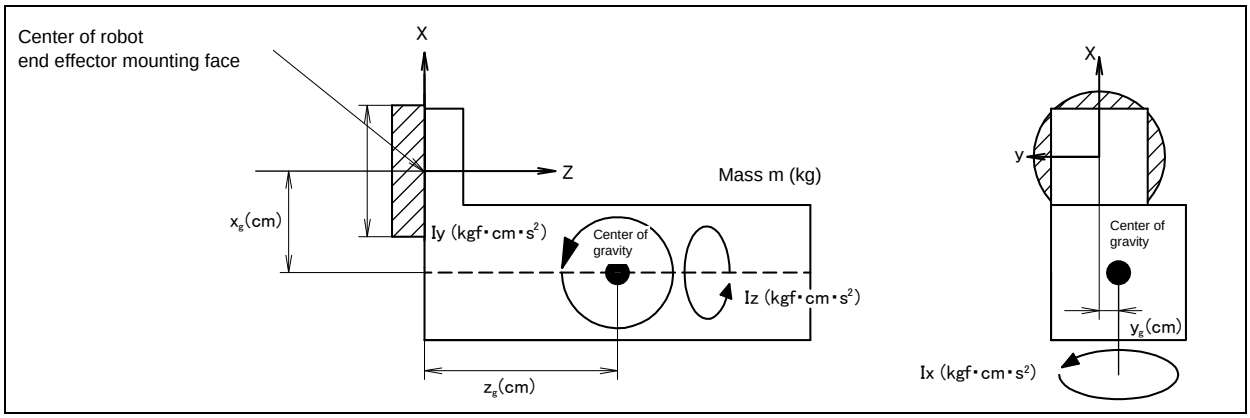


Fig. 4.3 Standard tool coordinate

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

7 Press F3 ([NUMBER]) will bring you to the MOTION PAYLOAD SET screen for another condition

8 Press [PREV] key to return to the list screen. Press F5 SETIND, and enter a desired load setting condition number.

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

```
MOTION ARMLOAD SET        JOINT          100 %

      Group1
1     ARM LOAD AXIS #1 [ kg ]          0.00
2     ARM LOAD AXIS #3 [ kg ]         15.00

 [ TYPE ]  GROUP            DEFAULT  HELP
```

10 Specify the mass of the loads on the J2 base and J3 casing. When you enter ARM LOAD AXIS #1[kg] (Mass of the load on the J2 base) and ARM LOAD AXIS #3[kg] (Mass of the load on the J3 arm), the confirmation message "Path and Cycletime will change. Set it?" appears. Select F4 YES or F5 NO. Once the mass of a device is entered, it is put in effect by turning the power off and on again.

5 PIPING AND WIRING TO THE END EFFECTOR

⚠ WARNING

- Only use appropriately-specified mechanical unit cables.
- Do not add user cables or hoses inside of the mechanical unit.
- Please do not obstruct the movement of the mechanical unit when cables are added to 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. 5)
- 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.

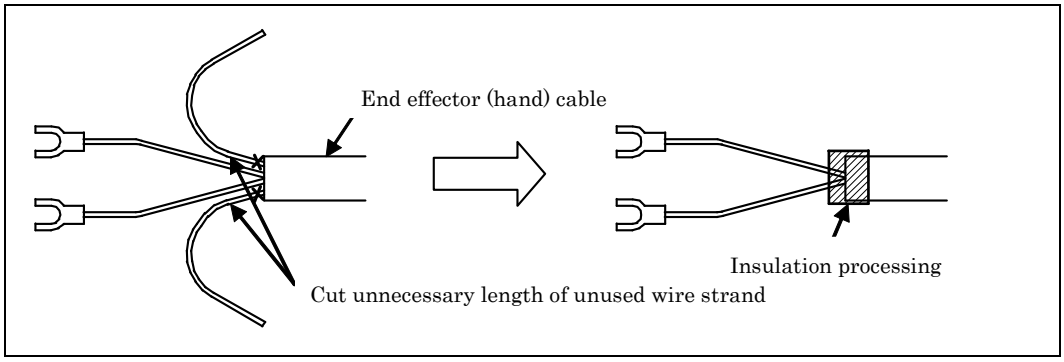


Fig. 5 Treatment method of end effector (hand) cable

5.1 AIR SUPPLY (OPTION)

Robot has air inlet and air outlet on the side of the J1 base and the front of the J3 casing used to supply air pressure to the end effector. The connector is a Rc1/2 female (ISO).
Because couplings are not supplied, it will be necessary to prepare couplings, which suit to the hose size.

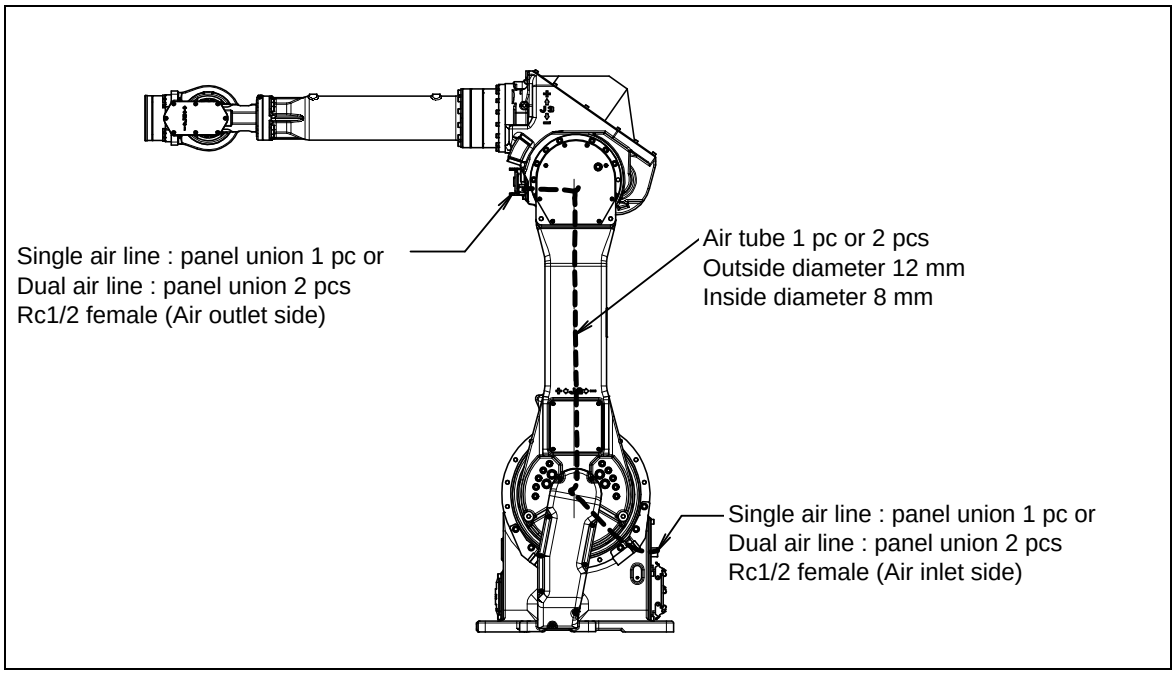


Fig. 5.1 Air supply (option)

5.2 AIR PIPING (OPTION)

Fig. 5.2 (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. A tap holes shown in Fig. 5.2 (b) are necessary for the installation of three points of air sets. Please prepare by customer.

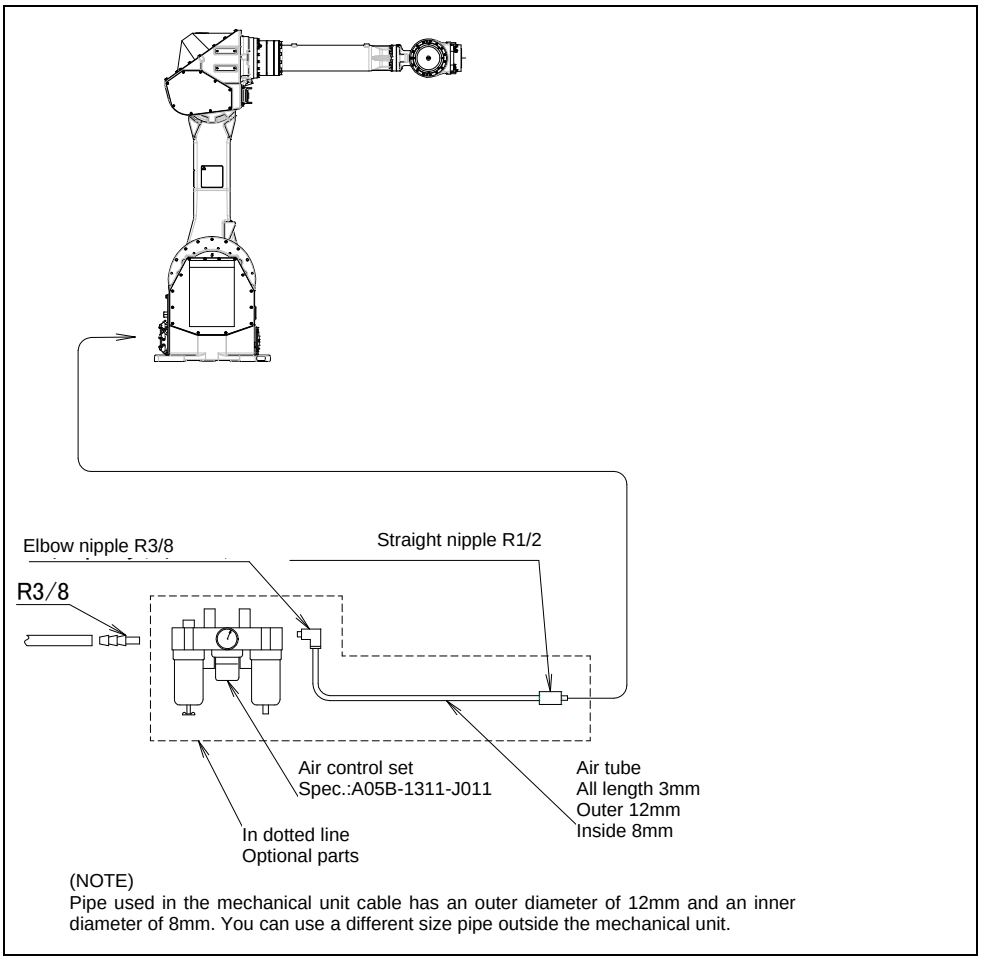


Fig. 5.2 (a) Air piping (option)

Air control set

For the lubricator of air control set, fill in turbine oil #90 to #140 to the specified level. The machine tool builder is required to prepare mounting bolts.

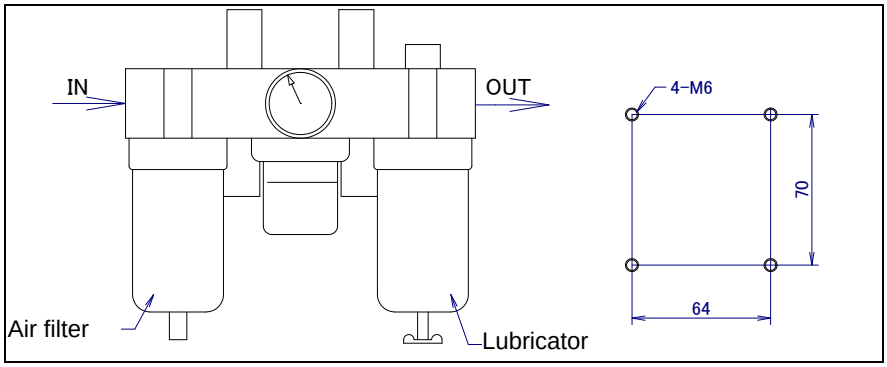


Fig. 5.2 (a) Air control set option (option)

NOTE
The capacity values of the robot is determined as follows.
These values must not be exceeded.

Air pressure	Supply air pressure	0.49 to 0.69MPa (5 to 7kgf/cm^2) Setting: 0.49MPa (5kgf/cm^2)
	Amount of consumption	Maximum instantaneous amount 150N//min (0.15Nm^3/min)

5.3 OPTION CABLE INTERFACE (OPTION)

Fig. 5.3 (a) to (i) show the position of the option cable interface. EE interface (RI/RO), user cable (signal line , signal line usable to force sensor and 3DL sensor and power line), camera cable, 3DL sensor, force sensor are prepared as options

NOTE

Each option cable is written like below on connector panel

EE interface	: EE
User cable (signal)	: AS
User cable (power)	: AP
User cable (signal usable to force sensor and 3DL sensor)	: ASi
Camera cable	: CAM
Force sensor, 3DL sensor cable	: SEN

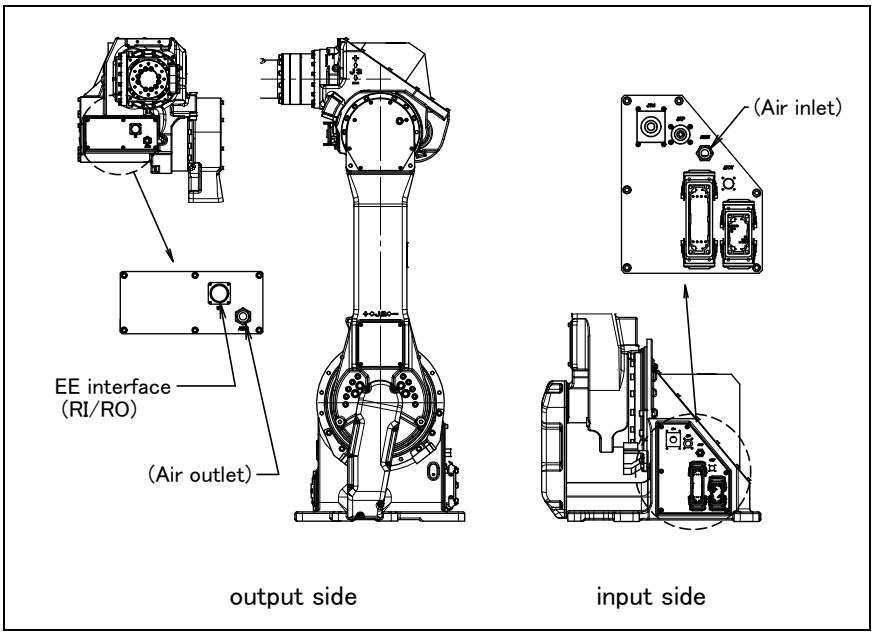


Fig. 5.3 (a) Position of air supply and option cable interface (RI/RO)
(When mechanical unit cable A05B-1125-H251 is specified)

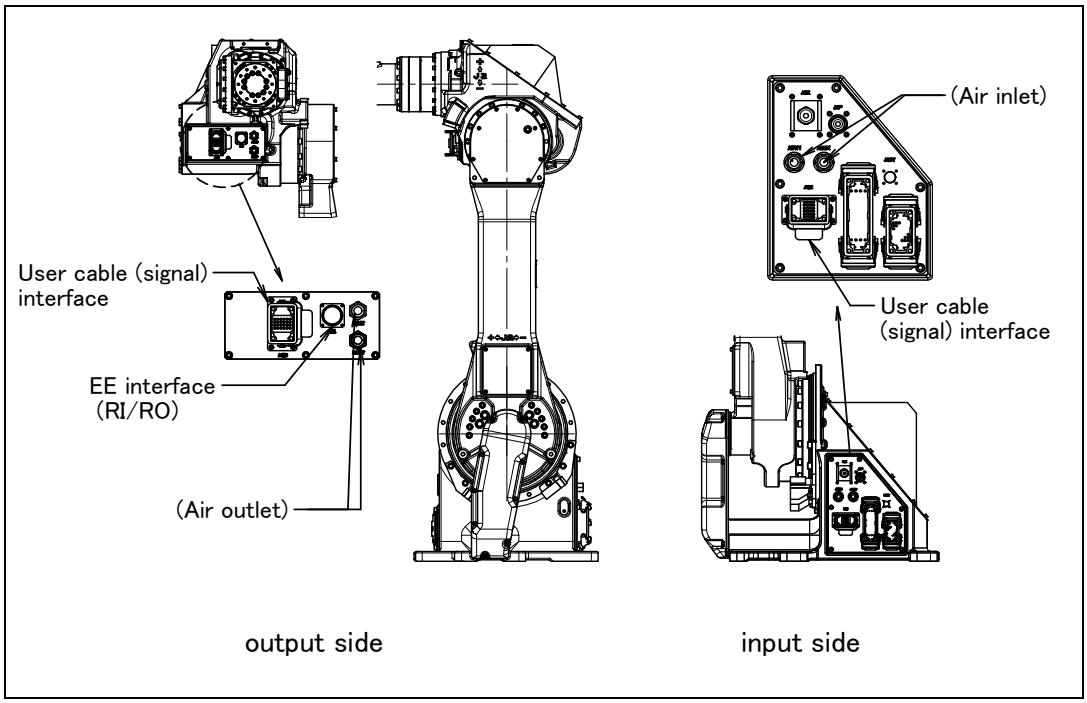


Fig. 5.3 (b) Position of air supply and option cable interface (RI/RO)
(When mechanical unit cable A05B-1125-H258 is specified)

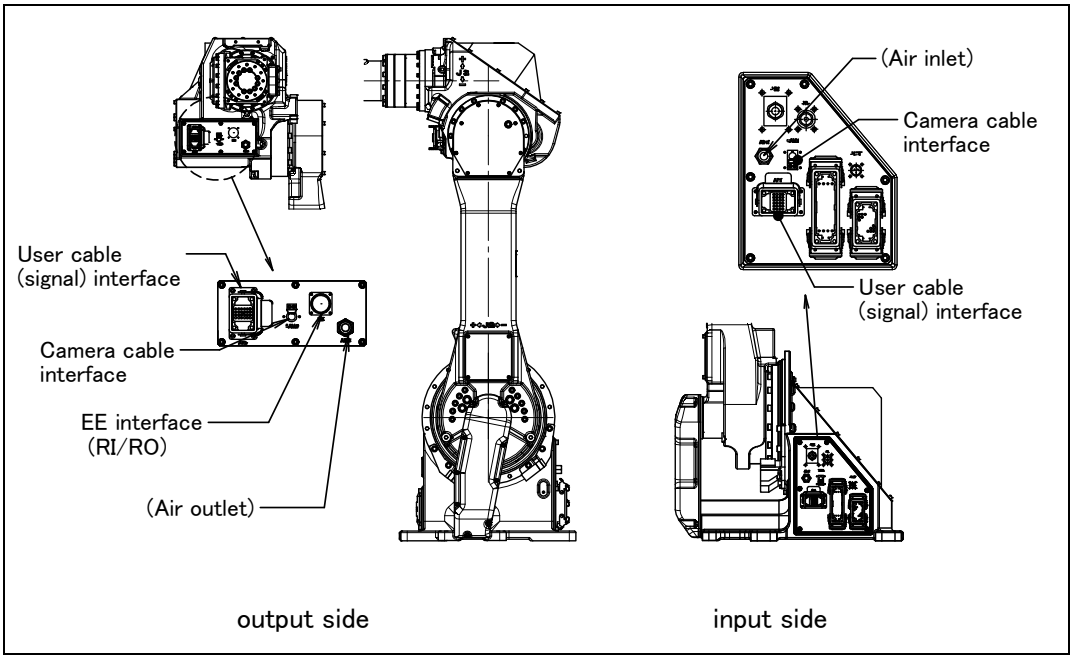


Fig. 5.3 (c) Position of air supply and option cable interface (RI/RO)
(When mechanical unit cable A05B-1125-H259 is specified)

