2411, MSRAEN-241-027, 001

NACHI

INSTRUCTION MANUAL MANIPULATOR

SRA-01 series [FD11/FD18/FD20]

27th edition

- Before attempting to operate the robot, please read through this operating manual carefully, and comply with all the safety-related items and instructions in the text.
- The installation, operation and maintenance of this robot should be undertaken only by those individuals who have attended one of our robot course.
- When using this robot, observe the low related with industrial robot and with safety issues in each country.
- This operating manual must be given without fail to the individual who will be actually operating the robot.
- Please direct any queries about parts of this operating manual which may not be completely clear or any inquiries concerning the after-sale service of this robot to any of the service centers listed on the back cover.

NACHI-FUJIKOSHI CORP.

This manual explains the robot specifications, structure of each part and the basic handling precautions for inspection and maintenance to maintain function of the robot for a long period of time.

It is strongly recommended that this manual is read by robot utilization planners and installation staff as well as inspectors and maintenance staff for handling robot. And the robot is handled only after understanding this manual thoroughly.

To use robot safely

Read this manual and other concerning manuals carefully prior to installation, operation, maintenance, and inspection, so you can use all the equipment correctly. Use the robot only after fully understanding the equipment, all the safety guidelines, and the precautions. (☞ "Precautions for handling industrial robots" or ☞ "Instruction Manual SETUP"-"Chapter 1 Point on Safety")

In this manual, we use the symbols shown below to show the level of danger of the each label.

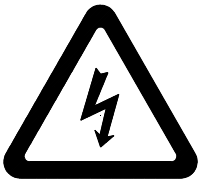
 DANGER	This indicates that the possibilities of danger can occur when the robot is handled incorrectly.(e.g. Death or serious injuries can occur.) And also includes urgency of warnings in a highly dangerous situation. Always observe these precautions to safely use the robot.
 WARNING	This indicates that the possibilities of danger can occur when the robot is handled incorrectly.(e.g. Death or serious injuries can occur.) Always observe these precautions to safely use the robot.
 CAUTION	This indicates that the possibilities of danger can occur when the robot is handled incorrectly. (e.g. Minor injuries or property damage can occur.) Always observe these precautions to safely use the robot.

The following symbol is also used for important checkpoints.

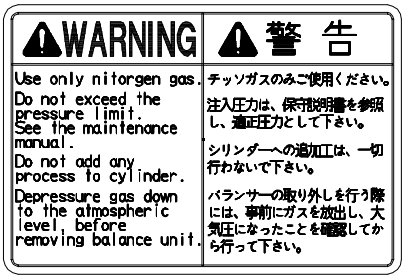
 IMPORTANT	A particularly important checkpoint is indicated.

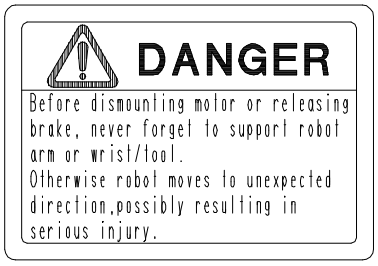
Danger and caution signs on manipulator

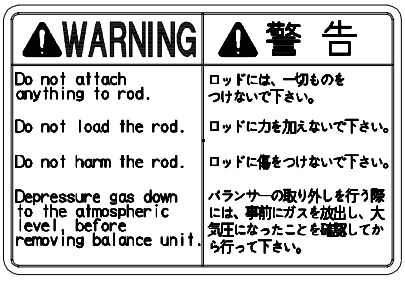
Following signs are applied on manipulator. These signs location may vary or even may not be on the robot according to the robot's type and its axes

	This sign indicates a power supply inlet for the robot. Motor and detecting device power is supplied to connectors and terminal blocks, which is inside of the connector covers of each parts of the robot. Never touch connectors or terminal blocks directly or indirectly with conductive items when the main power is on, as electric shock may occur. If connectors or terminal blocks are disconnected when the main power is on, electric shock or malfunction of the robot may occur. Make sure to turn OFF the main power on the controller when performing any maintenance.
	This sign indicates the parts of the robot, which will become hot. Carelessly touching the parts, where the signs are may result in serious burns.
	This sign indicates the dangerous area, operators may get caught by the robot. Never come close to the area, where these signs are. Brakes can be released not only during teaching, but also while the motors are OFF. Please pay extra attention and make prevention plan in advance when performing maintenance or any types of work to avoid pinching any parts of your body before coming close to this area.

Signs for other types of caution and warnings;
Ignoring these signs and disassembling some parts may cause fatal injuries, death, or damage any equipment around.







Signs for protection;

Chapter 1 Basic specifications

1.1 List of basic specifications

Standard type

Item		Specifications				
Robot type		SRA100-01	SRA166-01	SRA210-01	SRA240-01	SRA250-01
Structure		Articulated				
Degree of Freedom		6				
Drive system		AC servo motor				
Maximum Motion range	Axis 1	±3.14 rad (±180°)				
	Axis 2	-1.40 ～ +1.05 rad (-80 ～ +60°)				
	Axis 3	-2.56 ～ +2.62 rad (-146.5 ～ +150°)				-2.44 ～ +2.62rad (-140 ～ +150°)
	Axis 4	±6.28 rad (±360°)				
	Axis 5	±2.36 rad (±135°)		±2.27 rad (±130°)		
	Axis 6	±6.28 rad (±360°)				
Maximum Velocity	Axis 1	2.37 rad/s (136°/s)	2.18 rad/s (125°/s)	2.01 rad/s (115°/s)	1.83 rad/s (105°/s)	1.75 rad/s (100°/s)
	Axis 2	2.36 rad/s (135°/s)	2.01 rad/s (115°/s)	1.83 rad/s (105°/s)	1.57 rad/s (90°/s)	1.57 rad/s (90°/s)
	Axis 3	2.36 rad/s (135°/s)	2.11 rad/s (121°/s)	1.97 rad/s (113°/s)	1.74 rad/s (100°/s)	1.66 rad/s (95°/s)
	Axis 4	4.19 rad/s (240°/s)	3.14 rad/s (180°/s)	2.44 rad/s (140°/s)	2.27 rad/s (130°/s)	2.18 rad/s (125°/s)
	Axis 5	4.07 rad/s (233°/s)	3.02 rad/s (173°/s)	2.32 rad/s (133°/s)	2.18 rad/s (125°/s)	2.18 rad/s (125°/s)
	Axis 6	6.13 rad/s (351°/s)	4.54 rad/s (260°/s)	3.49 rad/s (200°/s)	3.40 rad/s (195°/s)	3.32 rad/s (190°/s)
Maximum pay load	Wrist	100 kg	166 kg	210 kg	240 kg	250 kg
	Forearm *1	45 kg (90 kg at maximum)			20 kg (45 kg at maximum)	
Maximum static load torque	Axis 4	580 N·m	951 N·m	1,337 N·m		
	Axis 5	580 N·m	951 N·m	1,337 N·m		
	Axis 6	290 N·m	490 N·m	720 N·m		
Maximum moment of inertia *2	Axis 4	60 kg·m^2	88.9 kg·m^2	141.1 kg·m^2		225.4 kg·m^2
	Axis 5	60 kg·m^2	88.9 kg·m^2	141.1 kg·m^2		225.4 kg·m^2
	Axis 6	30 kg·m^2	45.0 kg·m^2	79.0 kg·m^2		196.0 kg·m^2
Position repeatability *3		±0.06 mm				
Mounting Condition		Floor				
Ambient conditions		Temperature: 0 to 45 ºC *4 Humidity: 20 to 85%RH (No dew, nor frost allowed) Vibration to the installation face: Not more than 0.5G (4.9 m/s^2)				
Protection class		Wrist ; IP67 equivalent, Body ; IP54 equivalent				
Noise *5		79.6 dB				
Robot weight		960 kg		990 kg		1,030 kg

1[rad] = 180/π[°], 1[N·m] = 1/9.8[kgf·m]
- Axis 1 - Axis 6 are displayed as J1-J6 each on the controller screen.
- Specifications are subject to change without prior notice for technical changes
- Explosion-proof version is not available.

*1: This value changes by placement and load conditions of a wrist. *2: Maximum moment of inertia of a wrist changes due to the load condition. *3: JIS B 8432 conformance. *4: Using at 1000m or lower sea level. Ambient temperature has limitations when allowable altitude is exceeded. *5: Robot noise is A-weighted equivalent sound level measured under “JIS Z 8737-1” (ISO 11201) with maximum. payload and maximum velocity.

Long arm type

Item		Specifications		
Robot type		SRA120EL-01	SRA133L-01	SRA166L-01
Structure		Articulated		
Degree of Freedom		6		
Drive system		AC servo motor		
Maximum Motion range	Axis 1	±3.14 rad (±180°)		
	Axis 2	-1.40 ～ +1.05 rad (-80 ～ +60°)		
	Axis 3	-2.23 ～ +2.62 rad (-127.7 ～ +150°)	-2.33 ～ +2.62 rad (-133.4 ～ +150°)	
	Axis 4	±6.28 rad (±360°)		
	Axis 5	±2.36 rad (±135°)		
	Axis 6	±6.28 rad (±360°)		
Maximum Velocity	Axis 1	2.01 rad/s (115°/s)	2.18 rad/s (125°/s)	2.01 rad/s (115°/s)
	Axis 2	1.83 rad/s (105°/s)	2.01 rad/s (115°/s)	1.83 rad/s (105°/s)
	Axis 3	1.97 rad/s (113°/s)	2.11 rad/s (121°/s)	1.97 rad/s (113°/s)
	Axis 4	2.44 rad/s (140°/s)		
	Axis 5	3.02 rad/s (173°/s)		
	Axis 6	4.54 rad/s (260°/s)		
Maximum pay load	Wrist	120 kg	133 kg	166 kg
	Forearm *1	45 kg (90 kg at maximum)		
Maximum static load torque	Axis 4	687 N·m	800 N·m	951 N·m
	Axis 5	687 N·m	800 N·m	951 N·m
	Axis 6	353 N·m	400 N·m	490 N·m
Maximum moment of inertia *2	Axis 4	60 kg·m^2	76 kg·m^2	88.9 kg·m^2
	Axis 5	60 kg·m^2	76 kg·m^2	88.9 kg·m^2
	Axis 6	30 kg·m^2	38 kg·m^2	45.0 kg·m^2
Position repeatability *3		±0.06 mm		
Mounting Condition		Floor		
Ambient conditions		Temperature: 0 to 45 ºC *4 Humidity: 20 to 85%RH (No dew, nor frost allowed) Vibration to the installation face: Not more than 0.5G (4.9 m/s^2)		
Protection class		Wrist ; IP67 equivalent, Body ; IP54 equivalent		
Noise *5		79.6 dB		
Robot weight		985kg	980 kg	

1[rad] = 180/π[°], 1[N·m] = 1/9.8[kgf·m]
- Axis 1 - Axis 6 are displayed as J1-J6 each on the controller screen.
- Specifications are subject to change without prior notice for technical changes
- Explosion-proof version is not available.