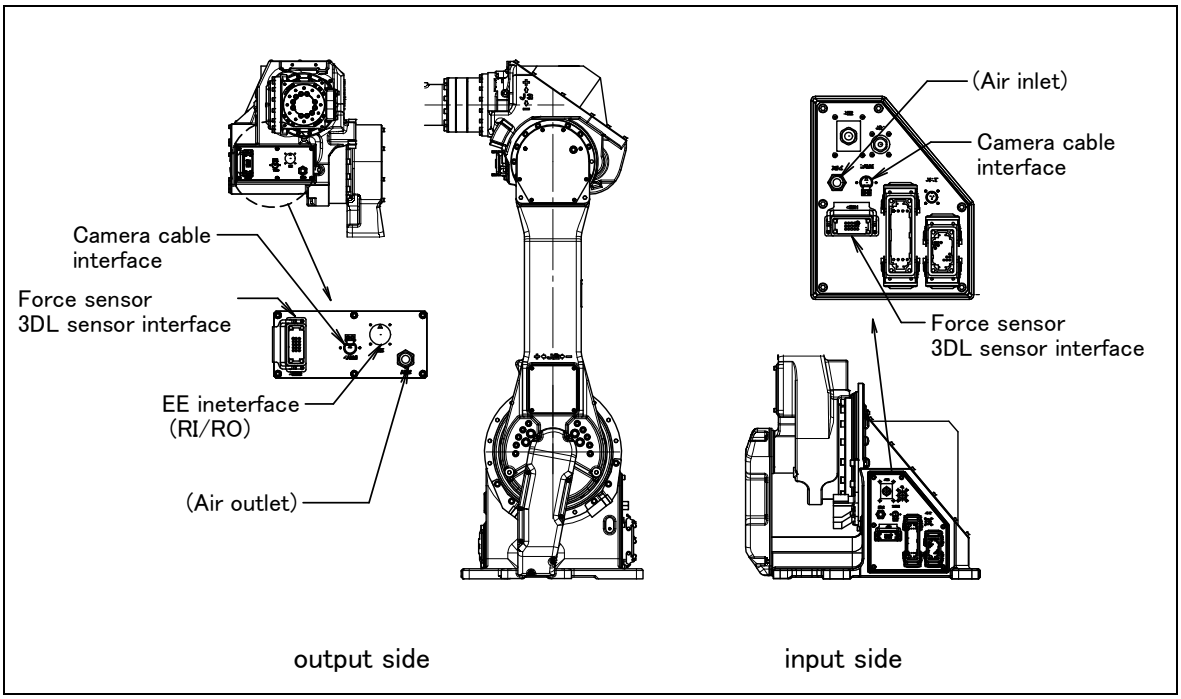


Fig. 5.3 (d) Position of air supply and option cable interface (RI/RO)
(When mechanical unit cable A05B-1125-H431 is specified)

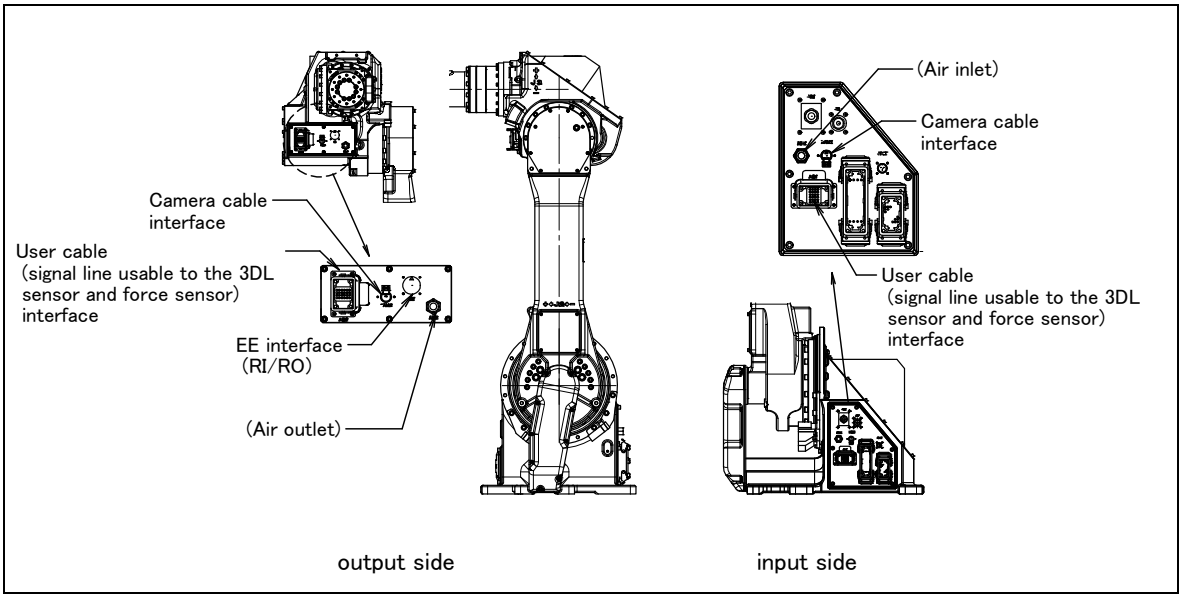


Fig. 5.3 (e) Position of air supply and option cable interface (RI/RO)
(When mechanical unit cable A05B-1125-H432 is specified)

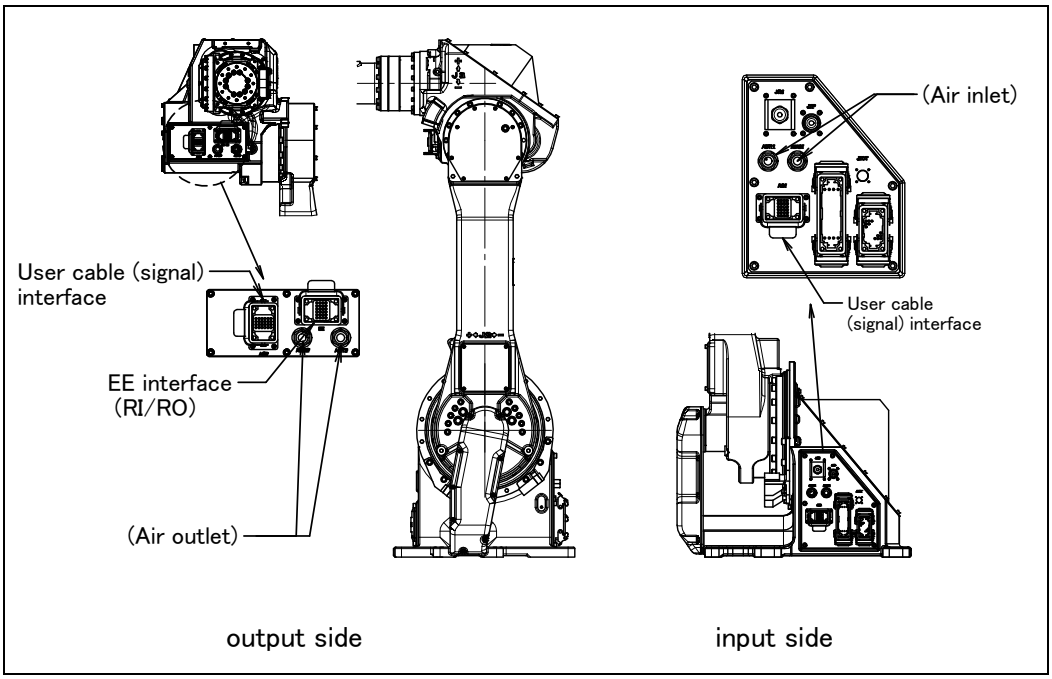


Fig. 5.3 (f) Position of air supply and option cable interface (RI/RO)
(When mechanical unit cable A05B-1125-H258 and severe dust/liquid protection is specified)

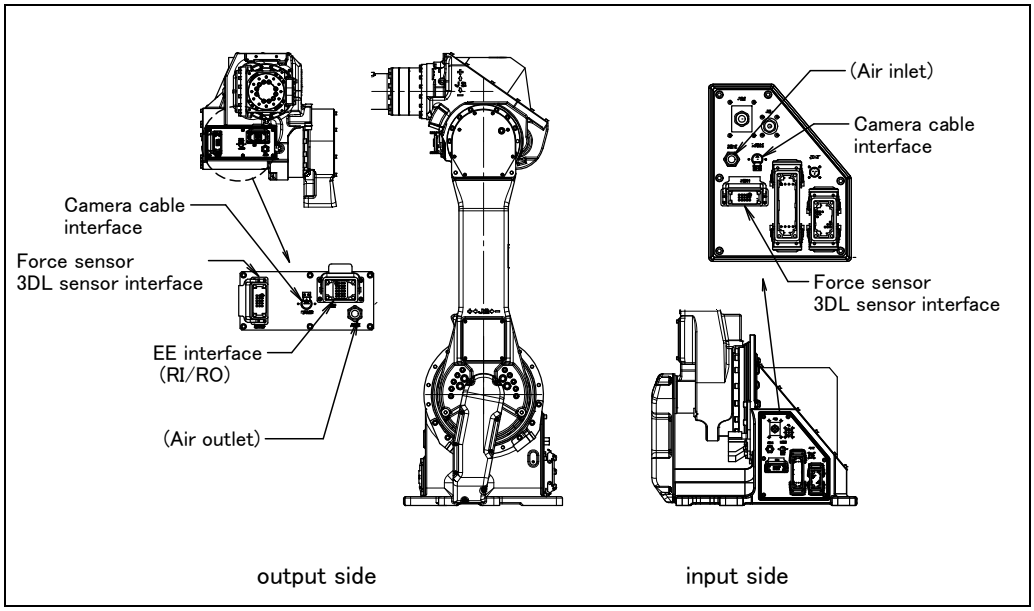


Fig. 5.3 (g) Position of air supply and option cable interface (RI/RO)
(When mechanical unit cable A05B-1125-H431 and severe dust/liquid protection is specified)

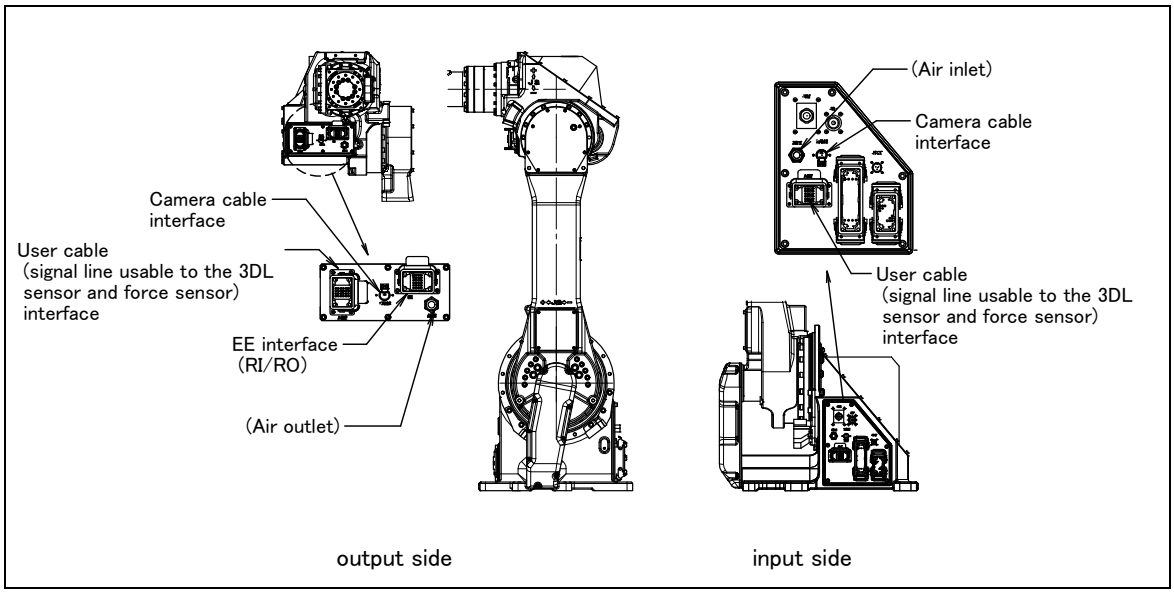


Fig. 5.3 (h) Position of air supply and option cable interface (RI/RO)
(When mechanical unit cable A05B-1125-H432 and severe dust/liquid protection is specified)

(1) EE interface (RI/RO)(Option)

Fig. 5.3 (i) and (j) show the pin layout for the EE interface (RI/RO). When severe dust/liquid protection package is specified, the connector has guide pins and bushes for preventing improper insertion. For cables prepared by the user, use these guide pins and bushes.

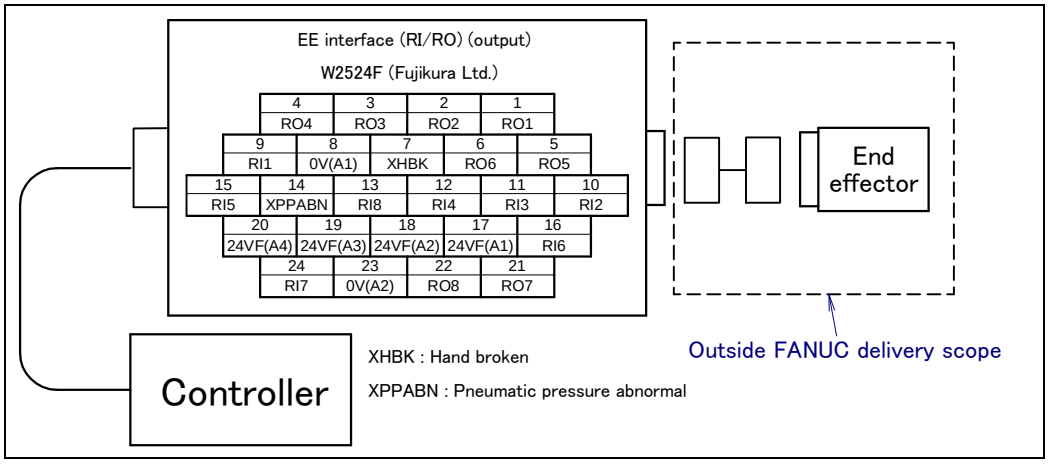


Fig. 5.3 (i) Pin layout for EE interface (RI/RO) (option)

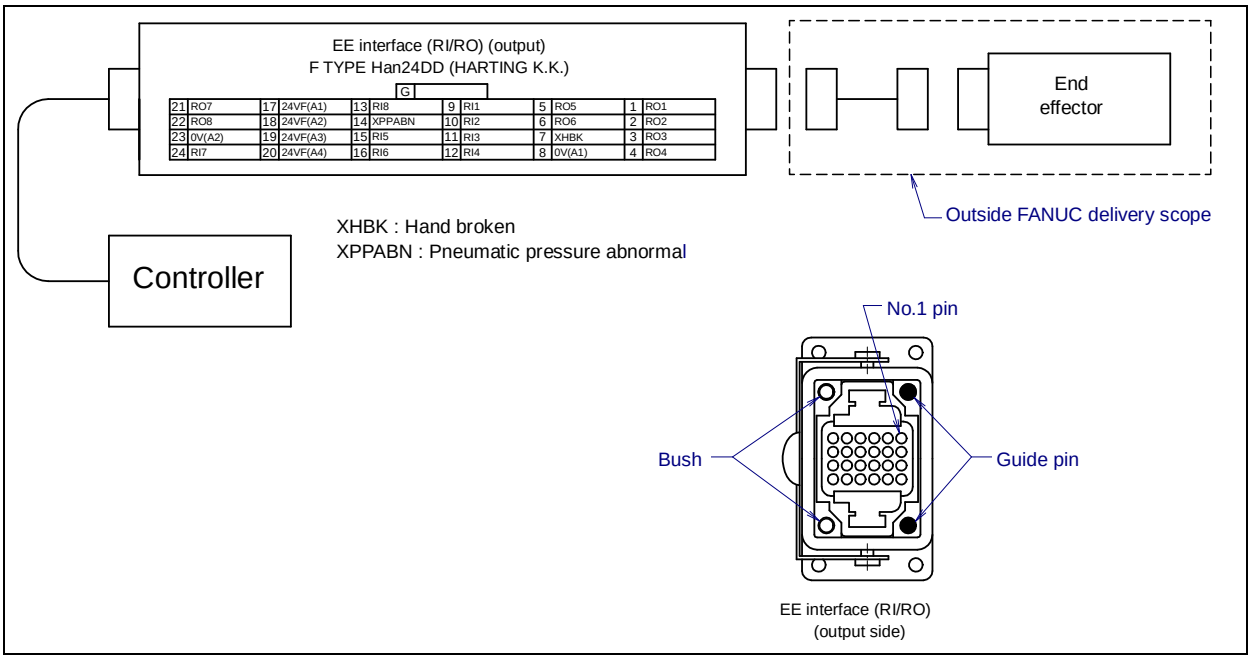


Fig. 5.3 (j) Pin layout for EE interface (RI/RO) (Severe dust/liquid protection package)

> ⚠ **CAUTION**
> For wiring of the peripheral device to the EE interface, refer to the Chapter 4 of CONNECTION section of CONTROLLER MAINTENANCE MANUAL, too.

(2) User cable (signal line) (AS) Interface (option)
Fig. 5.3 (k) shows pin layout for user cable (signal line) interface.
The connector has a code pin for preventing improper insertion. For cables prepared by the user, use this code pin.

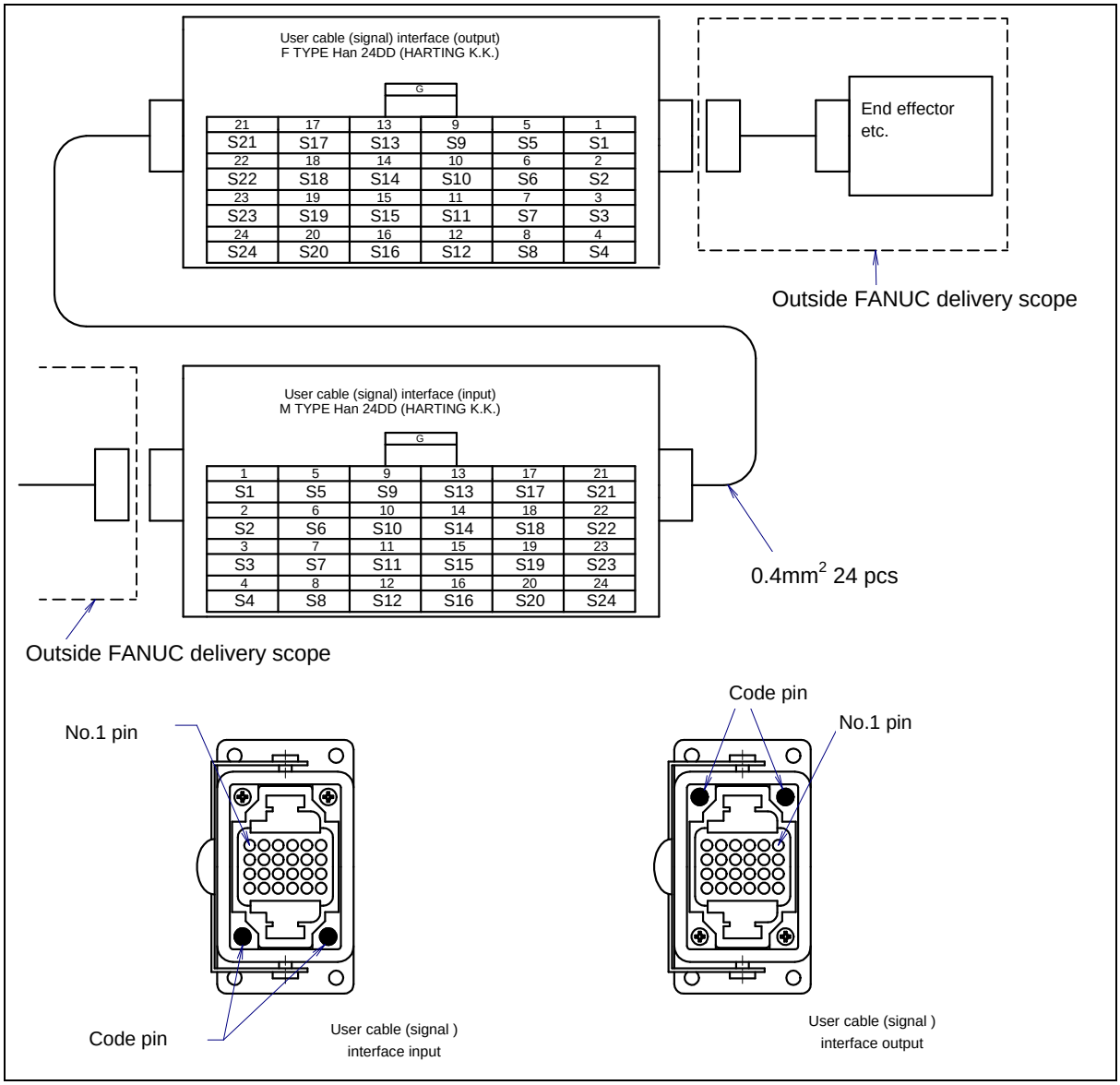


Fig. 5.3 (k) Pin layout for user cable (signal line) (AS) interface and code pin layout (option)

(3) User cable (signal line usable to force sensor and 3D Laser Vision sensor) (ASi) Interface (option)
Fig. 5.3 (l) shows the pin layout for the user cable (signal line usable to force sensor and 3D Laser Vision sensor) interface.
The connector has a code pin for preventing improper insertion. The code pin is required for the cable which is prepared by the user.

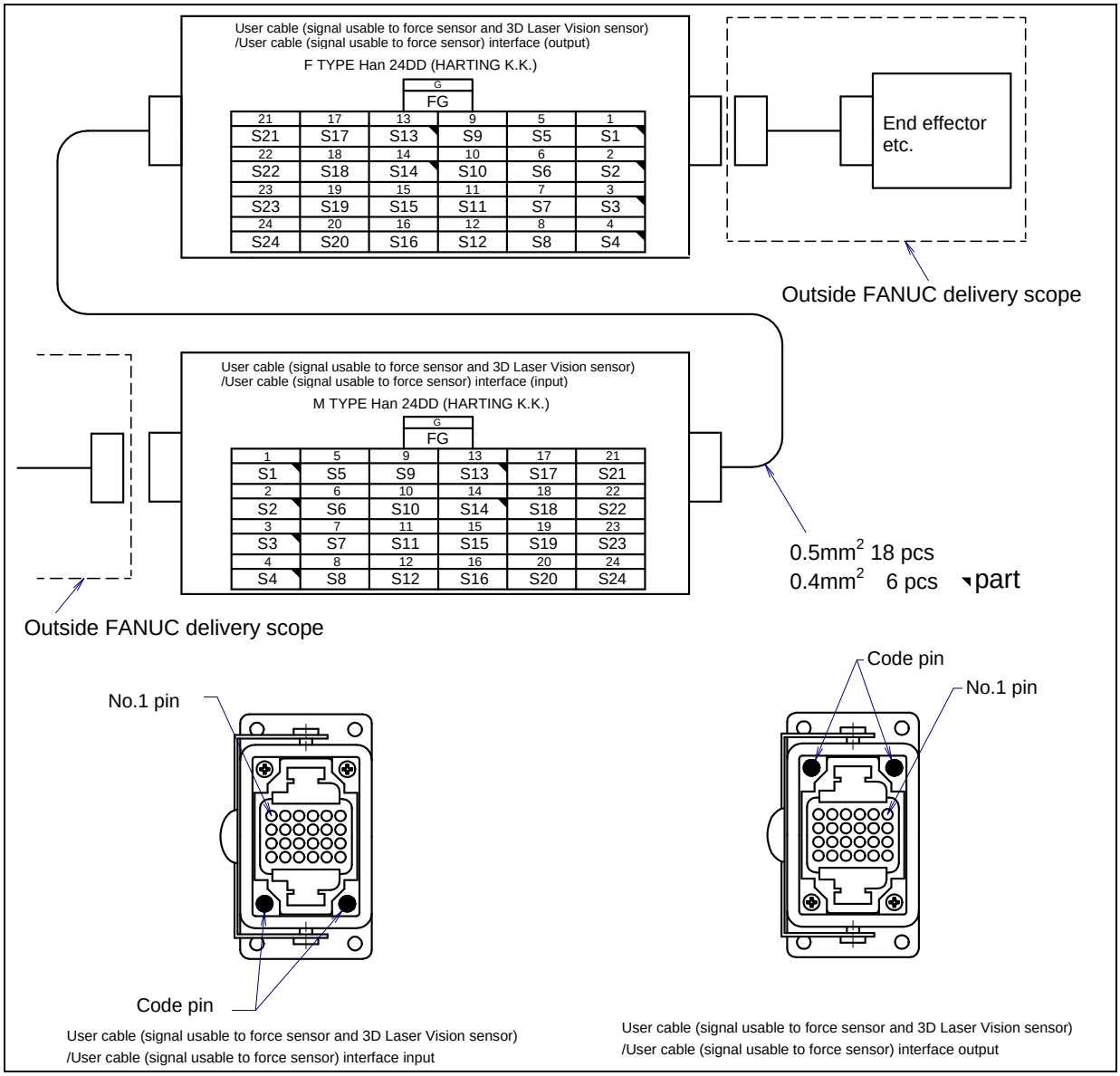


Fig. 5.3 (l) Pin layout for user cable (signal line usable to force sensor and 3D Laser Vision sensor) (ASi) interface and code pin layout (option)

(4) User cable (power line) (AP) Interface (option)
Fig. 5.3 (m) shows the pin layout for the user cable (power line) interface.
The connector has a code pin for preventing improper insertion. The code pin is required for the cable which is prepared by the user.

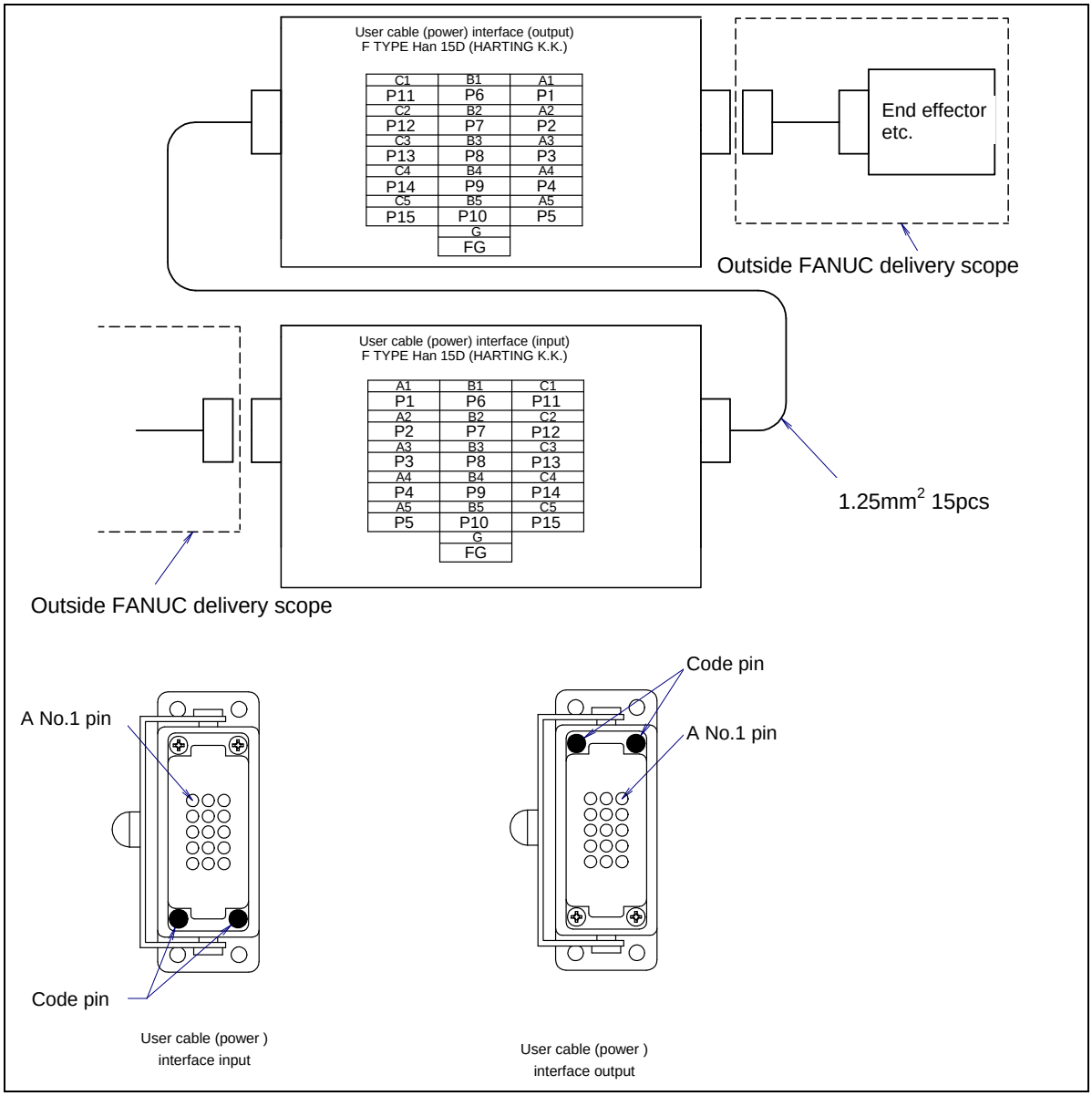


Fig. 5.3 (m) Pin layout for user cable (power line) (AP) interface and code pin layout (option)

Connector specifications

Table 5.3 (a) Connector specifications (Mechanical unit side)

Cable	Input side (J2 unit)		Output side (J3 casing)		Maker /Dealer
EE (RI/RO)	————		JMWR2524F		Fujikura .Ltd
AS ASi	Housing Insert Contact	09 30 006 0301 09 16 024 3001 09 15 000 6103	Housing Insert Contact	09 30 006 0301 09 16 024 3101 09 15 000 6203	Harting
AP	Housing Insert Contact	09 20 010 0301 09 21 015 3001 09 15 000 6103	Housing Insert Contact	09 20 010 0301 09 21 015 3101 09 15 000 6203	
EE(RI/RO) (Cable corresponds to the severe dust/liquid protection)	Housing Insert Contact Guide pin	————	Housing Insert Contact Guide pin	09 30 006 0301 09 16 024 3101 09 15 000 6204 09 30 000 9908	
LMP1	JMWR1303M		————		Fujikura .Ltd

Table 5.3 (b) Connector specifications (User side)

Cable	Input side (J2 unit)		Output side (J3 casing)		Maker /Dealer
EE (RI/RO)	————		JMSP2524M (*1) Straight JMLP2524M Angle		Fujikura .Ltd
AS ASi	Hood (NOTE 2)	09 30 006 1540 Side entry 1541 ↓ 0542 0543 1440 Top entry 1441 ↓ 0442 0443	Hood	←The same	Harting
	Insert	09 16 024 3101	Insert	09 16 024 3001	
	Contact (NOTE 2)	09 15 000 6204 AWG 26-22 6203 AWG 20 6205 AWG 18 6202 AWG 18 6201 AWG 16 6206 AWG 14	Contact (NOTE 2)	09 15 000 6104 AWG 26-22 6103 AWG 20 6105 AWG 18 6102 AWG 18 6101 AWG 16 6106 AWG 14	
	Clamp (NOTE 2)	09 00 000 5083 5086 5090 5094 etc.	Clamp	←The same	
AP	Hood (NOTE 2)	09 30 006 1541 Side entry 0540 ↓ 0541 1440 Top entry 0440 ↓ 0441	Hood	←The same	Harting
	Insert	09 21 015 3101	Insert	09 21 015 3001	
	Contact (NOTE 2)	09 15 000 6204 AWG 26-22 6203 AWG 20 6205 AWG 18 6202 AWG 18 6201 AWG 16 6206 AWG 14	Contact (NOTE 2)	09 15 000 6104 AWG 26-22 6103 AWG 20 6105 AWG 18 6102 AWG 18 6101 AWG 16 6106 AWG 14	
	Clamp (NOTE 2)	09 00 000 5083 5086 5090 5094 etc.	Clamp	←The same	

Cable	Input side (J2 unit)	Output side (J3 casing)		Maker /Dealer
EE (RI/RO) (These are attached to the cables which are corresponded to the sever dust/liquid protection.)	Clamp (NOTE 2)	Hood (NOTE 2)	09 30 006 1540 Side entry 1541 ↓ 0542 0543 1440(*2) Top entry 1441 ↓ 0442 0443	
		Insert	09 16 024 3001 (*3)	
		Contact (24 pcs)	09 15 000 6104 (*4) AWG 26-22 6103 AWG 20 6105 AWG 18 6102 AWG 18 6101 AWG 16 6106 AWG 14	
		Clamp (NOTE 2)	09 00 000 5085 (*5) 5086 5090 5094 Many other types are available	
		Guide pin (2 pcs)	09 33 000 9908 (*6)	
		Bush (2 pcs)	09 33 000 9909 (*7)	
LMP1	JMSP1303F (*8) Straight plug JMLP1303F Angle plug	_____		Fujikura .Ltd

NOTE 1

Underlined parts are attached. Below shows spec. to order in our company.

(*1) A63L-0001-0234#S2524M
(*2) A63L-0001-0453#06B1440
(*3) A63L-0001-0453#24DDM
(*4) A63L-0001-0453#CA6104
(*5) A63L-0001-0453#A-152D
(*6) A63L-0001-0453#A-9908
(*7) A63L-0001-0453#A-9909
(*8) A63L-0001-0234#S1303F

NOTE 2

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

5.4 J1-AXIS OT CONNECTION INTERFACE (OPTION)

Fig. 5.4 shows an example of how the J1-axis OT connection interface (option) is used.

When the J1-axis OT connection interface (option) is specified, a connector for limit switch connection is provided on the connector panel on the J2 base of the mechanical unit of the robot. The user should prepare a plug, normally-closed limit switch, and connection cable with reference to Fig. 5.4. The user should also create a system in which the limit switch is activated if the stroke end of the J1-axis (traveling unit) is reached.

NOTE
With the J1-axis OT connection interface (option), note that an over travel alarm cannot be reset if a limit switch is not connected.

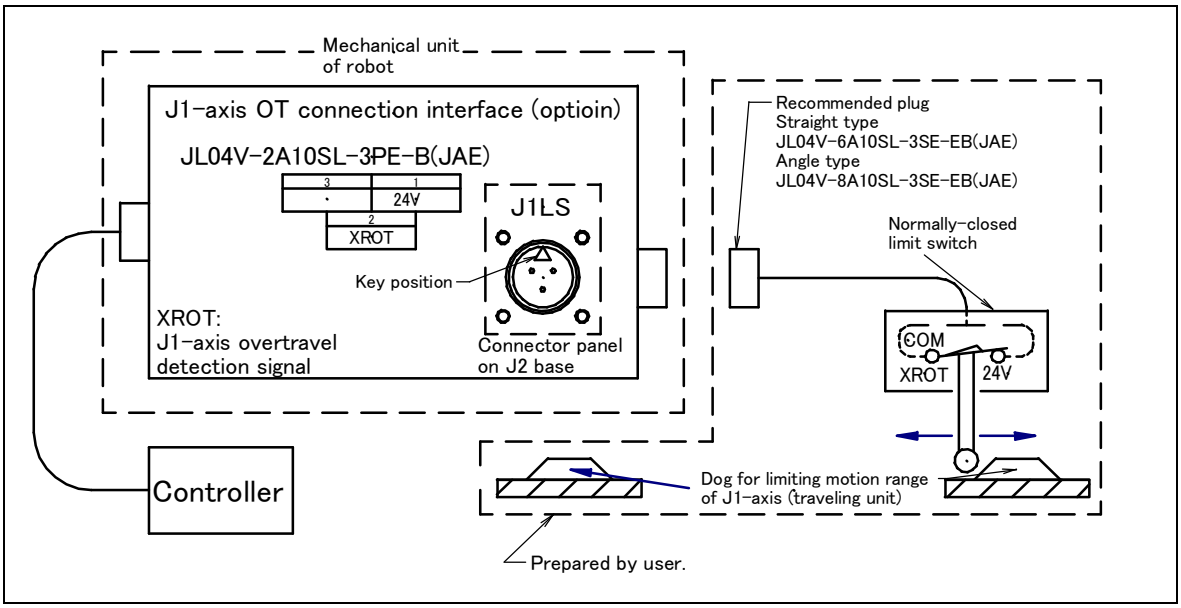


Fig. 5.4 J1-axis OT connection interface (option)

6 AXIS LIMIT SETUP

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.

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

- Used motion range of robot is limited.
- There's an area where tool and peripheral devices interfere with robot.
- The length of cables and hoses attached for application is limited.

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

- Axis limit by DCS (All axes (option))
- Axis limit adjustable mechanical stopper (J2, J3 axis(J3-axis is option.)

⚠ CAUTION

1 Changing the motion 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 J2/J3-axis, use the adjustable mechanical stoppers or DCS function so that damage to peripheral equipment and injuries to human bodies can be avoided.
3 Mechanical stoppers are physical obstacles. The robot cannot move beyond them. For the J2 and J3 axis, it is possible to re-position the mechanical stoppers. For J5 axes, the mechanical stoppers are fixed. For the J4 and J6 axes, only DCS-specified limits are available.
4 Adjustable mechanical stoppers (J2, J3-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.

6.1 CHANGE AXIS LIMIT BY DCS (OPTION)

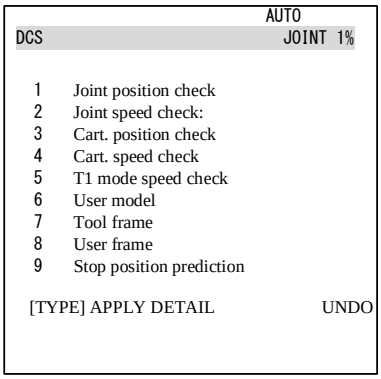
The robot motion can be restricted with DCS (Dual check safety) function by using the following software. For J2/J3-axis, the same effect as adjustable mechanical stopper described in Section 6.2 can be obtained. The robot motion can be restricted at any angle and position if it is in robot motion area. DCS functions are certified to meet the requirements of International Standard ISO13849-1 and IEC61508 approved by internationally accredited certification body. If only the operating space is set using Joint Position Check, the robot stops after it goes beyond the workspace. When the motor power is shut down, the robot's momentum causes it to move some distance before it completely stops. The actual "Robot Stop Position" will be beyond the workspace. To stop the robot within the robot workspace, use the DCS Stop Position Prediction function. The stop position prediction is disabled by default.