*1: This value changes by placement and load conditions of a wrist. *2: Maximum moment of inertia of a wrist changes due to the load condition. *3: JIS B 8432 conformance. *4: Using at 1000m or lower sea level. Ambient temperature has limitations when allowable altitude is exceeded. *5: Robot noise is A-weighted equivalent sound level measured under “JIS Z 8737-1” (ISO 11201) with maximum. payload and maximum velocity.

Long arm type

Item		Specifications	
Robot type		SRA210L-01	SRA240L-01
Structure		Articulated	
Degree of Freedom		6	
Drive system		AC servo motor	
Maximum Motion range	Axis 1	±3.14 rad (±180°)	
	Axis 2	-1.40 ～ +1.05 rad (-80 ～ +60°)	
	Axis 3	-2.31 ～ +2.62 rad (-132.4 ～ +150°)	-2.37 ～ +2.62 rad (-135.8 ～ +150°)
	Axis 4	±6.28 rad (±360°)	
	Axis 5	±2.27 rad (±130°)	
	Axis 6	±6.28 rad (±360°)	
Maximum Velocity	Axis 1	1.75 rad/s (100°/s)	
	Axis 2	1.57 rad/s (90°/s)	
	Axis 3	1.66 rad/s (95°/s)	
	Axis 4	2.18 rad/s (125°/s)	
	Axis 5	2.18 rad/s (125°/s)	
	Axis 6	3.32 rad/s (190°/s)	
Maximum pay load	Wrist	210 kg	240 kg
	Forearm *1	20 kg	
Maximum static load torque	Axis 4	1,000 N·m	1,140 N·m
	Axis 5	1,000 N·m	1,140 N·m
	Axis 6	720 N·m	720 N·m
Maximum moment of inertia *2	Axis 4	141.1 kg·m^2	
	Axis 5	141.1 kg·m^2	
	Axis 6	79.0 kg·m^2	
Position repeatability *3		±0.06 mm	
Mounting Condition		Floor	
Ambient conditions		Temperature: 0 to 45 ºC *4 Humidity: 20 to 85%RH (No dew, nor frost allowed) Vibration to the installation face: Not more than 0.5G (4.9 m/s^2)	
Protection class		Wrist ; IP67 equivalent, Body ; IP54 equivalent	
Noise *5		79.6 dB	
Robot weight		1050 kg	

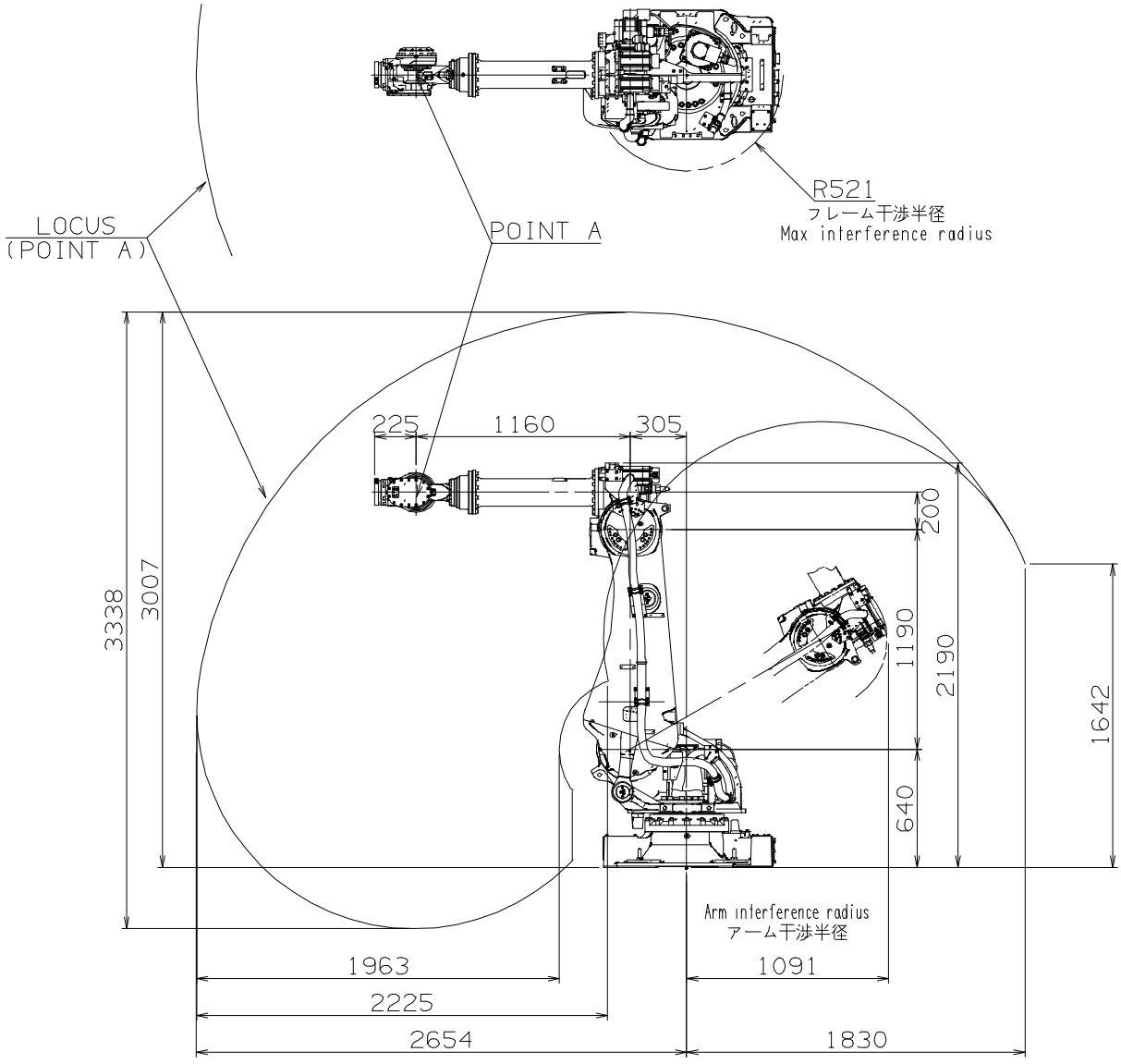
1[rad] = 180/π[°], 1[N·m] = 1/9.8[kgf·m]
- Axis 1 - Axis 6 are displayed as J1-J6 each on the controller screen.
- Specifications are subject to change without prior notice for technical changes
- Explosion-proof version is not available.

*1: This value changes by placement and load conditions of a wrist. *2: Maximum moment of inertia of a wrist changes due to the load condition. *3: JIS B 8432 conformance. *4: Using at 1000m or lower sea level. Ambient temperature has limitations when allowable altitude is exceeded. *5: Robot noise is A-weighted equivalent sound level measured under “JIS Z 8737-1” (ISO 11201) with maximum. payload and maximum velocity.