- DCS position/speed check function (J567)

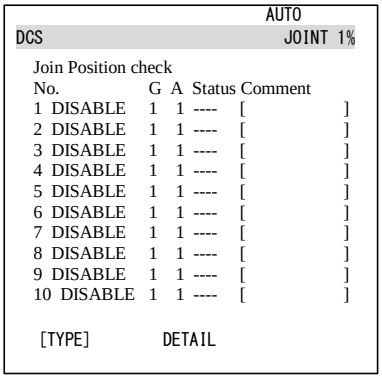
As an example, we shows the procedure to set $\pm 30^{o}$ for J2-axis in here. Refer to R-30*i*B/R-30*i*B Mate /R-30*i*B Plus Controller Dual check safety function Operator's Manual (B-83184EN) for details of other setting, function and DCS stop position prediction.

Setting procedure

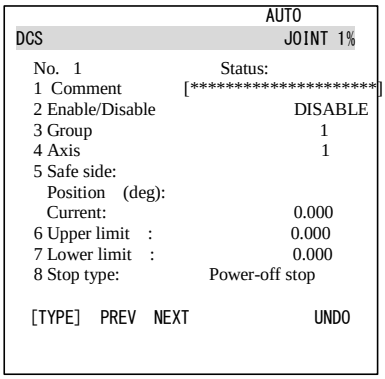
1 Press the [MENU] key to display the screen menu.
2 Press [0 NEXT] and press [6 SYSTEM].
3 Press the F1 (]TYPE]).
4 Select [DCS]. The following screen will be displayed.



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

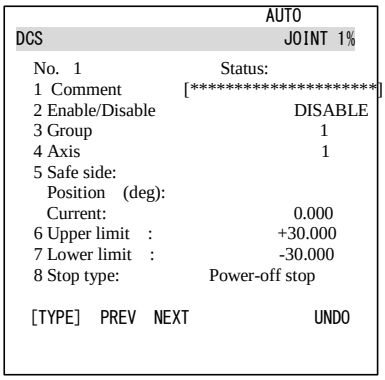


6 Move the cursor to [1], then press the [DETAIL].

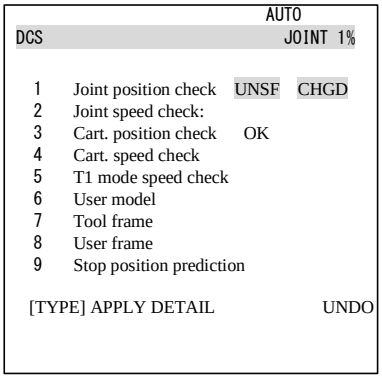


7 Move the cursor to [DISABLE], then press [CHOICE], set the status to [ENABLE].
8 Move the cursor to [Group], then input the robot group number, then press the [ENTER] key.
9 Move the cursor to [Axis], then input “2”, then press the [ENTER] key.
10 Move the cursor to [Upper limit] right side, then input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

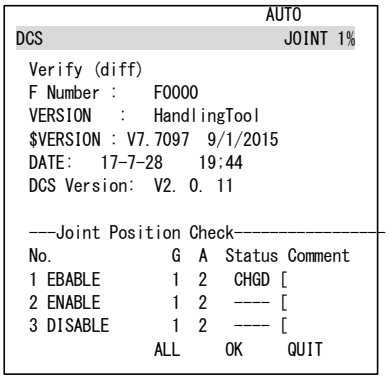
⚠ WARNING
If only the operating space is set using Joint Position Check, the robot stops after it goes beyond the workspace. When the motor power is shut down, the robot's momentum causes it to move some distance before it completely stops. The actual "Robot Stop Position" will be beyond the workspace.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



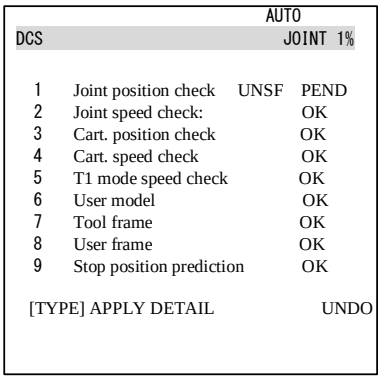
12 Press the [PREV] key two times, back to the first screen.



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



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



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

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

6.2 ADJUSTABLE MECHANICAL STOPPER AND LIMIT SWITCH SETTING (OPTION)

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

Change the position of the mechanical stoppers according to the desired movable range.

Table 6.2 motion range that can be set by the adjustable mechanical stopper and space between the upper and lower limits

Item		Motion range
J2 axis adjustable mechanical stopper	Upper limit	Settable in steps of 20° in the range of -81° to +119°.
	Lower limit	Settable in steps of 10° in the range of -142° to +58°.
	Space between the upper and lower limits	A space of 61° degrees or more is required.
J3 axis adjustable mechanical stopper	Upper limit	Settable in steps of 20° in the range of -20° to +160° and 30° and +170°. A mechanical stopper is also provided at the upper limit +283.5° of the standard movable range.
	Lower limit	Settable in steps of 20° in the range of -40° to +140° and 50° and +150°. A mechanical stopper is also provided at the lower limit -163.5° of the standard movable range.
	Space between the upper and lower limits	A space of 60° degrees or more is required.

> **NOTE**
> 1 If the newly set operation range does not include 0°, it is necessary to change it by zero position mastering so that 0° is included.
> 2 When adjustable mechanical stopper is ordered, mounting bolt is attached.
> 3 When motion range is changed by movable mechanical stopper, be sure to set the motion range of soft same refer to Subsection 6.2.2.

6.2.1 Installing adjustable mechanical stopper option

Attach adjustable mechanical stoppers referring to Fig. 6.2.1 (a) to (d).

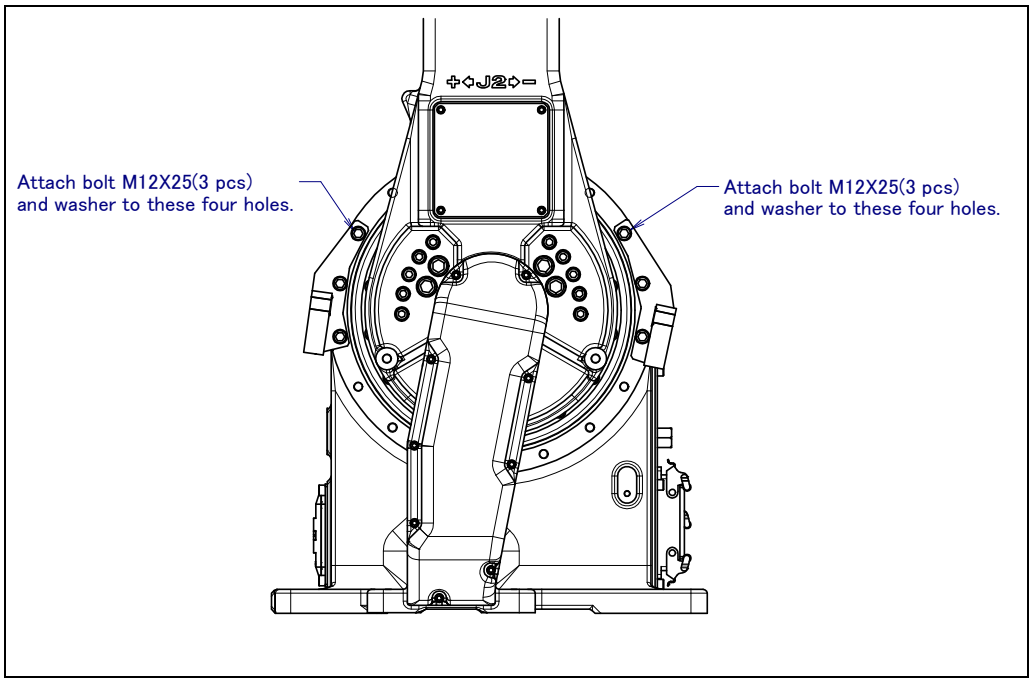
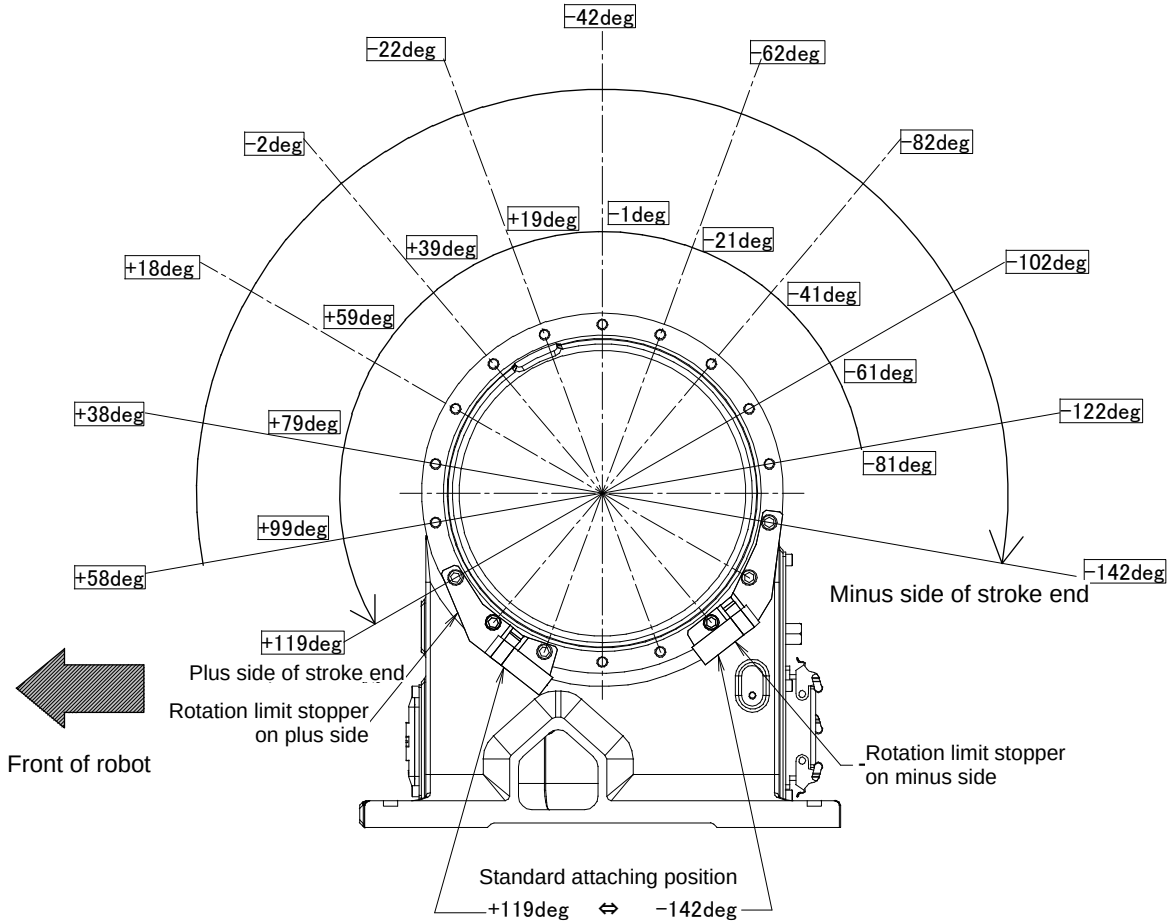


Fig. 6.2.1 (a) J2-Axis movable mechanical stopper

Notes on attaching the J2-axis mechanical stoppers

The motion range limited by the J2-axis mechanical stoppers can be changed in steps of 20° by attaching them to different holes.

Use the attaching holes corresponding to the desired limit angle with reference to the figure below.



(NOTE) Left side view of J2-axis base

A minimum space of 61° is required between the plus side stopper and minus side stopper.

Fig. 6.2.1 (b) Attachment of J2-axis movable mechanical stopper

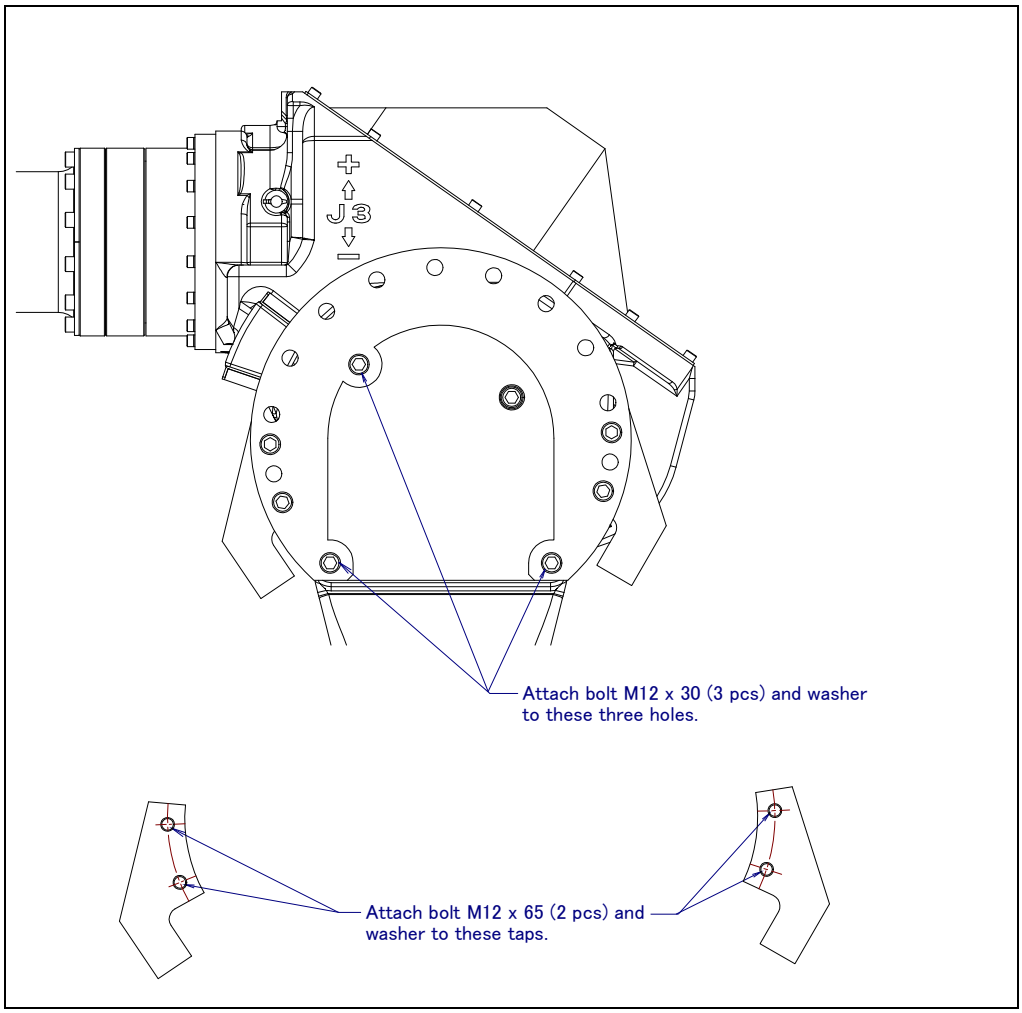


Fig. 6.2.1 (c) J3-Axis movable mechanical stopper

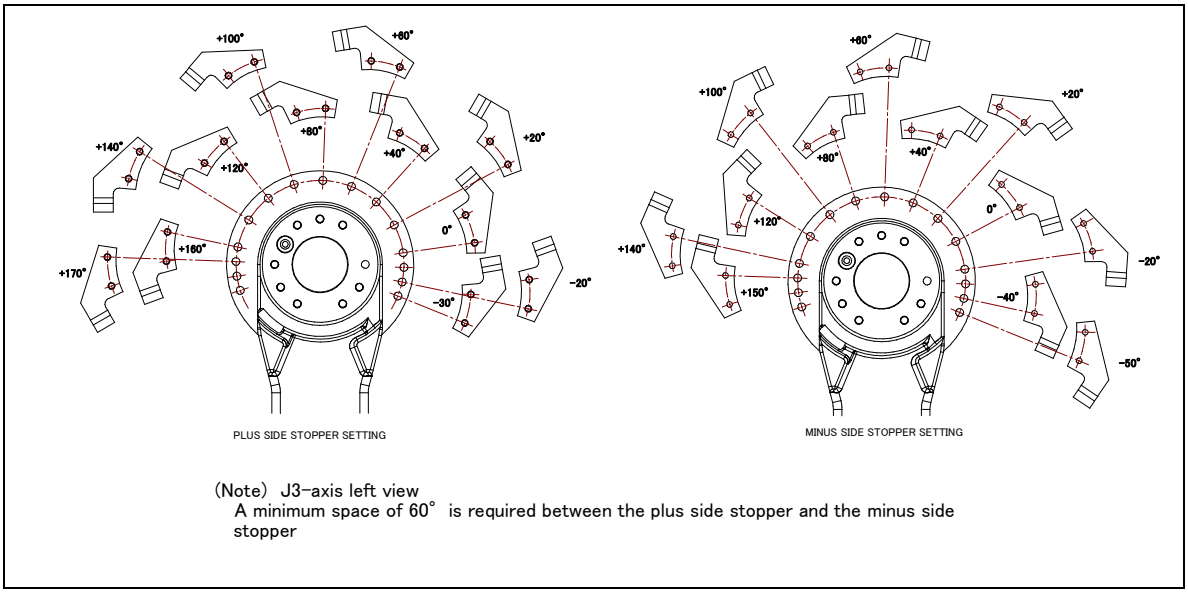
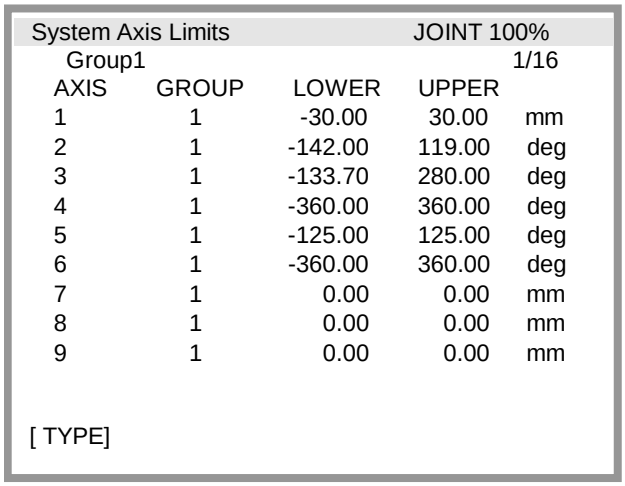


Fig. 6.2.1 (d) Attachment of J3-axis movable mechanical stopper

6.2.2 Changing the parameter setting

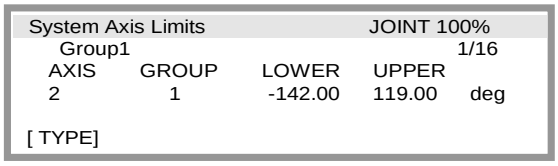
Setting procedure

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



NOTE
0.00 indicates the robot does not have these axes.