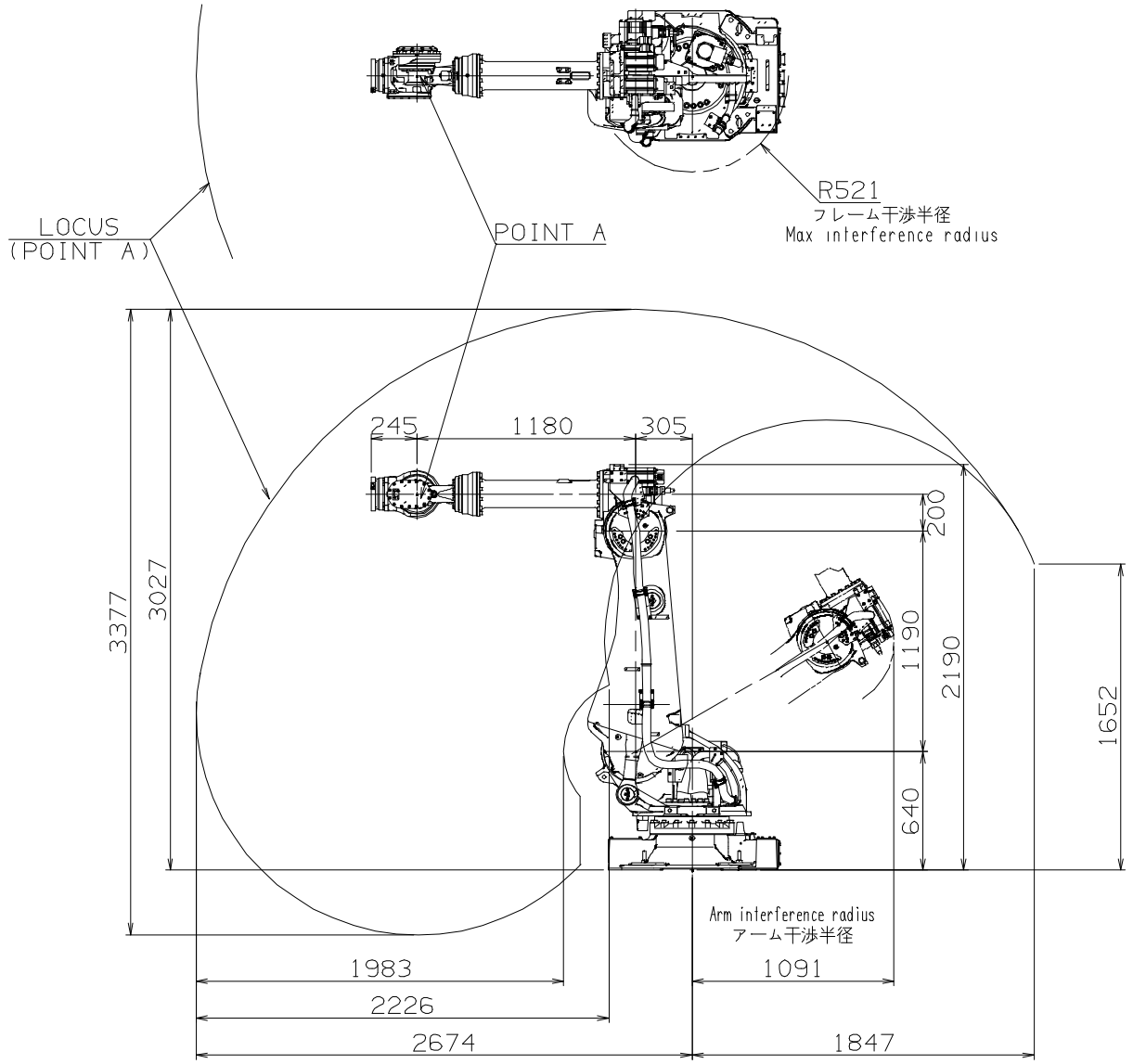
CAUTION	**Position repeatability is defined in accordance with JIS B 8432 (ISO 9283) (Pose repeatability). Repeatability under the following conditions is not guaranteed.** ・During repeated operation, the case in which approaching movement involves different directions and different orientations toward the measuring point. ・During repeated operation, the case in which payload condition changes. (for example, existence / no-existence of work-piece) ・During repeated operation, the case in which environment temperature changes. (Robot arm may cause the position repeatability to deteriorate.) ・The case in which position repeatability before and after warm-up is required. ・The case in which position repeatability of numeric position written in robot coordinate system and position in real space is required. (this is "Absolute position accuracy") ・The case in which position repeatability of position generated by shift command or palletize command and position in real space is required.

1.2 Dimensions and motion range

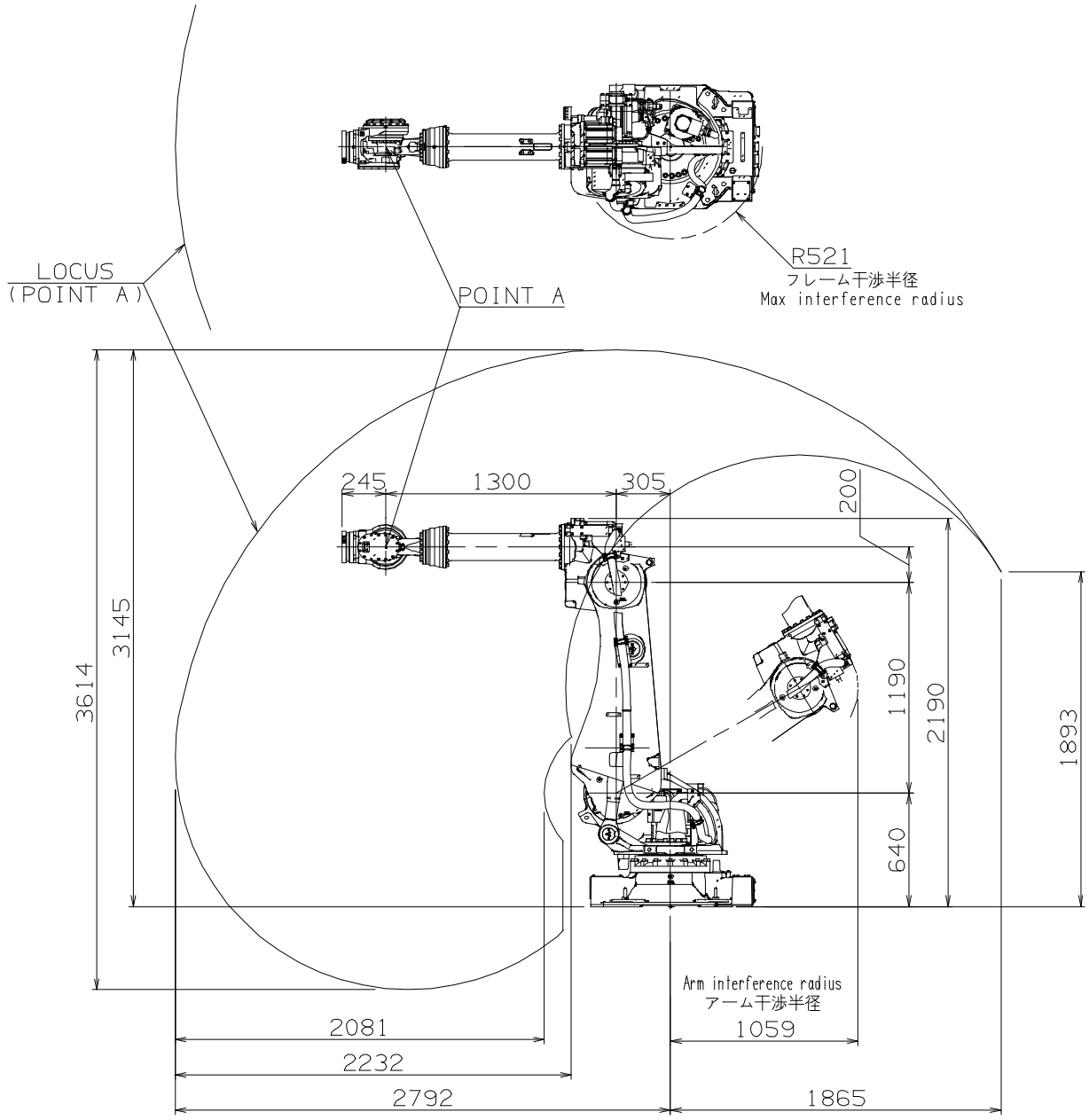
[SRA100-01] [SRA166-01]



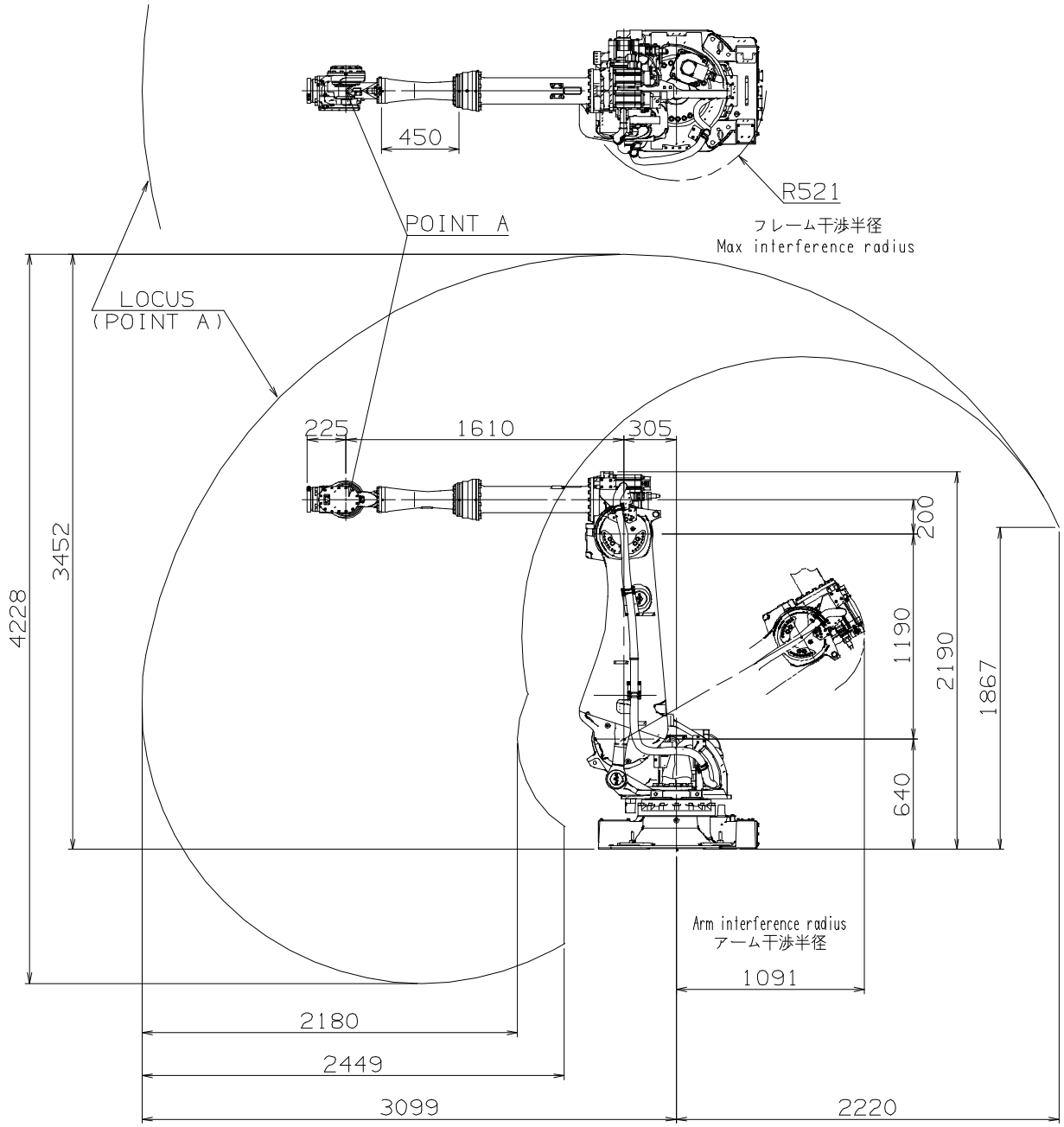
[SRA210-01] [SRA240-01]