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



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

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

6.2.3 The maximum stopping distance (position) of adjustable mechanical stopper

The movable mechanical stopper is a mechanism that can be adjusted in its position. The robot can work safely inside the adjusted motion range, up to the maximum range as shown in Table 6.2.3 and Fig. 6.2.3 (a), (b). A robot attempting to travel beyond this set range of motion, will be stopped by these stoppers, by collision; and therefore the robot will remain contained within the setup range.
Stopping the robot will cause the mechanical stopper to be “transformed” (means : permanently damaged). Be sure to exchange such “transformed” stopper.

Table 6.2 (b) The maximum stopping distance(position) of movable mechanical stopper

Item		Plus side	Minus side
M-710*i*C/50T/70T	J2	+19°	-18°
	J3	+11°	-10°

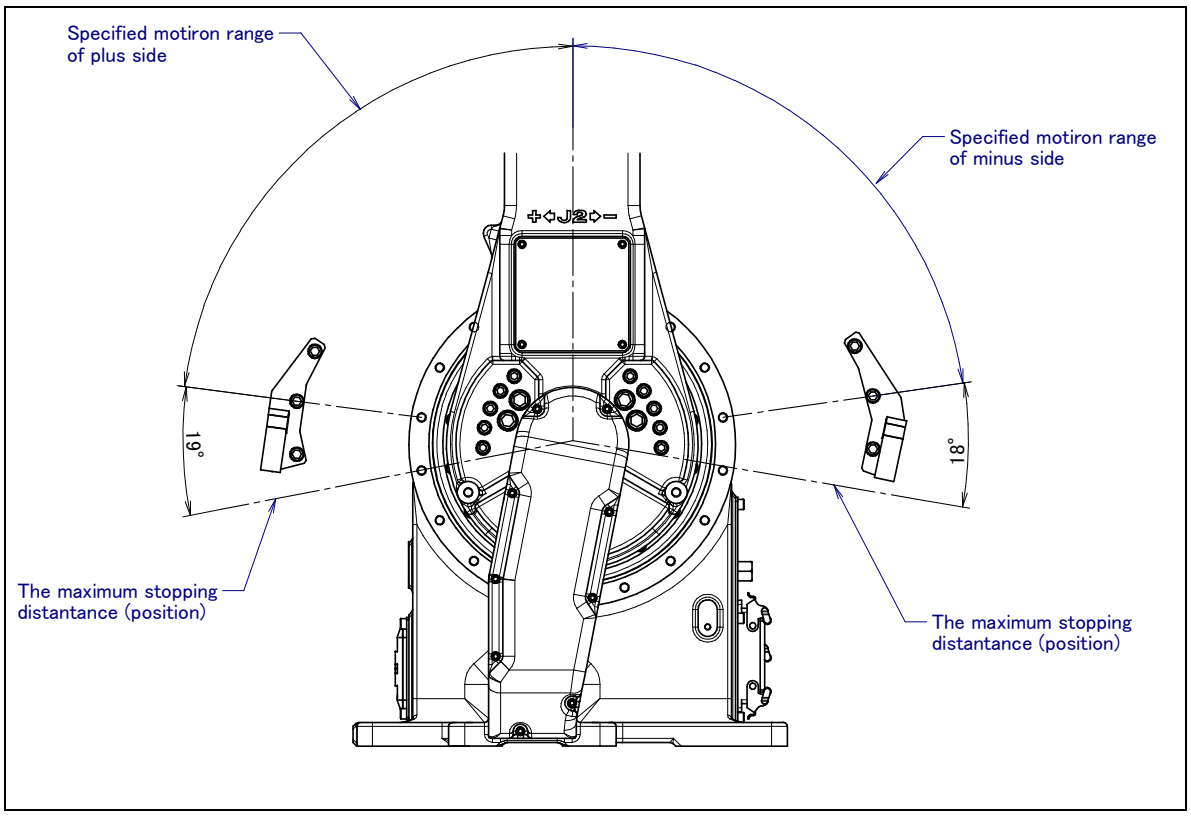


Fig. 6.2.3 (a) The maximum stopping distance of movable mechanical stopper (J2-axis)

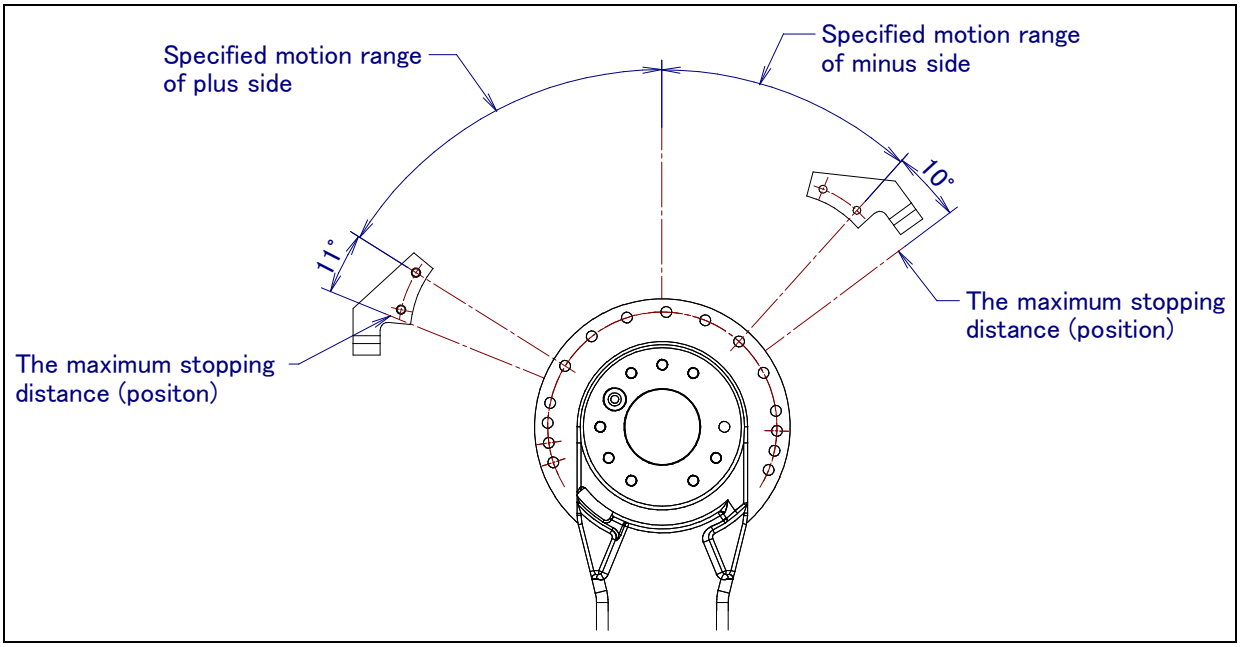


Fig. 6.2.3 (b) The maximum stopping distance of movable mechanical stopper (J3-axis)

7 CHECKS AND MAINTENANCE

Optimum performance of the robot can be maintained by performing the periodic 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 time interval should be divided by 2.

7.1 CHECKS AND MAINTENANCE

7.1.1 Daily Checks

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

Check items	Check points and management
Oil seepage	Check to see if there is oil on the sealed part of each joint. If there is an oil seepage, clean it. **⇒"7.2.1 Confirmation of Oil Seepage"**
Air control set	(When air control set or air purge kit is used) **⇒"7.2.2 Confirmation of the Air Control Set"**
Vibration, Abnormal noises	Check whether vibration or abnormal noises occur. When vibration or abnormal noises occur, perform measures referring to the following section: **⇒"9.1 TROUBLESHOOTING" (symptom : Vibration, Noise)**
Positioning accuracy	Check that the taught positions of the robot have not deviated from the previously taught positions. If displacement occurs, perform the measures as described in the following section: **⇒"9.1 TROUBLESHOOTING" (symptom : Displacement)**
Peripheral equipment for proper operation	Check whether the peripheral equipment operate properly according to commands from the robot and the peripheral equipment.
Brakes for each axis	Check that the end effector drops 0.5 mm or less when the servo power is turned off. If the end effector (hand) drops more than the prescribed amount, perform the measures as described in the following section: **⇒"9.1 TROUBLESHOOTING" (symptom : Dropping axis)**
Warnings	Check whether unexpected warnings occur in the alarm screen on the teach pendant. If unexpected warnings occur, perform the measures as described in the following manual: **⇒"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)"**

7.1.2 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	If the controller ventilation system is dusty, turn off power and clean the unit.	17
	○					Check for external damage or peeling paint	Check whether the robot has external damage due to the interference with the peripheral devices or peeling paint. If an interference occurs, eliminate the cause. Also, if the external damage is serious and causes a problem in which the robot cannot be used, replace the damaged parts.	1
	○					Check for water	Check whether the robot is subjected to water or cutting oils. If water is found, remove the cause and wipe off the liquid.	2
	○ Only 1st check	○				Check for damages to the teach pendant cable, the operation box connection cable or the robot connection cable	Check whether the cable connected to the teach pendant, operation box and robot are unevenly twisted or damaged. If damage is found, replace the damaged cables.	16
		○				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. **⇒"7.2.3 Check the Mechanical Unit Cables and Connectors"**	3
		○				Check the connection of each axis motor and other exposed connectors	Check the connection of each axis motor and other exposed connectors. **⇒"7.2.3 Check the Mechanical Unit Cables and Connectors"**	4
	○ Only 1st Check	○				Retightening the end effector mounting bolts	Retighten the end effector mounting bolts. Refer to the following section for tightening torque information: **⇒"4.1 END EFFECTOR INSTALLATION TO WRIST"**	5
	○ Only 1st Check	○				Retightening the cover mounting bolts and external main bolts	Retighten the bolts which were installed or removed during the inspection and exposed. Refer to the recommended bolt tightening torque guidelines at the end of the manual. Some bolts are attached with adhesive. Tightening the bolts with a torque greater than what is recommended might damage the adhesive. Therefore, follow the recommended bolt tightening torque guidelines when retightening the bolts.	6

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	○				Check the mechanical stopper and the adjustable mechanical stopper	Check that there is no evidence of a collision on the mechanical stopper, the adjustable mechanical stopper, and check the looseness of the stopper mounting bolts. Check that the J1-axis swing stopper rotates smoothly. **⇒"7.2.4 Check of Fixed Mechanical Stopper and Adjustable Mechanical Stopper"**	7
	○ 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 wrist flange). Insulation failure might occur when spatter has collected around the wrist flange or welding torch, and there is a possibility of damaging the robot mechanism by the welding current. (See Appendix C)	8
	○ Only 1st Check	○				Check for damage to the end effector (hand) connection cable	Check whether the end effector connection cables are unevenly twisted or damaged. If damage is found, replace the damaged cables.	9
			○			Replacing the mechanical unit batteries	Replace the mechanical unit batteries **⇒"7.3.1 Replacing the Batteries"**	10
				○		Replacing the grease of drive mechanism	Replace the grease of each axis reducer and gearbox **⇒"7.3.2 Replacing the Grease of the Drive Mechanism"**	11 to 14
					○	Replacing the mechanical unit cable	Replace the mechanical unit cable Contact your local FANUC representative for information regarding replacing the cable.	15
					○	Replacing the controller batteries	Replace the controller batteries **⇒Chapter 7 Replacing batteries of R-30*i*B/R-30*i*B Plus CONTROLLER MAINTENANCE MANUAL(B-83195EN) or R-30*i*B Mate/R-30*i*B Mate Plus CONTROLLER MAINTENANCE MANUAL (B-83525EN) or R-30*i*A CONTROLLER MAINTENANCE MANUAL (B-82595EN) or R-30*i*A CONTROLLER MAINTENANCE MANUAL (For Europe) (B-82595EN-1) or R-30*i*A CONTROLLER MAINTENANCE MANUAL(For RIA) (B-82595EN-2)"**	18

7.2 CHECK POINTS

7.2.1 Confirmation of Oil Seepage

Check items

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

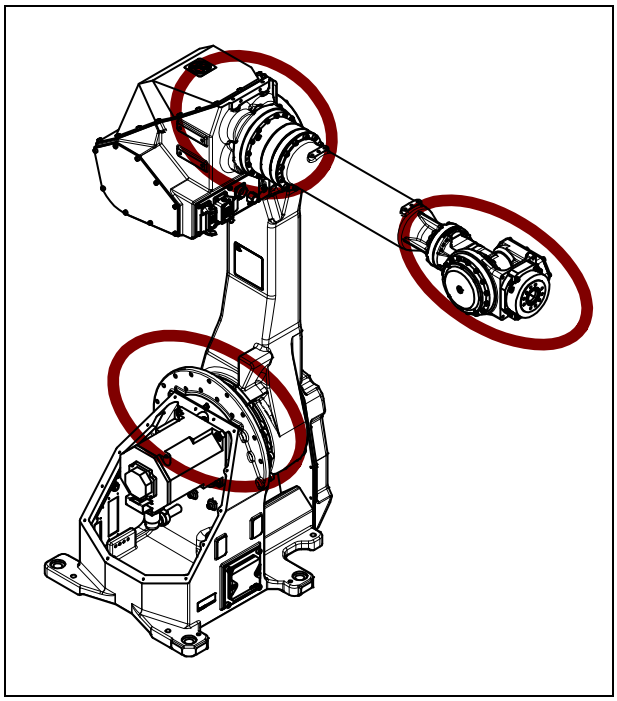


Fig. 7.2.1 Check parts of oil seepage

Management

- Oil might accumulate on the outside of the seal lip depending on the movement condition or environment of the axis. If the oil viscosity changes, the oil might drip depending on the axis movement. To prevent oil spots, be sure to wipe away any accumulated oil under the axis components in Fig. 1.2.1 before you operate the robot.
- In case of oil seepage, please consider replacing the grease and the oil altogether. This replacement potentially can help improve the seepage situation.
- 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 achieved by venting the grease outlet. (When opening the grease outlet, refer to Subsection 7.3.2 and ensure that grease is not expelled onto the machine or tooling.)

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

- If you must wipe oil frequently, and opening the grease outlet does not stop the seepage, perform the measures below.
  ⇒" 9.1 TROUBLESHOOTING" (symptom : Grease leakage)

7.2.2 Confirmation of the Air Control Set (Option)

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

Item	Check items	Check points
1	Air pressure	Check the air pressure using the pressure gauge on the air control set as shown in Fig. 7.2.2. 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 handle for lubricator adjustment. 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.

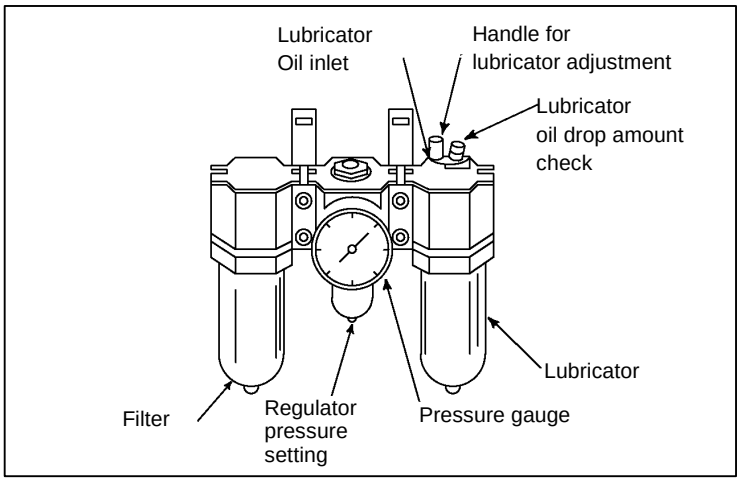


Fig. 7.2.2 Air control set (option)

7.2.3 Check the Mechanical Unit Cables and Connectors

Inspection points of the mechanical unit cables

For the J2-axis, check cables after remove J2 motor cover. For the J3-axis, check cables after remove cover of J3 casing. When severe dust/liquid protection option is selected, gaskets are attached to the cover. If you remove covers, replace the gaskets for the new article absolutely.

Check items

Check the cables for a jacket break and wear. If wires of the cable appear, replace it.

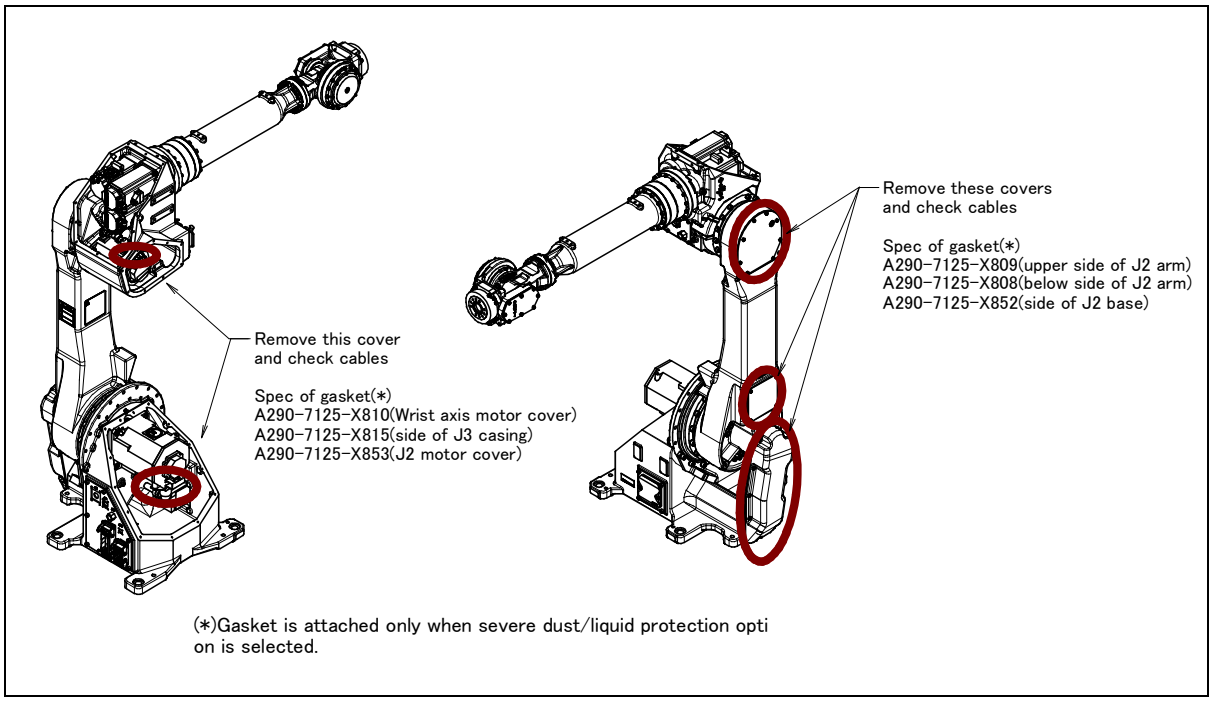


Fig. 7.2.3 (a) Inspection points of the mechanical unit cables

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

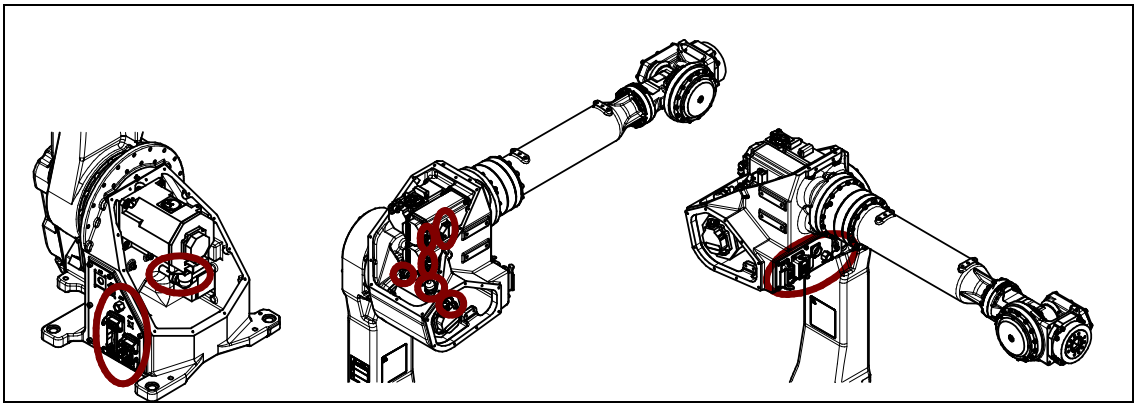


Fig. 7.2.3 (b) Connector Inspection points

7.2.4 Check of Fixed Mechanical Stopper and Adjustable Mechanical Stopper

- Check that there is no evidence of a collision on the mechanical stopper and the adjustable mechanical stopper. If there is evidence of a collision on the stopper, replace the parts.
- Check the tightness of the stopper mounting bolts. If they are loose, retighten them.
- Refer to Section 6.2 of the operator's manual for details regarding the adjustable mechanical stopper.