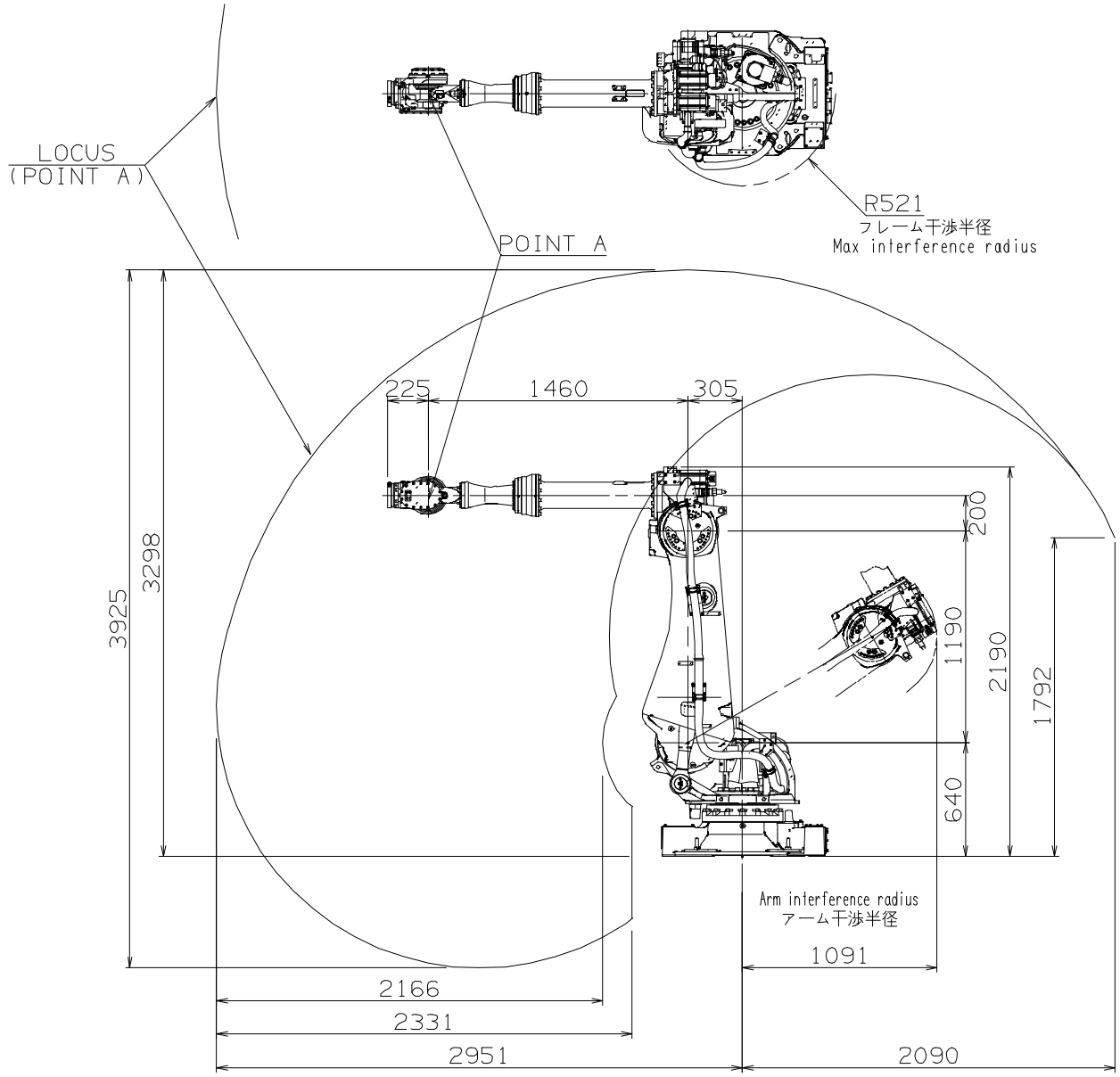
[SRA250-01]


LOCUS
(POINT A)
POINT A
R521
フレーム干渉半径
Max interference radius
245
1300
305
200
3614
3145
1190
2190
1893
640
Arm interference radius
アーム干渉半径
2081
1059
2232
2792
1865

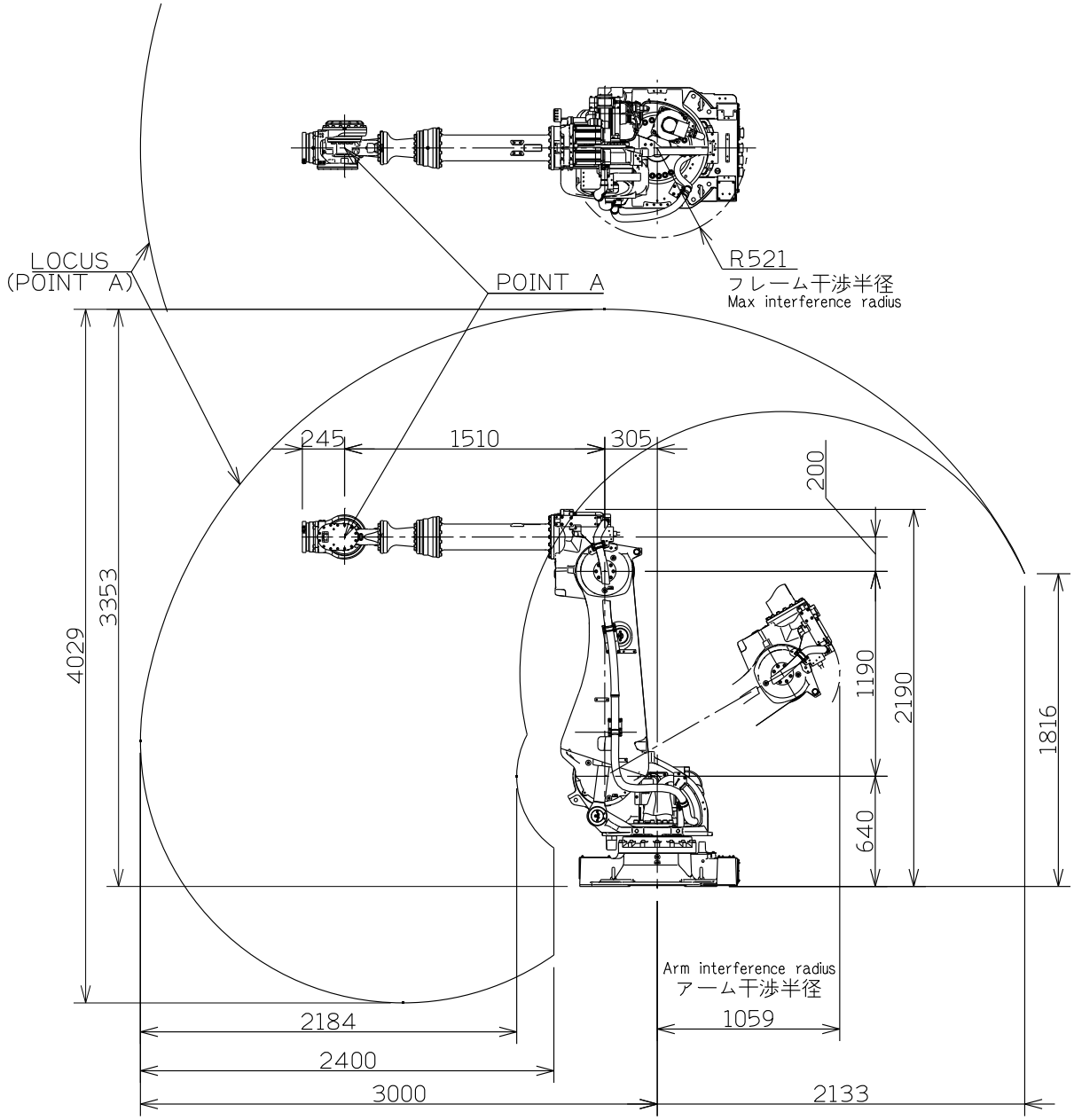
【SRA120EL-01】


450
R521
フレーム干渉半径
Max interference radius
POINT A
LOCUS
(POINT A)
225
1610
305
200
1190
2190
1867
640
3452
4228
Arm interference radius
アーム干渉半径
1091
2180
2449
3099
2220

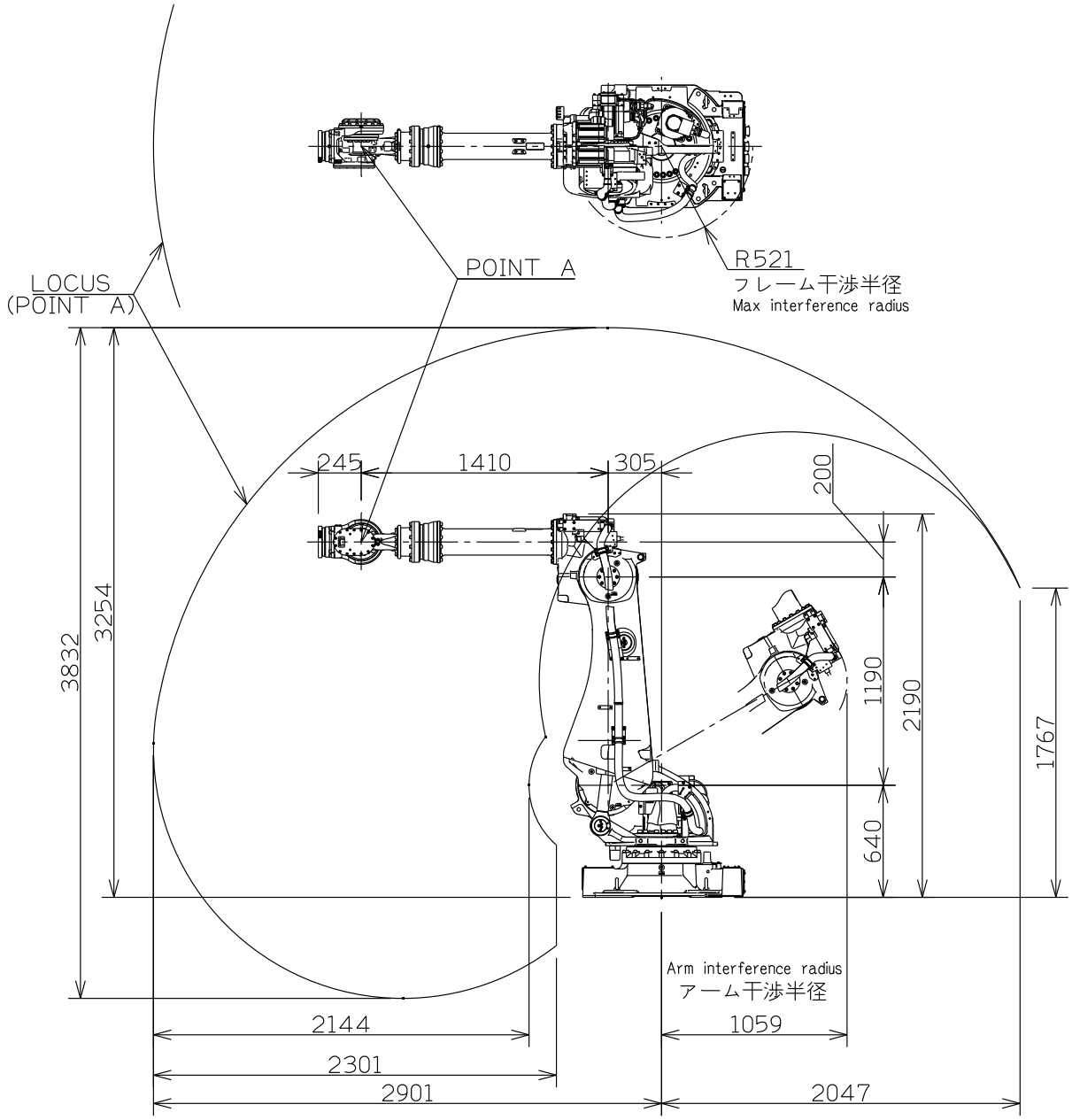
[SRA133L-01] [SRA166L-01]



[SRA210L-01]


LOCUS
(POINT A)
POINT A
R521
フレーム干渉半径
Max interference radius
245
1510
305
200
3353
4029
1190
2190
1816
640
Arm interference radius
アーム干渉半径
2184
1059
2400
3000
2133

[SRA240L-01]


LOCUS
(POINT A)
POINT A
R521
フレーム干渉半径
Max interference radius
245
1410
305
200
3832
3254
1190
2190
1767
640
Arm interference radius
アーム干渉半径
2144
1059
2301
2901
2047

1.3 Details of load mounting face

■ Wrist

For the end effecter fixing bolts, use the mounting P.C.D. shown in the following drawings.
Another P.C.D. is prepared as option. Consult with each NACHI-FUJIKOSHI office for the details.

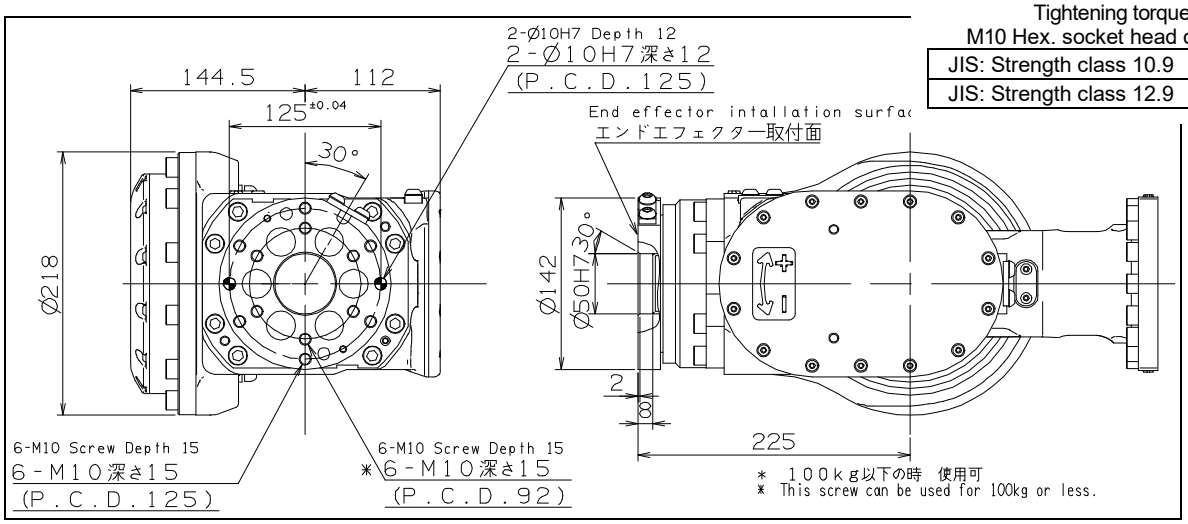
CAUTION	Be sure to screw the M10 end effecter fixing bolts in the wrist not deeper than the screw depth in the installation face. Screwing the bolts deeper than the screw depth may damage the wrist.

[SRA100-01] [SRA166-01] [SRA120EL-01] [SRA133L-01] [SRA166L-01]

IMPORTANT	Be sure to use P.C.D.125 tap hole when tool weight is100 kg or more.

Tightening torque of M10 Hex. socket head cap screw

JIS: Strength class 10.9	55 N･m
JIS: Strength class 12.9	67 N･m

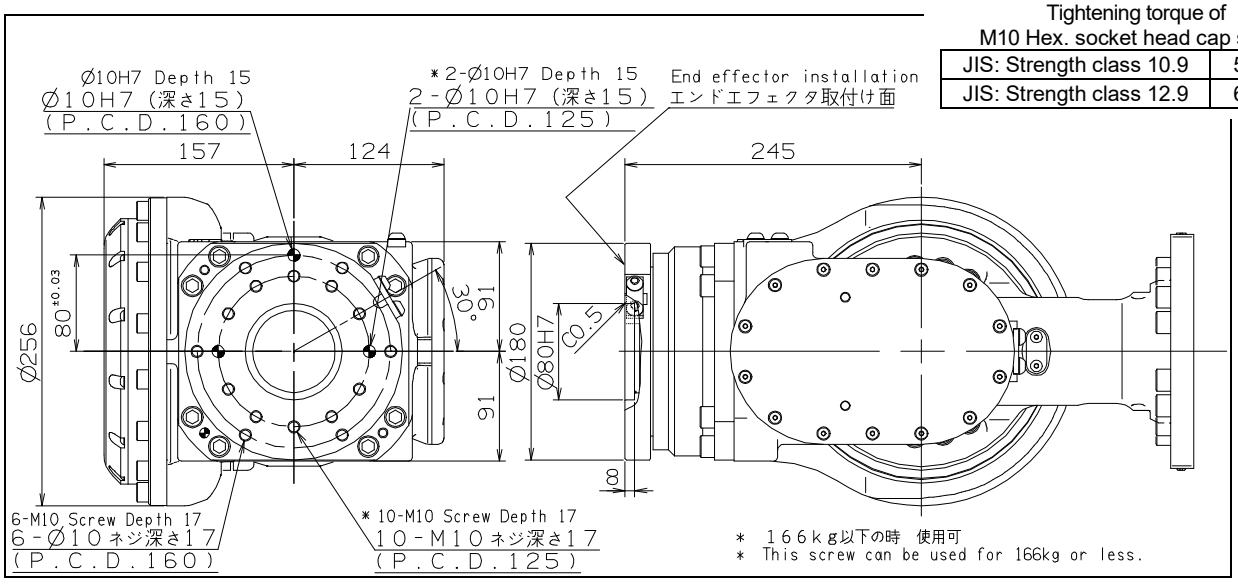


[SRA210-01] [SRA240-01] [SRA250-01] [SRA210L-01] [SRA240L-01]

IMPORTANT	Be sure to use P.C.D.160 tap hole when tool weight is166 kg or more.