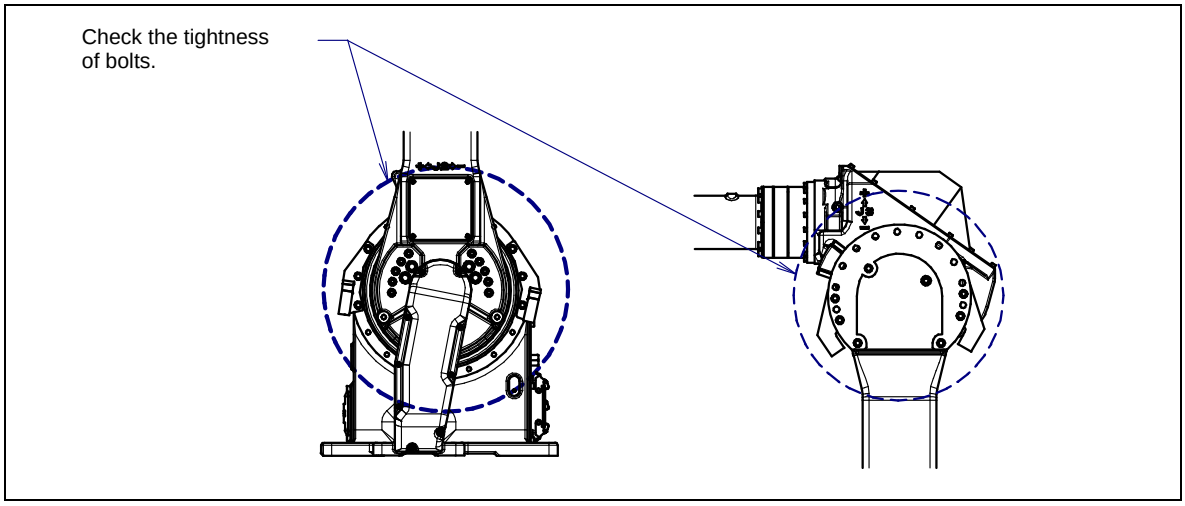


Fig. 7.2.4 Check of fixed mechanical stopper and adjustable mechanical stopper

7.3 MAINTENANCE

7.3.1 Replacing the Batteries (1.5 Years checks)

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

Procedure of replacing the battery

1 Keep the power on. 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. (Fig. 7.3.1 (a))
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.

> ⚠ **CAUTION**
> When using a robot with the severe dust/liquid protection option, remove the cover from the battery case as shown in Fig. 7.3.1 (b) to replace the battery. After replacing the battery, reinstall the cover. In this time, please be sure to replace the gasket with new one for effects of severe dust/liquid protection.

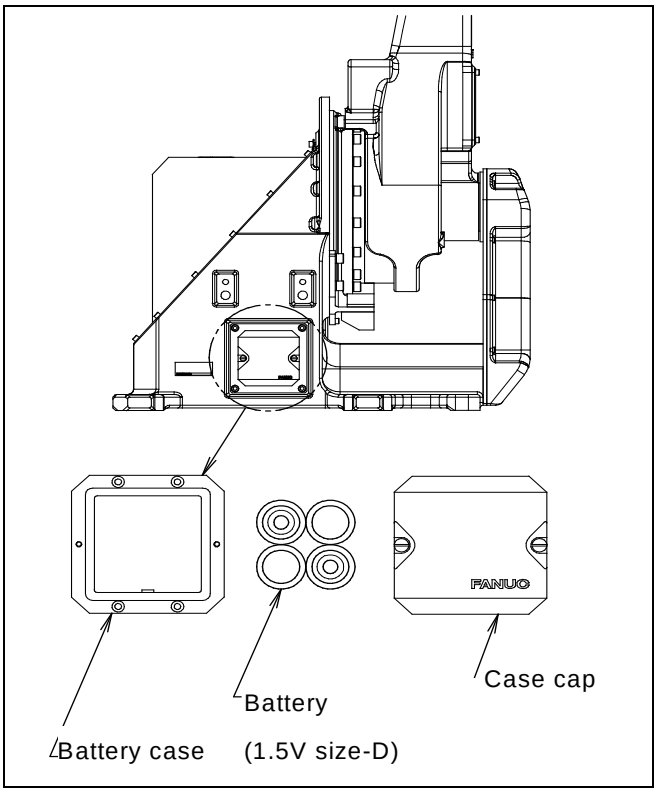


Fig. 7.3.1 (a) Replacing the battery

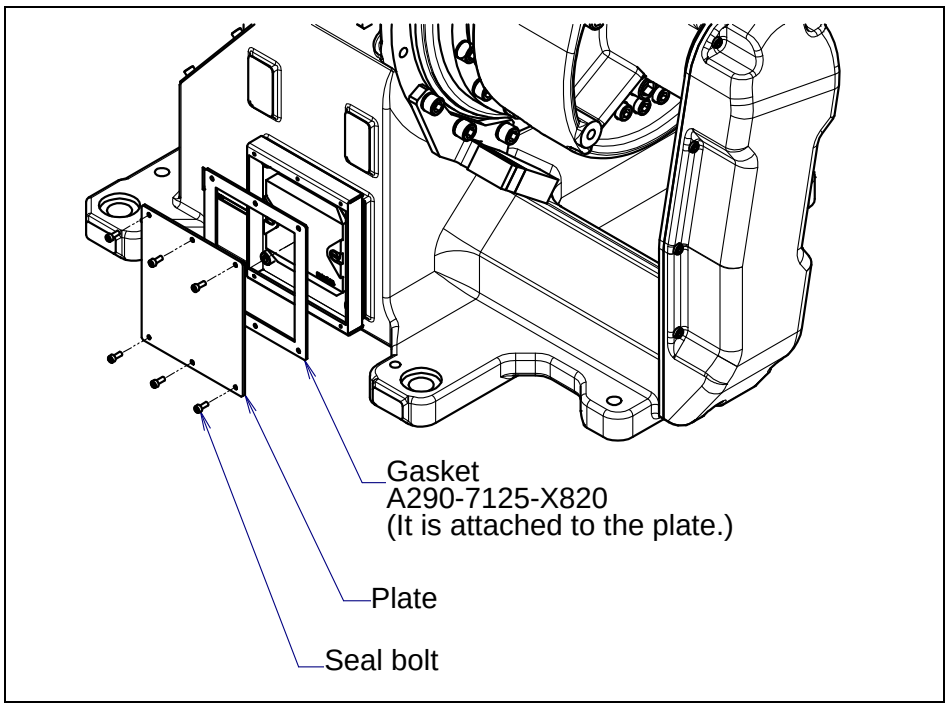


Fig. 7.3.1 (b) Removing the plate (When severe dust/liquid protection is specified)

7.3.2 Replacing the Grease of the Drive Mechanism (3 years (11520 hours) checks)

According to below, replace the grease of J2, J3 axes reducer, J4/J5/J6-axis gearbox and wrist at the intervals based on every 3 years or 11520 hours, whichever comes first. See Table 7.3.2 (a) for the grease name and the quantity.

Table 7.3.2 (a) Grease for 3-year periodical replacement

Supply position	Quantity	Gun tip pressure	Grease name
J2-axis reducer	1500g (1660ml)	0.1MPa or less(NOTE)	Kyodo yushi VIGOGREASE RE0 Spec. : A98L-0040-0174
J3-axis reducer	950g (1060ml)		
J4/J5/J6-axis gearbox	810g (920ml)		
Wrist	540g (610ml)		

NOTE
When using a hand pump, apply grease approximately once per two seconds.
For grease replacement or replenishment, use the postures indicated below.

⚠ 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 a suit if necessary.

Table 7.3.2 (b) Postures for greasing

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

⚠ CAUTION
Failure to supply grease correctly may cause an increase of the internal pressure of the grease bath. Such pressure increase will then damage the seal, which in turn leads to grease leakage and abnormal robot operation.
When performing greasing, therefore, observe the following precautions.

1 Before starting to grease, remove the seal bolt or the taper plug to allow the grease to come out
2 A grease inlet may optionally have a plug. Replace the plug with the attached grease nipple and then start greasing.
3 A grease inlet may optionally have a plug. Replace the plug with the attached grease nipple and then start greasing.
4 Whenever possible, avoid using an air pump, which is powered by the factory air supply.
If the use of an air pump is unavoidable, supply grease with the pump at a pressure lower than or equal to the gun tip pressure (see Table 7.3.2 (a)).
5 Use grease only of the specified type. Grease of a type other than that specified may damage the reducer or lead to other problems.
6 After greasing, release remaining pressure from the grease bath using the procedure given in Section 7.3.6, and then close the grease outlet.
7 To prevent accidents caused by slipping, completely remove any excess grease from the floor or robot.

7.3.3 Grease Replacement Procedure of the J2, J3-Axis Reducer

1 Move the robot to the greasing posture described in Table 7.3.2 (b).
2 Turn off controller power.
3 Remove the seal bolt from grease outlet. (Fig.7.3.3 (a) to 7.3.3 (b))
4 Supply new grease through the grease inlet until new grease is output from grease outlet.
5 After greasing, release remaining pressure as the Subsection 7.3.6.

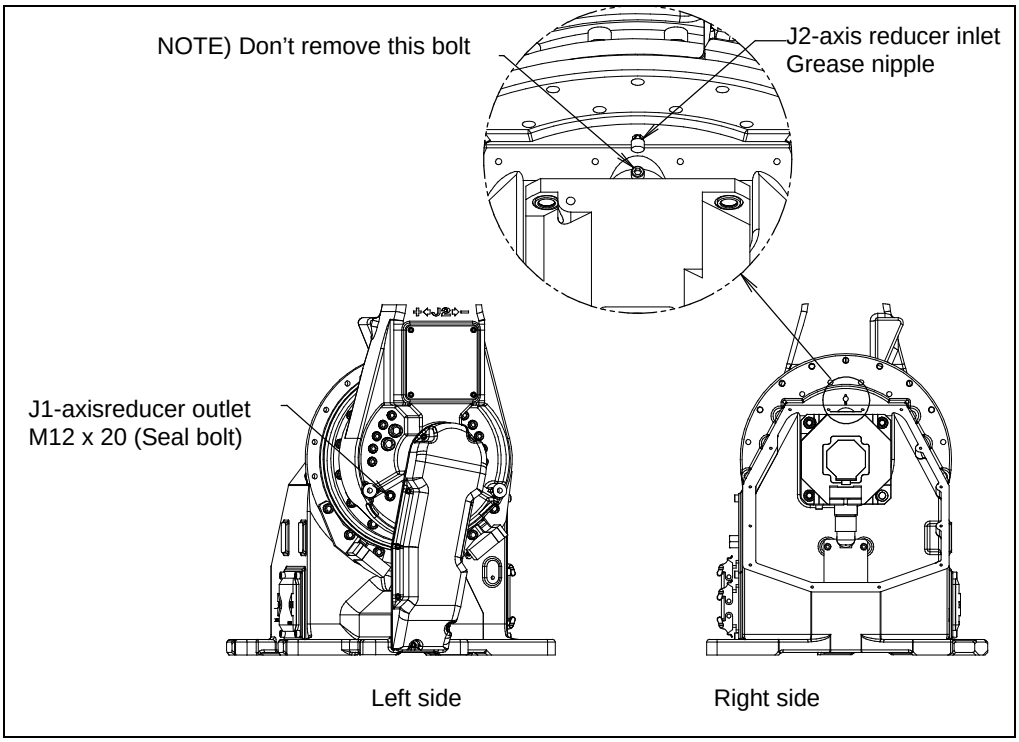


Fig. 7.3.3 (a) Replacing grease of the J2-axis reducer

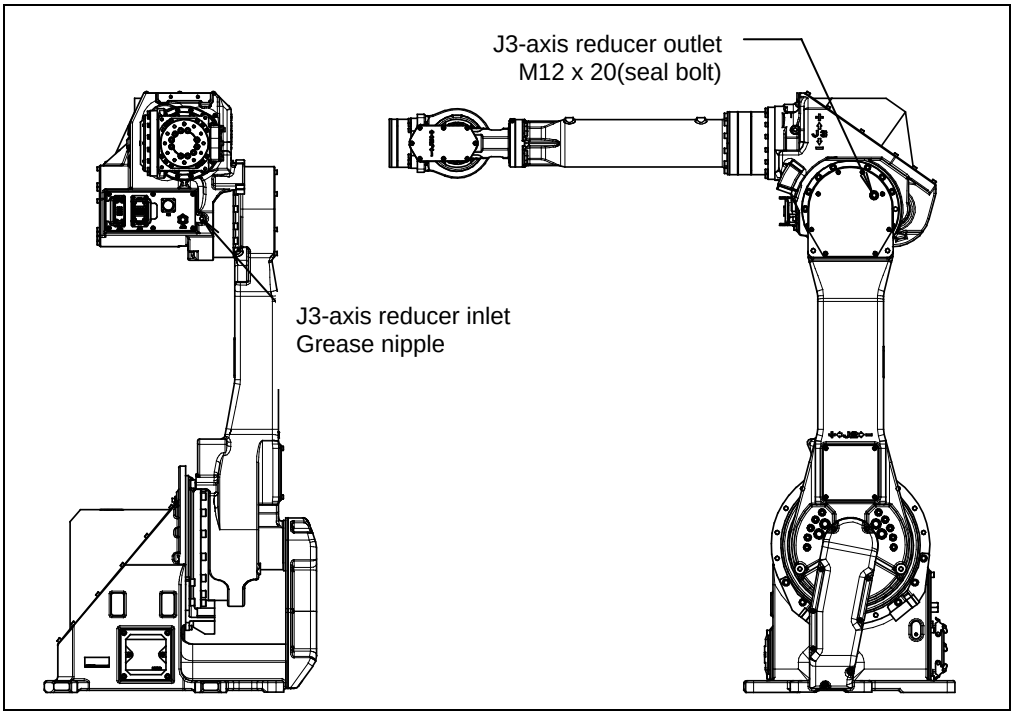


Fig. 7.3.3 (b) Replacing grease of the J3-axis reducer

7.3.4 Grease Replacement Procedure for the J4/J5/J6-Axis Gearbox

1 Move the robot to the greasing posture described in Table 7.3.2 (b).
2 Turn off controller power.
3 Remove the seal bolt from the grease outlet. (Fig. 7.3.4)
4 Supply new grease until new grease is output from the grease outlet.
5 After greasing, release remaining pressure as the Subsection 7.3.6.

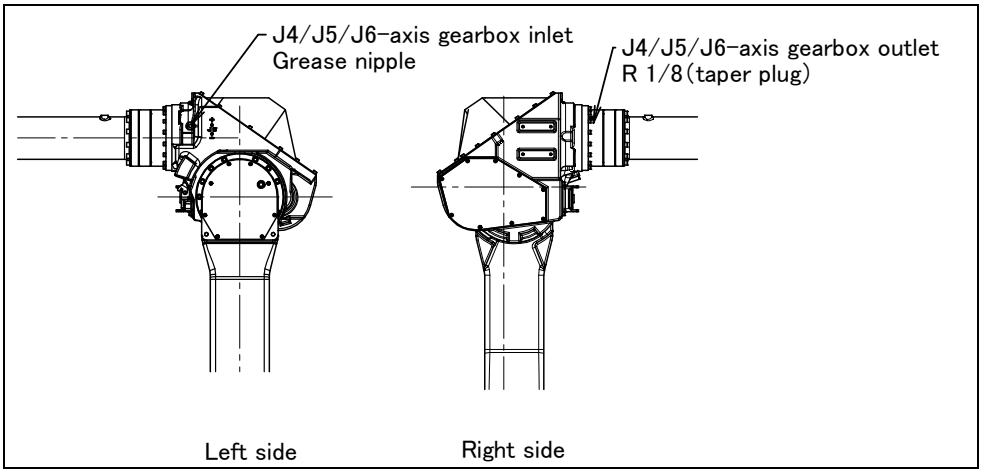


Fig. 7.3.4 Replacing grease of the J4/J5/J6-axis gearbox

7.3.5 Grease Replacement Procedure for the Wrist

1 Move the robot to the greasing posture described in Table 7.3.2 (b).
2 Turn off controller power.
3 Remove the plug with a sealant from the wrist grease outlet and attach the grease nipple that comes with the robot (Fig. 7.3.5).
4 Supply new grease through the wrist grease inlet until new grease is output from wrist grease outlet.
5 After greasing, release remaining pressure as the Subsection 7.3.6.

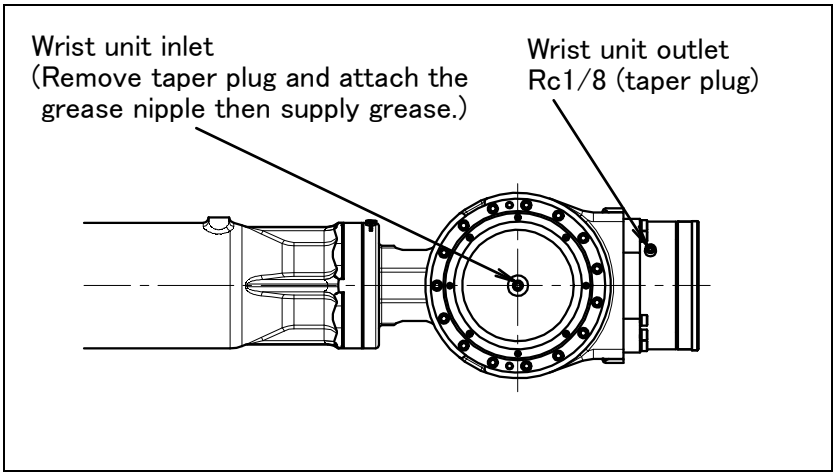


Fig. 7.3.5 Replacing grease of the wrist

7.3.6 Procedure for Releasing Remaining Pressure within the Grease Bath

After greasing, operate the robot for 20 minutes or more with the grease nipple of the grease inlet and the seal bolt of the grease outlet uncapped to release remaining pressure within the grease bath.
Attach the reclaim bags under the grease inlet and grease outlet to prevent spilled grease from splattering.