Tightening torque of M10 Hex. socket head cap screw

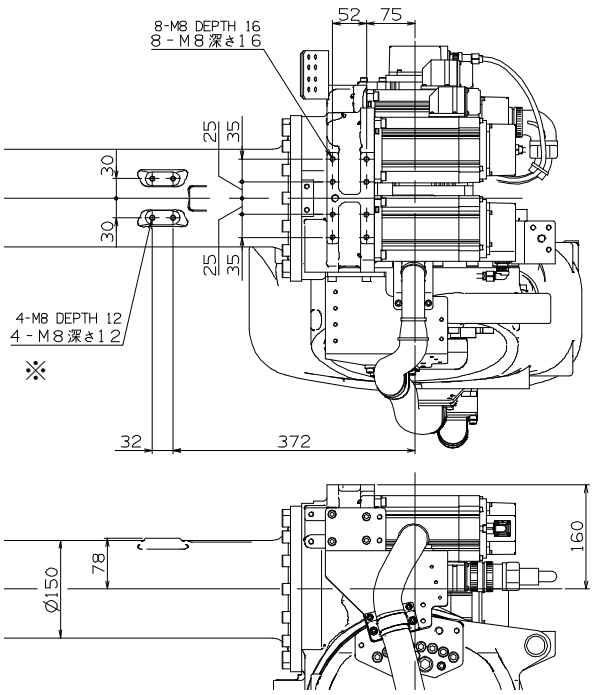
JIS: Strength class 10.9	55 N･m
JIS: Strength class 12.9	67 N･m



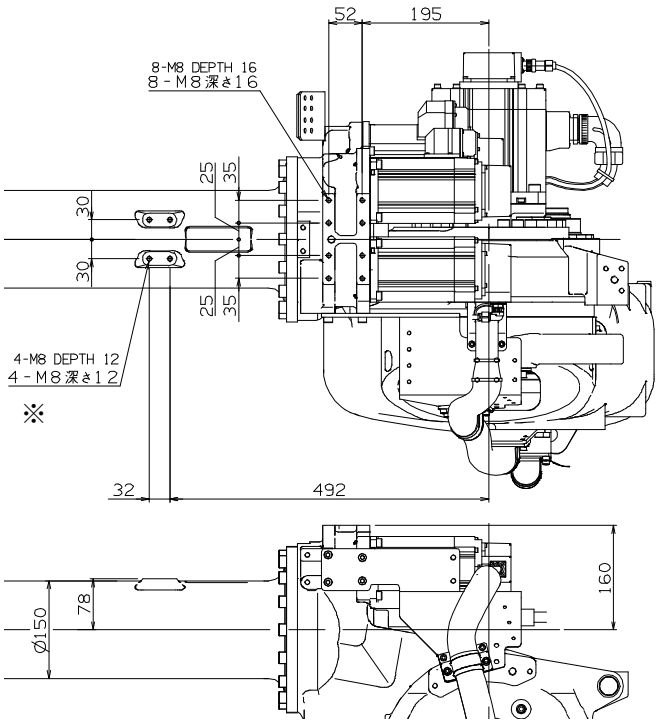
■ **Upper part of forearm**

Ancillary equipment can be mounted to the upper part of robot forearm.
In case of A-Trac4 model, screw holes of 4-M8 depth 12 marked ※ cannot be used because they are hidden in the cover part.

【SRA100-01】【SRA166-01】【SRA210-01】
【SRA240-01】【SRA100-01A】【SRA166-01A】
【SRA210-01A】【SRA120EL-01】【SRA133L-01】
【SRA166L-01】



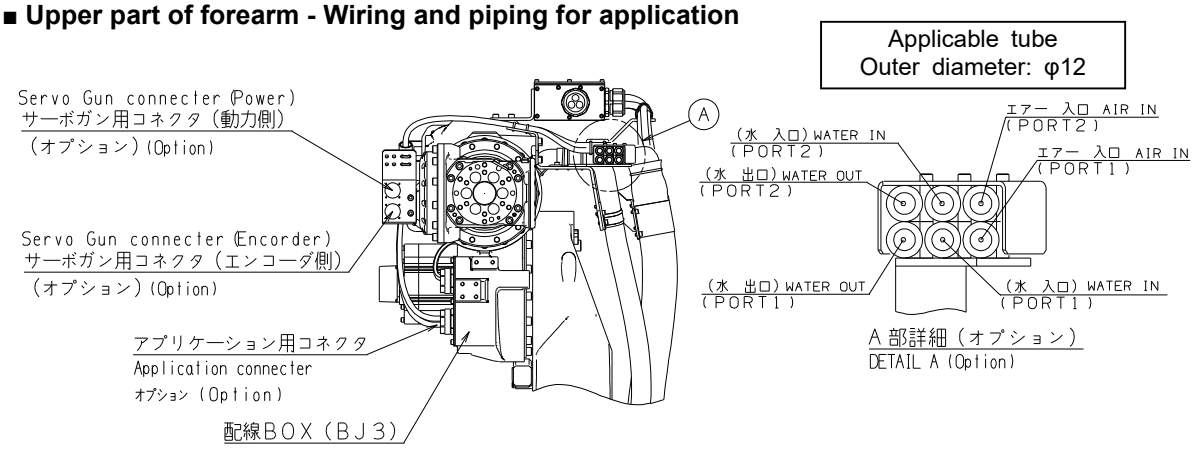
【SRA210L-01】
【SRA240L-01】
【SRA250-01】



1.4 Wiring and piping diagram for application

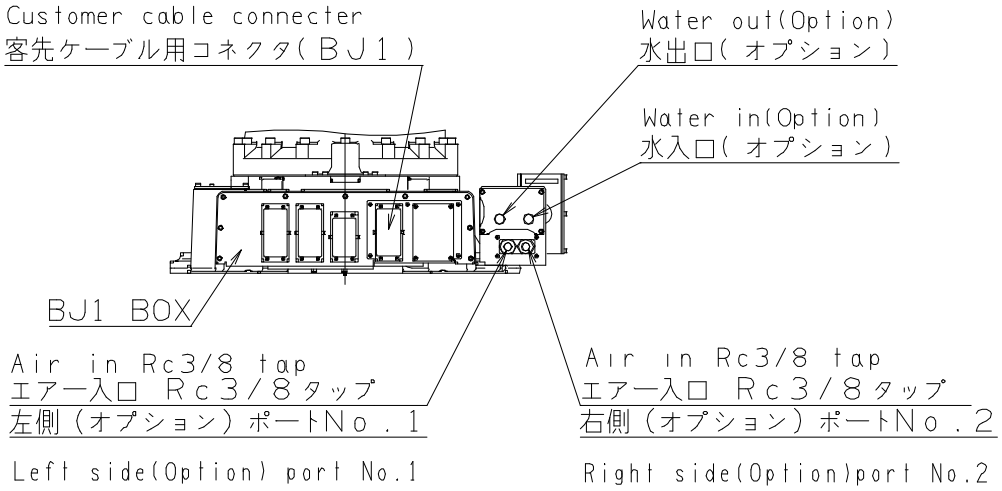
IMPORTANT	Use air pressure not more than 0.49MPa.

■ Upper part of forearm - Wiring and piping for application



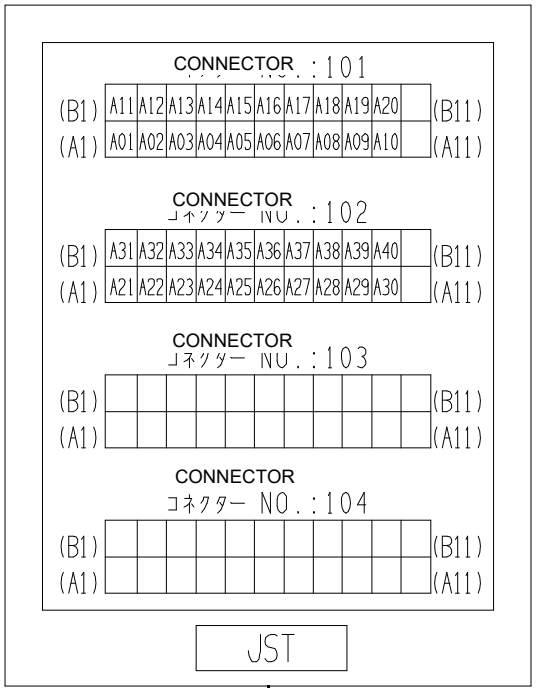
(NOTE) In the wiring box, there are application connectors shown in the next page

■ Base frame block - Wiring and piping for application



■ Details of application connectors

(1) BJ1-side (Connectors) (Option)



User-side Connectors

Wire-side shell : JFM-WSA-4-A (JST)
JFM-WSA-4-C (JST)
Guide plate A kit : JFM-GPAK-4 (JST)
Receptacle housing : JFM2FDN-22V-K (JST)
Receptacle contact
a SJ2F-01GF-P1.0 (JST)
(Suitable cable: 0.20~0.50sq)
b: SJ2F-01GF-P1.0 (JST)
(Suitable cable: 0.30~0.75sq)

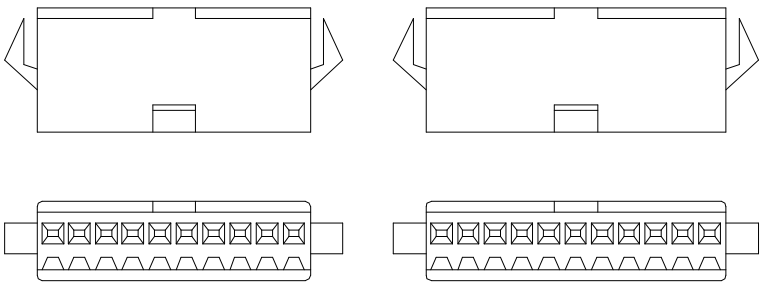
Manual crimp tool
a: YRS-8861
b: YRF-1120

Cable diameter suitable for wire-side shell
JFM-WSA-4-A : φ26.2~φ28.0
JFM-WSA-4-C : φ15.5~φ16.5

(Pin location shows the connector equipped on robot body and is the view from connecting side.)

Specification of Application wires
Rated voltage maximum AC/DC 115 V
Rated ampere maximum 1 A

(2) BJ3-side (Joint connectors) (Option)



Connector models (CN61,CN63)
Housing SMP-10V-BC (JST)
User-side connectors
Housing SMR-10V-B (JST)
Contact SYM-001T-P0.6
(Suitable cable: AWG#22~28)
Manual crimp tool: YRS-121

Connector models (CN62,CN64)
Housing SMP-11V-BC (JST)

User-side connectors
Housing SMR-11V-B (JST)
Contact SYM-001T-P0.6
(Suitable cable: AWG#22~28)
Manual crimp tool: YRS-121

CN61

1	2	3	4	5	6	7	8	9	10
A01	A02	A03	A04	A05	A06	A07	A08	A09	A10

CN62

1	2	3	4	5	6	7	8	9	10	11
A11	A12	A13	A14	A15	A16	A17	A18	A19	A20	ECE

CN63

1	2	3	4	5	6	7	8	9	10
A21	A22	A23	A24	A25	A26	A27	A28	A29	A30

CN64

1	2	3	4	5	6	7	8	9	10	11
A31	A32	A33	A34	A35	A36	A37	A38	A39	A40	ECE

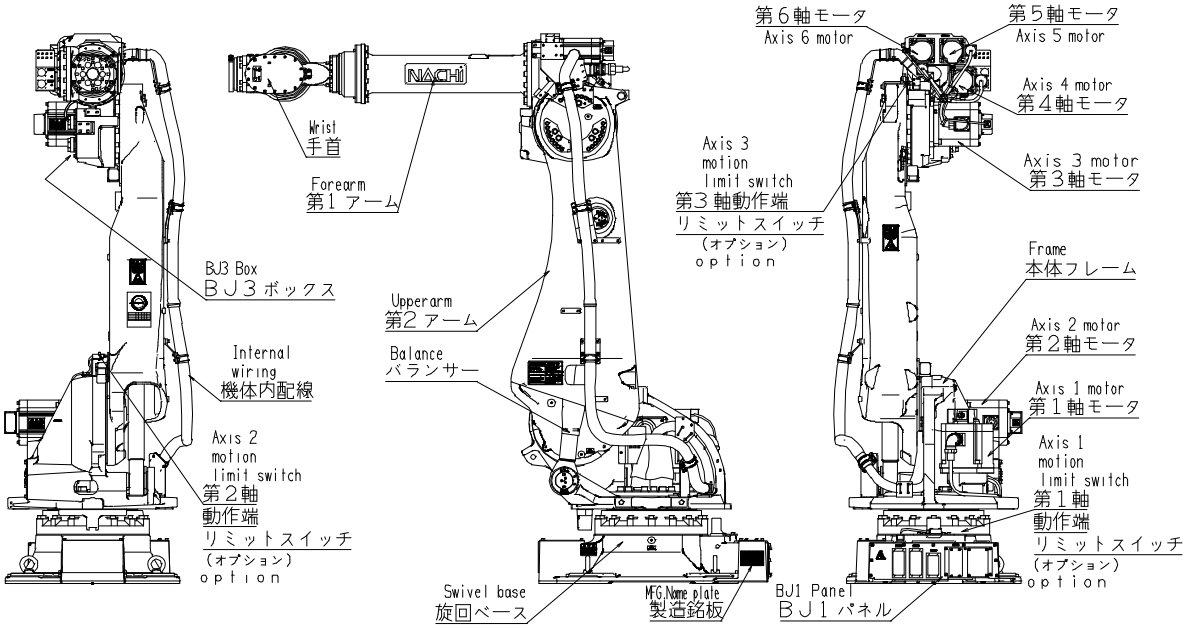
Notes) In case of spot welding specification, CN61 and CN62 connectors are wired through to the wrist flange for the application cable, and CN61 and CN62 connectors do not exist inside the BJ3 box.

CAUTION	Do not apply external force or connect other cables to the robot cables.

NOTE

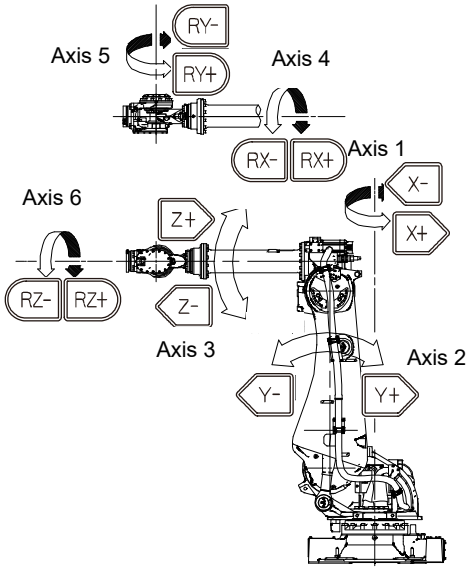
Chapter 2 Precautions for handling

2.1 Names of robot components



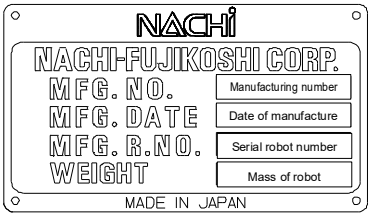
IMPORTANT	The over travel limit switches are the option.
WARNING	The balancer device is internally compressed even in the normal state. Never attempt to dismount or disassemble this device. Otherwise it will result in a highly hazardous situation.

■Name of the operating axis and each of their movement's direction



*Axis 1 to 6 is displayed as "J1 to J6" on the controller display.

Manufacturing plate



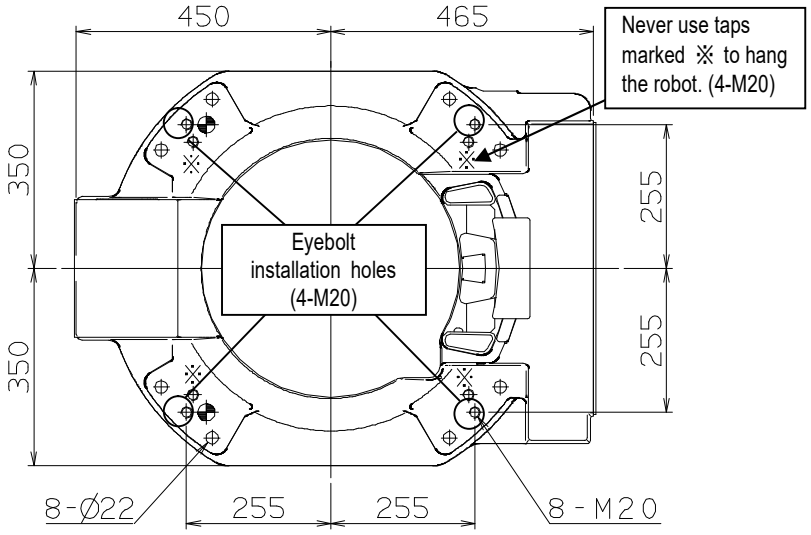
(Mass is typed only for CE specification.)

2.2 Transport procedure

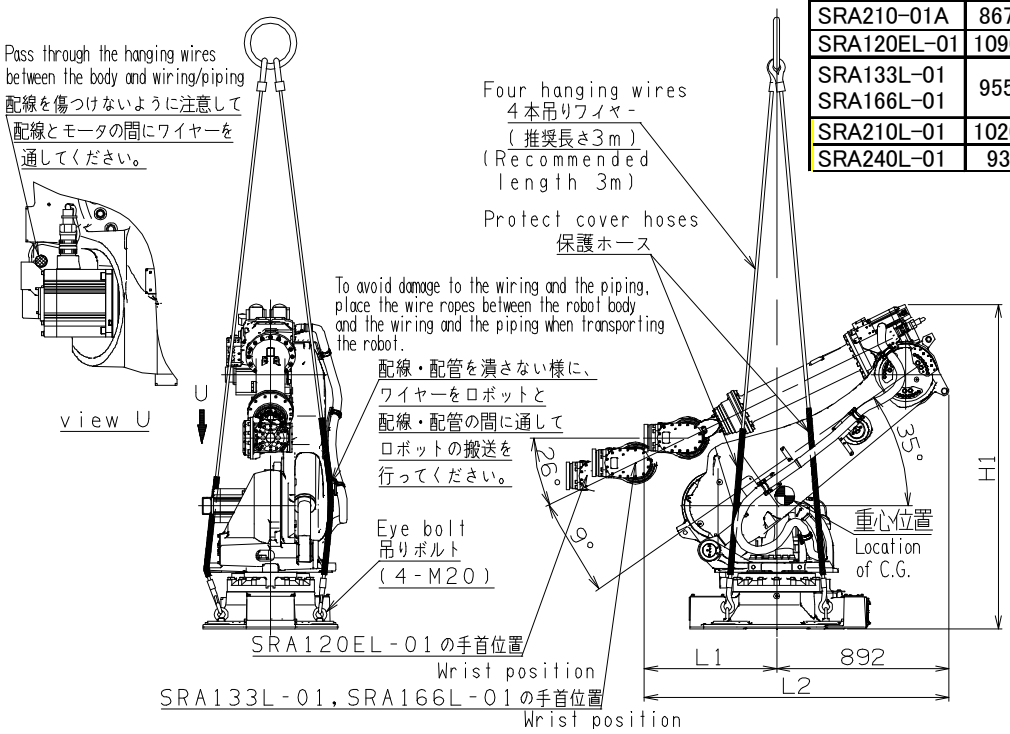
WARNING	The robot must be transported by personnel who have licenses required for slinging work, crane operation, forklift truck operation, and others. Check for the weight, and then handle them according to procedures suitable for the weight.
WARNING	To lift the robot or the controller, follow the procedures specified in the Maintenance Manual. Following any procedures other than those specified will cause the robot to topple over or drop during transport, thus resulting in accidents.
CAUTION	During transport or installation work, pay utmost care not to cause damage to wirings. After installation, take protective measures such as using protective guards so that the wirings will not be damaged by workers or other persons, or forklift trucks or else.
CAUTION	Gas in balancer must be released when robot is transported by air. This procedure can be done using the gas charging unit by referring to manipulator maintenance manual .Customer needs to prepare this unit. (☞ Refer to “Chapter 5” for detail.)
CAUTION	Please pay utmost care not to hurt the motor and encoder cables by hanging wires.

To transport the robot, set a rule to use a crane.