<table>
<tr><th>Operating axis
Grease replacement part</th><th>J2-axis</th><th>J3-axis</th><th>J4-axis</th><th>J5-axis</th><th>J6-axis</th></tr>
<tr><td>J2-axis reducer</td><td>Axis angle of 60° or more OVR 100%</td><td colspan="4">Arbitrary</td></tr>
<tr><td>J3-axis reducer</td><td>Arbitrary</td><td>Axis angle of 60° or more OVR 100%</td><td colspan="3">Arbitrary</td></tr>
<tr><td>J4/J5/J6-axis gearbox</td><td colspan="2">Arbitrary</td><td colspan="3">Axis angle of 60° or more OVR 100%</td></tr>
<tr><td>Wrist axis</td><td colspan="2">Arbitrary</td><td colspan="3">Axis angle of 60° or more OVR 100%</td></tr>
</table>

If the above operations cannot be performed due to local circumstances, the same count operation is necessary. (When the maximum allowable axis angle is 30°, perform twice the operation for 40 minutes or more.)
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.

7.4 STORAGE

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

8 MASTERING

Mastering is a manipulation performed associating 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.

8.1 OVERVIEW

The current position of the robot is determined according to the pulse count value supplied from the Pulsecoder on each axis.
Mastering is factory0-performed. It is unnecessary to perform mastering in daily operations. However, mastering is required under the following conditions:

- 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 are gone dead. Replace the batteries in the controller and mechanical units periodically. Alarm will alert decreasing the battery voltage.

Types of Mastering

Table 8.1 describes the following mastering methods. Note that "Quick Mastering for Single Axis" is not supported in software version 7DC2 (V8.20P) or earlier.

Table 8.1 Type of mastering

Fixture position mastering	Mastering which 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 performing the mastering, the positioning (calibration) is indispensable. The Positioning is an operation which recognizes the robot current position loading the pulse count value.

This section describes zero-position mastering, quick mastering, 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. For that reason, the Master/Cal screen is designed to appear only when the $MASTER_ENB system variable is set to 1 or 2. After performing positioning, press the F5 ([DONE]) on the Master/Cal screen. The $MASTER_ENB system variable is reset to 0 automatically. And the Master/Cal screen will disappear.
2 Before performing mastering, recommend to back up the current mastering data.

8.2 RESETTING ALARMS AND PREPARING FOR MASTERING

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

Alarm displayed

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

Procedure

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

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

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

8.3 ZERO POSITION MASTERING

Zero-position mastering (witness mark mastering) is performed with all axes set at the 0-degree position. A zero-position mark (witness mark) is attached to each robot axis. 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].

```
SYSTEM Master/Cal          AUTO   JOINT 10 %
                                  TORQUE = [ON ]
 1 FIXTURE POSITION MASTER
 2 ZERO POSITION MASTER
 3 QUICK MASTER
 4 QUICK MASTER FOR SINGLE AXIS
 5 SINGLE AXIS MASTER
 6 SET QUICK MASTER REF
 7 CALIBRATE
     Press 'ENTER' or number key to select.

 [ TYPE ]   LOAD   RES_PCA                DONE
```

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, cycle power of the controller.

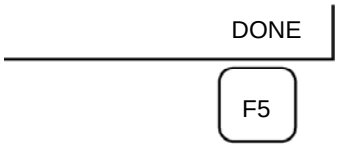
6 Select [2 ZERO POSITION MASTER]. Press F4 [YES].

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

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.

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

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



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

Table 8.3 Posture with position marks (witness mark) aligned

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

⚠ CAUTION
There is no J6-axis for M-710*i*C/50H.

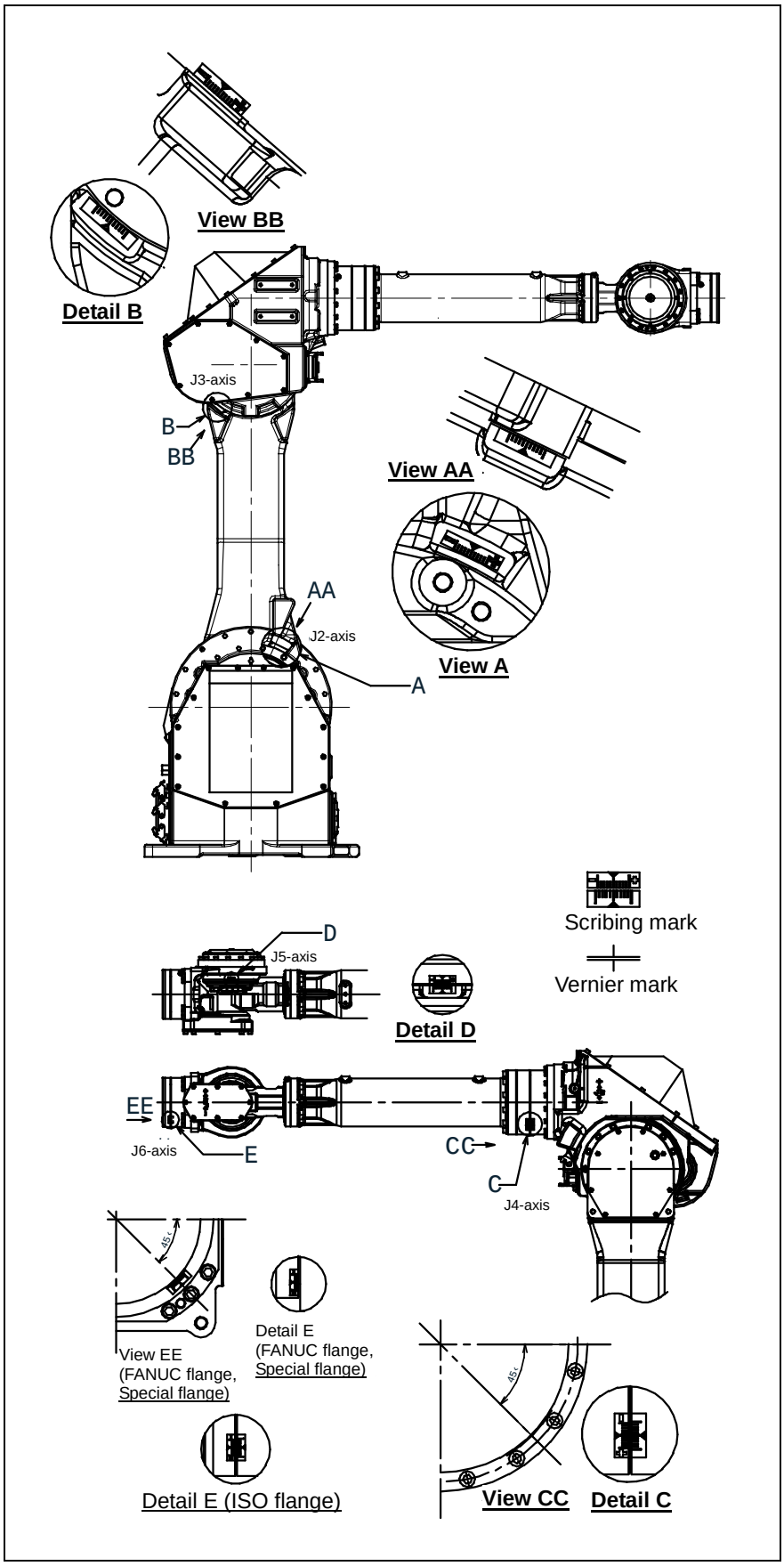


Fig. 8.3 zero-position mark (witness mark) for each axis

8.4 QUICK MASTERING

Quick mastering is performed at a user-specified position. The pulse 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 8.3. 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 Pulsecoder 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. Master/Cal screen will be displayed.

```
SYSTEM Master/Cal          AUTO   JOINT 10 %
                                  TORQUE = [ON ]
 1 FIXTURE POSITION MASTER
 2 ZERO POSITION MASTER
 3 QUICK MASTER
 4 QUICK MASTER FOR SINGLE AXIS
 5 SINGLE AXIS MASTER
 6 SET QUICK MASTER REF
 7 CALIBRATE
     Press 'ENTER' or number key to select.

 [ TYPE ]   LOAD   RES_PCA                DONE
```

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.

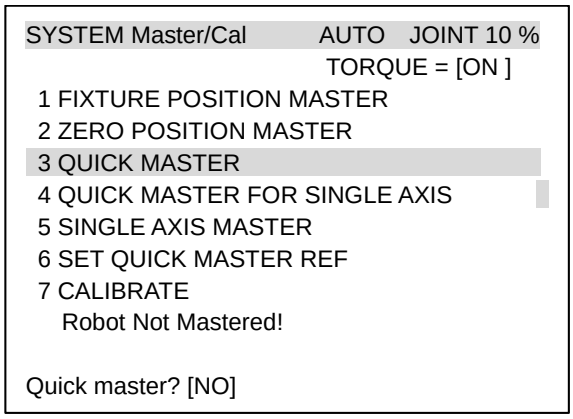
```
 5 SINGLE AXIS MASTER
 6 SET QUICK MASTER REF
 7 CALIBRATE
```

F4

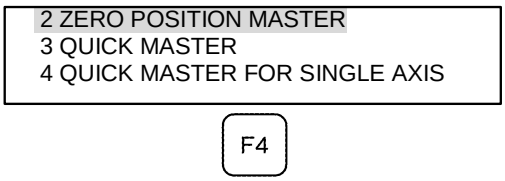
> **⚠ CAUTION**
> If the robot has lost mastering data due to mechanical disassembly or repair, you cannot perform this procedure. In this case, perform Fixture position mastering or Zero position mastering to restore mastering data.

Procedure of Quick Mastering

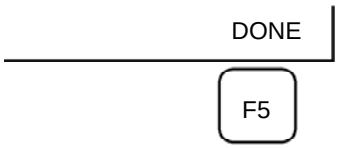
1 Display the Master/Cal screen.



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



4 Select [7 CALIBRATE] and press [ENTER] key. Calibration is executed. Calibration is executed by cycling power.
5 After completing the calibration, press F5 [Done].



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

8.5 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 8.3. 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 Pulsecoder 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.

```
SYSTEM Master/Cal          AUTO   JOINT 10 %
                                  TORQUE = [ON ]
 1 FIXTURE POSITION MASTER
 2 ZERO POSITION MASTER
 3 QUICK MASTER
 4 QUICK MASTER FOR SINGLE AXIS
 5 SINGLE AXIS MASTER
 6 SET QUICK MASTER REF
 7 CALIBRATE
     Press 'ENTER' or number key to select.

 [ TYPE ]   LOAD   RES_PCA                DONE
```

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.

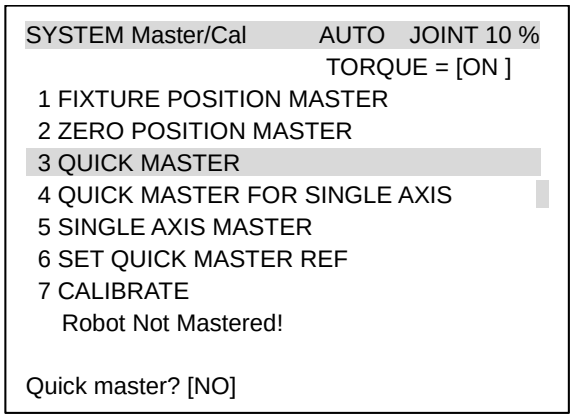
```
 5 SINGLE AXIS MASTER
 6 SET QUICK MASTER REF
 7 CALIBRATE
```

F4

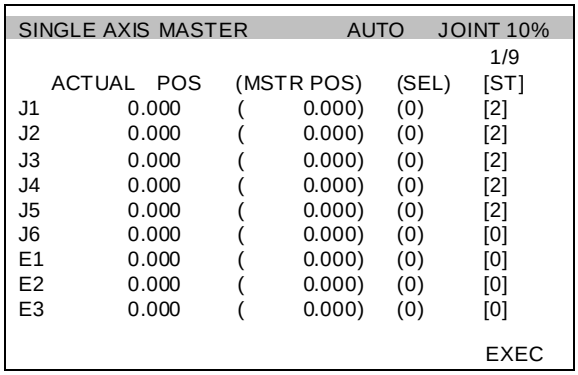
> **⚠ CAUTION**
> If the robot has lost mastering data due to mechanical disassembly or repair, you cannot perform this procedure. In this case, perform Fixture position mastering or Zero position mastering to restore mastering data.

Procedure of Quick Mastering for single axis

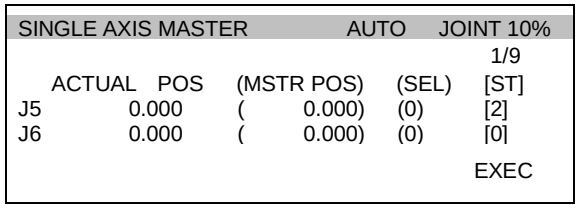
1 Display the Master/Cal screen.



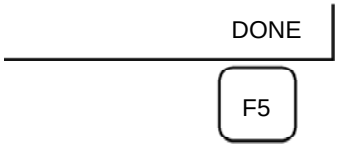
2 Select [4 QUICK MASTER FOR SINGLE AXIS]. The quick master for single axis screen will be displayed.



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.



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 [ENTER] key. Calibration is 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.

8.6 SINGLE AXIS MASTERING

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

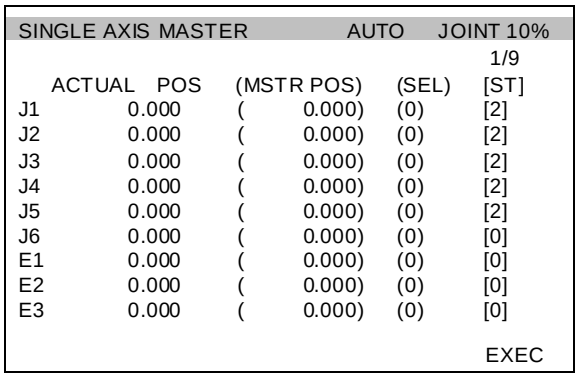


Table 8.6 Items set in single axis mastering

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 the 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].

```
SYSTEM Master/Cal          AUTO   JOINT 10 %
                                  TORQUE = [ON ]
 1 FIXTURE POSITION MASTER
 2 ZERO POSITION MASTER
 3 QUICK MASTER
 4 QUICK MASTER FOR SINGLE AXIS
 5 SINGLE AXIS MASTER
 6 SET QUICK MASTER REF
 7 CALIBRATE
     Press 'ENTER' or number key to select.

 [ TYPE ]   LOAD   RES_PCA                DONE
```

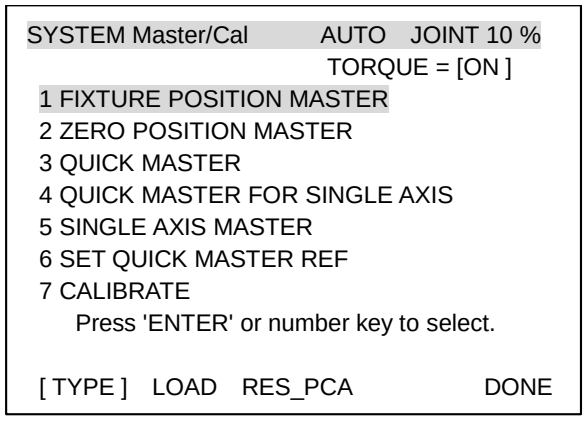
3 Select [5 SINGLE AXIS MASTER]. The following screen will be displayed.

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

                                          EXEC
```

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.

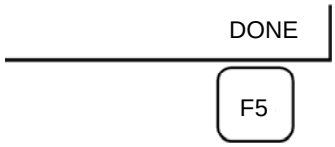
```
SINGLE AXIS MASTER          AUTO    JOINT 10%
                                          6/9
    ACTUAL   POS    (MSTR POS)    (SEL)   [ST]
J1          0.000   (     0.000)  (0)     [2]
J2          0.000   (     0.000)  (0)     [2]
J3          0.000   (     0.000)  (0)     [2]
J4          0.000   (     0.000)  (0)     [2]
J5          0.000   (     0.000)  (0)     [2]
J6         90.000   (     0.000)  (1)     [0]
E1          0.000   (     0.000)  (0)     [0]
E2          0.000   (     0.000)  (0)     [0]
E3          0.000   (     0.000)  (0)     [0]

                                          EXEC
```

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].



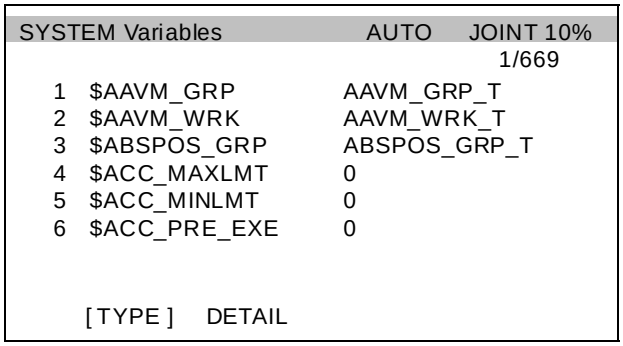
11 Return brake control to original setting, and cycle power of the controller.

8.7 MASTERING DATA ENTRY

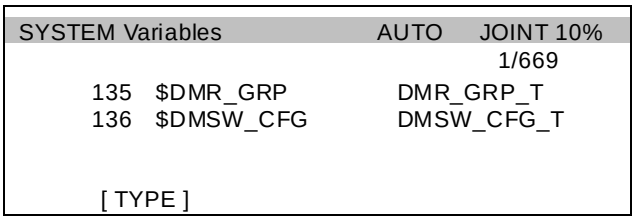
This function enables mastering data values to be assigned directly to a system variable. It can be used if mastering data has been lost but the pulse count is preserved.

Mastering data entry method

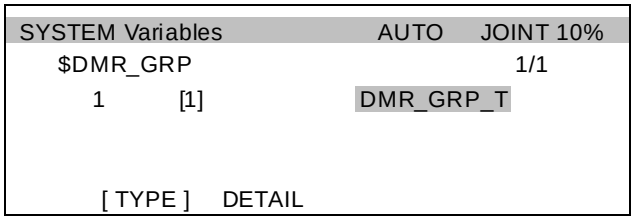
1 Press [MENU] key, then press [0 NEXT] and select [6 SYSTEM].
2 Press F1 [TYPE]. Select [Variables]. The system variable screen will be displayed.

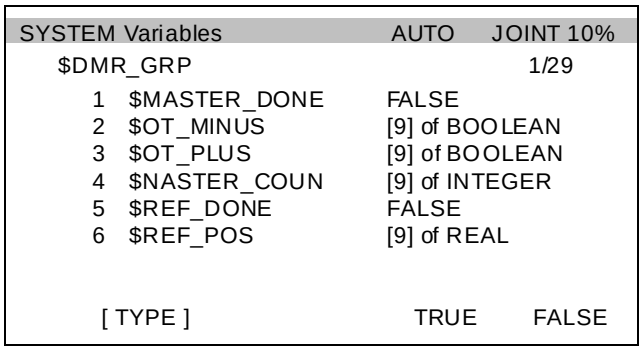


3 Change the mastering data. The mastering data is saved to the $DMR_GRP.$MASTER_COUN system variable.



4 Select $DMR_GRP.





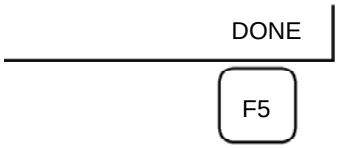
5 Select $MASTER_COUN, and enter the mastering data you have recorded.

```
SYSTEM Variables                    AUTO    JOINT 10%
   $DMR_GRP[1].$MASTER_COUN                  1/9
     1     [1]              95678329
     2     [2]              10223045
     3     [3]              3020442
     4     [4]              30405503
     5     [5]              20497709
     6     [6]              2039490
     7     [7]              0
     8     [8]              0
     9     [9]              0


      [ TYPE ]
```

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

```
SYSTEM Variables                    AUTO    JOINT 10%
   $DMR_GRP                                  1/29
     1  $MASTER_DONE          TRUE
     2  $OT_MINUS             [9] of BOOLEAN


      [ TYPE ]                  TRUE    FALSE
```

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



8.8 CHECKING THE MASTERING

1 How to check the robot mastered properly

Usually, positioning is performed automatically at the power on. To check whether mastering has been performed correctly, examine if the current displayed position meets the actual robot position by using the procedure described below:

(1) Reproduce a particular point in a program. Check whether the point agrees with the specified position.

(2) Set all axes of the robot to their 0-degree (0 rad) positions. Check that the zero-degree position marks indicated in Section 8.3 of OPERATOR'S MANUAL are aligned. No need of 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 in 2. Alternatively, the mastering data in system variable $DMR_GRP.$MASTER_COUN may have been overwritten as a result of an operation error or some other reason.

Compare the data with the values indicated on the supplied data sheet. This system variable is overwritten whenever mastering is performed. Whenever mastering is performed, record the value of the system variable on the data sheet.

2 Alarm type displayed during mastering and their Solution methodology

(1) BZAL alarm

This alarm is alert if the Pulsecoder's backup battery voltage decreases to 0 V while the power to the controller is disconnected. Furthermore, if Pulsecoder connector is removed for replacing cables etc. this alarm is output as the voltage decreased to 0. Confirm if the alarm will disappear by performing pulse reset (See Section 8.2.). And then cycle power of the controller to check if the alarm disappears or not.

The battery may be drained if the alarm is still displayed. Perform pulse reset, turn off and on the controller power after replacing the battery. Note that, if this alarm displayed, all the original data held by the Pulsecoder will be lost. Mastering is required.

(2) BLAL alarm

Warn 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) Alarm notification like CKAL, RCAL, PHAL, CSAL, DTERR, CRCERR, STBERR, and SPHAL may have trouble with Pulsecoder, contact your local FANUC representative.

9 TROUBLESHOOTING

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

9.1 TROUBLESHOOTING

Table 9.1 shows the problems that may occur in the mechanical unit and their probable causes. If you cannot pinpoint the cause of a failure or which measures to take, contact your local FANUC representative.

Table 9.1 Troubleshooting

Symptom	Description	Cause	Measure
Vibration Noise	- As the robot operates, the J2 base lifts off the J1-axis traveling unit. - There is a gap between the J2 base and J1-axis traveling unit. - A bolt for fastening the J2 base is loose.	[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.
	- As the robot operates, the J1-axis traveling unit or rail vibrates.	[J1-axis traveling unit or rail] - It is likely that the J1-axis traveling unit or rail is not sufficiently rigid.	- Reinforce the J1-axis traveling unit or rail to make it more rigid. - If it is impossible to reinforce the J1-axis traveling unit or rail, modify the robot operation program; doing so might reduce the amount of vibration.
	- Vibration becomes more serious when the robot adopts a specific posture. - If the operating speed of the robot is reduced, vibration stops. - Vibration is most noticeable when the robot is accelerating. - Vibration occurs when two or more axes operate at the same time.	[Overload] - It is likely that the load on the robot is greater than the maximum rating. - It is likely that the robot control program is too demanding for the robot hardware. - It is likely that the ACCELERATION value is excessive.	- Check the maximum load that the robot can handle once more. If the robot is found to be overloaded, reduce the load, or modify the robot control program. - Vibration in a specific portion can be reduced by modifying the robot control program while slowig the robot and reducing its acceleration (to minimize the influenece on the entire cycle time).

Symptom	Description	Cause	Measure
Vibration Noise (Continued)	- Vibration or noise was first noticed after the robot collided with an object or the robot was overloaded for a long period. - The grease of the vibrating or noise occurring axis has not been exchanged for a long period. - Cyclical vibration and noise occur.	[Gear, bearing, or reducer] - It is likely that collision or overload applied an excessive force on the drive mechanism, thus damaging the geartooth surface or rolling surface of a bearing, or reducer. - Prolonged overloaded use may cause fretting fatigue on the gear tooth surface or the rolling surface of bearing and reducer. - It is likely that foreign material caught in a gear, bearing, or within a reducer caused damage on the gear tooth surface or rolling surface of the bearing, or reducer. - It is likely that foreign material caught in a gear, bearing, or within a reducer cause vibration. - It is likely that, because the grease has not been changed for a long period, fretting occurred on the gear tooth surface or rolling surface of a bearing, or reducer due to metal fatigue 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 the problem cannot be identified from examination of the J1-axis traveling unit, rail, 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. - A 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 has an intermittent break, vibration might occur. - If the power source voltage drops below the rating, vibration might occur. - The robot may vibrate when an invalid robot control 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 there is a mechanical problem. - 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 cable jacket of the robot connection cable is damaged. If so, replace the connection cable, and check whether vibration still occurs. - Check whether the power cable jacket is damaged. If so, replace the power cable, and check whether vibration still occurs. - Check that the robot is supplied with the rated voltage. - Check that the robot control parameter is set to a valid value. If it is set to an invalid value, correct it. Contact your local FANUC representative for further information if necessary.

Symptom	Description	Cause	Measure
Vibration Noise (Continued)	- There is some relationship between the vibration of the robot and the operation of a machine near the robot.	[Noise from a nearby machine] - If the robot is not grounded properly, electrical noise is induced on the grounding wire, preventing commands from being transferred accurately, thus leading to vibration. - If the robot is grounded at an unsuitable point, its grounding potential becomes unstable, and noise is likely to be induced on the grounding line, thus leading to vibration.	- Connect the grounding wire firmly to ensure a reliable ground potential and prevent extraneous electrical noise.
	- There is an unusual sound after replacement of grease. - There is an unusual sound after a long period of time. - There is an unusual sound during operation at low speed.	- There may be an unusual sound when using other than the specified grease. - Even for the specified grease, there may be an unusual sound during operation at low speed immediately after replacement or after a long period of time.	- Use the specified grease. - When there is an unusual sound even for specified grease, perform operation for one or two days on an experiment. Generally, an usual sound will disappear.
Rattling	- While the robot is not supplied with power, pushing it with the hand causes part of the mechanical unit to wobble. - There is a gap on the mounting surface of the mechanical unit.	[Mechanical section coupling bolt] - It is likely that overloading or a collision has loosened a mounting bolt in the robot mechanical section.	- Check 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 effector retaining bolt

Symptom	Description	Cause	Measure
Motor overheating	- The motor overheated due to the temperature in the installation area rose. - After a cover was attached to the motor, the motor overheated. - After changing the Robot control program or the load, the motor overheats.	[Ambient temperature] - It is likely that the motor overheated along with the ambient temperature rose, and could not release heat. [Operating condition] - It is likely that the overcurrent above the specified permissive average current.	- Reducing the ambient temperature is the most effective means of preventing overheat. - If there is a source of heat near, 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.
	- After a control parameter (load setting etc.) was changed, the motor overheated.	[Parameter] - If data input for a workpiece is invalid, the robot cannot be accelerate or decelerate normally, so the average current increases, leading to the motor overheating.	- As for load setting, Input an appropriate parameter referring to Section 4.3.
	- Symptom 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 while standing still.
		[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 soak 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

Symptom	Description	Cause	Measure
Displace-ment	- The robot moves to a point other than the taught position. - The repeatability is not within the tolerance.	[Mechanical unit problems] - If the repeatability is unstable, probable causes are a failure in the drive mechanism or a loose bolt. - If the repeatability becomes stable, it is likely that a collision imposed an excessive load, leading to slipping on the base surface or the mating surface of an arm or reducer. - It is likely that the Pulsecoder is faulty.	- If the repeatability is unstable, repair the mechanical unit by referring to the above descriptions of vibration, noise, and rattling. - If the repeatability is stable, correct the taught program. The problem will not occur unless another collision occurs. - If the Pulsecoder is faulty, replace the motor.
	- 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	- The voltage of the memory backup battery is low. - The Pulsecoder cable is defective.	- Replace the battery. - Replace the cable.

10 SEVERE DUST/LIQUID PROTECTION PACKAGE (OPTION)

10.1 OVERVIEW

The package is intended to improve the Severe dust/Liquid protection characteristics of the robot so that it can be used in a severe environment.

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

Model	Severe dust/liquid protection specification
M-710*i*C/50T/70T	A05B-1125-J807 (*1)
	A05B-1125-J825 (*2)
	A05B-1125-J817 (*3)

(*1) When mechanical unit cable for camera is not selected.
(*2) When mechanical unit cable for camera A05B-1125-H432 is selected.
(*3) When mechanical unit cable for camera A05B-1125-H431 is selected.

10.2 CONFIGURATION OF THE SEVERE DUST/LIQUID PROTECTION PACKAGE

The following table lists the major differences between the M-710*i*C/50T/70T standard specification and severe dust/liquid protection package.

	Standard specification	Dust-proof/drip-proof enhancement option
Bolts	Dyed black steel bolt	FR coating bolt Stainless bolt
Washer	Dyed black washer	Black chrome washer
Cover		J2 cover Battery box cover
EE connector	Non-waterproof connector	Waterproof connector
Others		Gasket Packing is added.

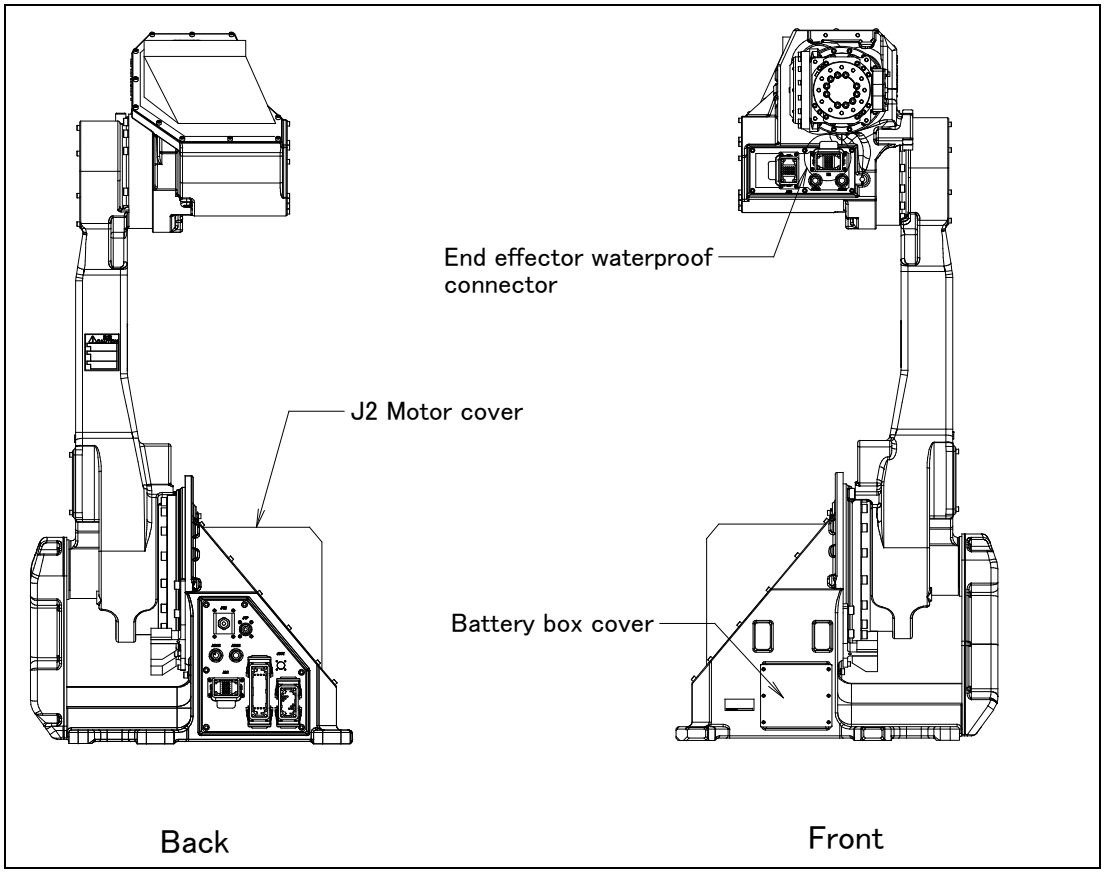


Fig. 10.2 Configuration of the severe dust/liquid protection package of M-710*i*C/50T/70T

APPENDIX

A PERIODIC MAINTENANCE TABLE

FANUC Robot M-710*i*C/50T/70T **Periodic Maintenance Table**

Items		Accumulated operating time (H))	Check time	Grease amount	First check 320	3 months 960	6 months 1920	9 months 2880	1 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 for water	0.1H	-		○	○	○	○	○	○	○	○	○	○	○
	3	Check the mechanical cable. (damaged or twisted)	0.2H	—					○				○			
	4	Check the motor connector. (loosening)	0.2H	—					○				○			
	5	Tighten the end effector bolt.	0.2H	—		○			○				○			
	6	Tighten the cover and main bolt.	2.0H	—		○			○				○			
	7	Check the mechanical stopper and adjustable mechanical stopper	0.1H			○			○				○			
	8	Clean spatters, sawdust and dust	1.0H	—		○			○				○			
	9	Check the end effector (hand) cable	0.1H			○			○				○			
	10	Replacing battery.	0.1H	—							●					
	11	Replacing grease of J2 axis reducer	0.5H	1700ml												
	12	Replacing grease of J3 axis reducer	0.5H	1100ml												
	13	Replacing grease of J4/J5/J6-axis gearbox	0.5H	920ml												
	14	Replacing grease of wrist axis unit	0.5H	610ml												
	15	Replacing cable of mechanical unit *	4.0H	—												
Controller	16	Check the robot cable, teach pendant cable and robot connecting cable	0.2H	—		○			○				○			
	17	Cleaning the controller ventilation system	0.2H	—	○	○	○	○	○	○	○	○	○	○	○	○
	18	Replacing battery *1	0.1H	—												

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

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

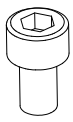
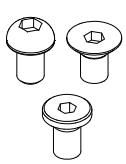
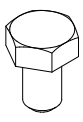
3 years 11520	12480	13440	14400	4 years 15360	16320	17280	18240	5 years 19200	20160	21120	22080	6 years 23040	24000	24960	25920	7 years 26880	27840	28800	29760	8 years 30720	Item
○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○		1
○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○		2
○				○				○				○				○					3
○				○				○				○				○					4
○				○				○				○				○					5
○				○				○				○				○					6
○				○				○				○				○					7
○				○				○				○				○					8
○				○				○				○				○					9
●						●						●						●		Overhaul	10
●												●									11
●												●									12
●												●									13
●												●									14
				●																	15
○				○				○				○				○					16
○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○		17
				●																	18

B STRENGTH OF BOLT AND BOLT TORQUE LIST

NOTE
When applying LOCTITE to a part, spread the LOCTITE on the entire length area 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 the oil on the engaging section. Make sure that there is no solvent left in the threaded holes. In this case, remove all the excess LOCTITE when you are finished screwing the bolts into the threaded holes.

Adopt following strength bolts. Comply with any bolt specification instructions as specified.
Hexagon socket head bolt made by 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 are not specified.

Recommended bolt tightening torques **Unit: Nm**

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

C INSULATION ABOUT ARC WELDING ROBOT

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

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

C.1 INSULATION AT THE WRIST

Please be careful to the following contents.

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

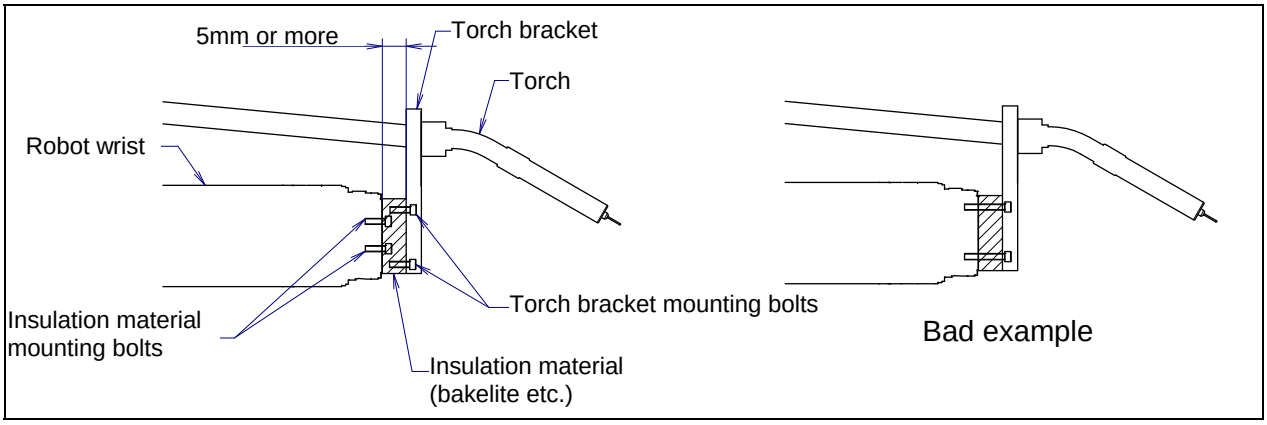


Fig. C.1 Insulation at the wrist

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

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REVISION RECORD

Edition	Date	Contents
05	Apr.,2018	• Addition of R-30*i*B Plus, R-30*i*B Mate Plus Controller • Corrections of errors
04	Jun.,2012	• Addition of R-30*i*B Controller • Addition of note for low temperature • Addition of check of oil exudation • Change of specification of mechanical unit cable • Corrections of errors
03	Nov.,2010	• Addition of stop type of robot • Addition of stopping time and distance when controlled stop is executed • Addition note of end effector (hand) cable • Corrections of errors
02	Jan.,2008	• Change the name of controller (From R-J3*i*C to R-30*i*A) • Addition of a procedure to move arms in emergency or abnormal situations • Addition of notes to transportation with an end effector attached • Add the note of the transportation equipments • Change the manufacture name of Daiichi Denshi Kogyo K.K to Fujikura Ltd. • Addition of coasting time and distance when emergency stop • Addition of Severe Dust/Liquid Protection Option Correction of errors
01	Oct.,2006	

B-82504EN/05