At first, move the robot to the configuration shown in figure and set four M20 hanger bolts to the robot frame. Then, be sure to lift the robot using four hanging wires (recommended length is 3m). Protect the areas of the robot by touching wires, cover the wires by rubber hoses. To see the area to be protected, please refer to the figures below



Robot type	L1	L2	H1
SRA100-01 SRA166-01	685	1577	1688
SRA210-01 SRA240-01	723	1615	1688
SRA250-01	831	1723	1637
SRA100-01A SRA166-01A	829	1721	1822
SRA210-01A	867	1759	1822
SRA120EL-01	1090	1982	1688
SRA133L-01 SRA166L-01	955	1847	1688
SRA210L-01	1020	1912	1688
SRA240L-01	930	1822	1688



2.3 Installation Procedure

Location and the procedure of the robot installation are critical factors to maintain robot functions. The ambient condition for installing robot is also very important facts. It affects the life of mechanical sections of the robot, but it also matters with safety. Therefore, it is strongly recommended to follow the circumstances shown below. Furthermore, pay extra attention for the installation procedure and the foundation for the robot in order to maintain the robot performance. Strictly observe the installation procedure for the robot provided below.

Installation

To installing the robot, first of all, consider the utmost safety to workers and take serious safety measures. The following describes precautions for safety.

Safety measures for entering in the robot operating area

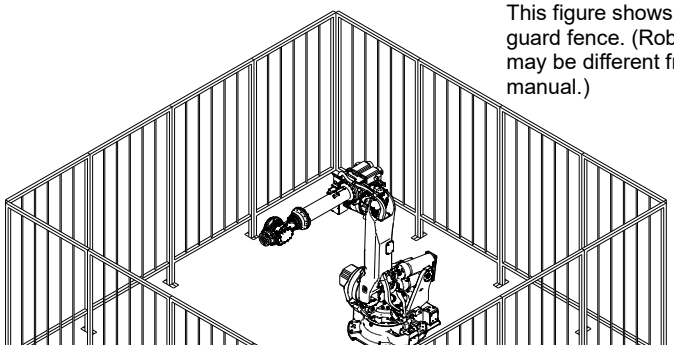
WARNING

While the robot is in operation, workers are in danger of coming in contact with the robot. To avoid that, install a **guard fence** to make sure to keep the worker away from the robot. Not installing guard fence will cause the workers or other persons to accidentally enter the operating area, thus resulting in accidents.

DANGER

Guard fence

Refer to information in ISO13857: Safety of machinery – Safety distances to prevent hazard zones being reached by upper and lower limbs



This figure shows the image of the guard fence. (Robot appearance may be different from that of this manual.)

Stop time and angle of axis 1 for a maximum travel

(After emergency stop signal occurred under maximum speed and maximum moment of inertia)

	SRA100-01	SRA166-01	SRA210-01 SRA120EL-01 SRA133L-01 SRA166L-01	SRA240-01	SRA250-01	SRA210L-01	SRA240L-01
Stop time	0.56 [sec]	0.80 [sec]	1.01 [sec]	0.86 [sec]	0.88 [sec]	0.90 [sec]	0.98 [sec]
Stop angle	0.65 [rad]	0.78 [rad]	0.92 [rad]	0.73 [rad]	0.72 [rad]	0.84 [rad]	0.98 [rad]

WARNING

The guard fence must be high enough and fixed firmly constructed so that the no one can easily get over or move the guard fence. The door for the guard fence must be equipped with a **safety plug** and designed not to open unless the safety plug is unplugged.

If above construction is not secured, anyone can get in the guard fence. Thus result in hazardous situation.

WARNING

Design the system so that **motor power is turned OFF** when safety plug is unplugged or access door is opened. This can make it possible to detect the entry of a person and atop the robot automatically. (The controller has an input signal of both the safety plug and to turn off the motor power.)

WARNING

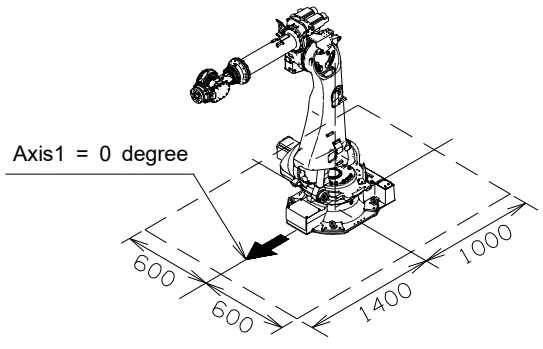
Design the system so that the robot will move with the **low-speed playback mode,** when the safety plug is unplugged. When the robot is operated at a high speed under such condition, no one can escape from the robot, thus resulting in accidents. (The controller has an input signal to select the playback mode of the “low-speed”.)

WARNING

Set up the Emergency Stop buttons of the robot, **where the place that workers can immediately reach**. In case the workers are in the location where he cannot press the switch immediately, accidents may occur. (The controller has an input signal of “emergency stop”.)

WARNING	In case the guard fence cannot be constructed, install **optoelectronic switches and/or mat switches, etc.** at all entrances to the robot operating area in the replacement of safety plug. These switches can function to automatically stop the robot when anyone enters beyond the guard fence.
WARNING	**By painting the floor** of the hazardous area (the robot operating area) **with color paint** anyone can recognize the hazardous area.

Safety measures for the robot and peripheral equipment locations

WARNING	In case of connecting the primary power supply to the controller and/or the peripheral equipment, please make sure that the supply side power is turned OFF. Since high voltages such as 100VAC, 200VAC, or 400VAC are applied, electric shocks can occur.
WARNING	Do not install the operation and the adjustment part within the robot operating area. Install the robot control panel, interlock panel, and all the other operation panels where it's safe, so that they can be operated **outside of the guard fence**. In case those operation panels are installed near the robot, workers can get caught in the robot, when the robot operation fails.
WARNING	To set up an operation stand, equip an **Emergency Stop button on that operation stand**. If any abnormality occurs while the robot is being operated by using the operation stand, make sure that the robot can make an emergency stop by pressing this switch.
WARNING	Make sure not to route wires and pipes (of the robot itself, control panel, interlock panel, and etc.) that workers will fall over them or forklift trucks will directly **tread** them. Otherwise workers might fall over and/or might break wires, then cause accidents.
WARNING	Never install the control panel, interlock panel, operation stand and any others in the places where the movements of the robot are **out of your eyesight**. Even though an abnormality had occurred in such situation, it is hard to recognize them. It can also cause serious accidents or even death, if the operator is not aware of the circumstances.
WARNING	If the necessary operating area of robot is smaller than the maximum motion range of the robot specification, then **limit the robot operating area**. The motion range can be controlled by using the limit switch and mechanical stopper. Even the robot was about to move over the regular operating area (due to an abnormality), this function will enable the robot to stop just before the operation. You can also set up software limit to avoid errors.
WARNING	Please install **light shielding boards or protectors during welding arcs,** if there's a possibility that direction of spatters or any other can reach the workers. In that case, please pay extra attention to the robot movement, when you installing them. Otherwise it may cause injuries to workers by spatters, or any other things.
WARNING	Provide a display which is **large and easy to recognize** so that anyone can notice whether the robot operation is automatic or manual from far distance. Furthermore, it is effective to use a buzzer or announcement to alert workers to initiate the automatic operation. Make sure that people can easily recognize automatic operation in progress from distant locations.
WARNING	Eliminate **protrusions** from the peripheral equipment and around the robot as possible. If necessary, make sure to cover them. Otherwise it may cause hazardous situation when a worker touches them or even a worker might fall over when he surprised with a sudden movement of the robot.
WARNING	Do not make a layout so that a worker will need to **put his/her hands into the guard fence** to take in or out work pieces. There are some possibilities when the worker put his/her hands in the guard fence, then the robot moves towards that direction, thus result in accidents.
IMPORTANT	When installing this robot, minimum work space is necessary for maintenance work. Such as motor replacement, balancer replacement and so on. (*Refer to this drawing.) 

Safety measures for installation work

WARNING	To install the robot, it is important to install the robot so that no workers will get pinched or hurt by the robot or a device around them. The robot must not operate in the maximum operating range with a tool equipped on, and make sure not to touch any peripheral equipment.
WARNING	Be sure to install the robot according to the specified procedure. Otherwise possibilities occur that robot's base may move or robot may fall over while in operation.
WARNING	You must fully understand the connection procedure to make proper wire connections between the robot and the controller or the robot and the peripheral equipment. Not following the proper procedure will cause the malfunction of the robot.
WARNING	Be sure to establish a proper grounding for the robot. If the equipment makes substantial noises such as a welder, conduct the specified grounding construction for the equipment.
WARNING	Please pay extra attention not to damage wirings during transportation or installation of the robot. Furthermore, after installing the robot, apply protective guards to wirings so that it won't be damaged by workers or other persons, or forklift trucks or any other.
WARNING	Installation structures (robot raiser, etc.) may cause problems such as vibration and servo tracking error. If such problem occurs, please promptly improve the installation structure. If installation structures are kept using as they are, reliability and lifetime of not only the robot but also the installation structures may be damaged, due to the vibration and sudden braking of robot.

■ Installation location and ambient conditions

Conditions (temperature, humidity, height and vibration) are written in "Chapter 1 Basic Specifications". Further ambient conditions listed below must be observed.

(1) Construct the drainage structure so that swivel base is not flooded, when the liquid such as water or cutting fluid is splashed on the robot body
(2) Location with no flammable or corrosive fluid or gas.
(3) Type D grounding (the grounding resistance is 100Ω or less) is necessary.
(4) The following liquids and aqueous solutions are not applicable because of the risk of deteriorating rubber parts (gaskets, oil seals, O-rings, etc.) used in the robot.
- Organic solvents
- Chlorine-based cutting fluids
- Amine-based cleaning fluids
- Corrosive liquids and aqueous solutions such as acids and alkalis
- Other liquids and aqueous solutions that NBR (nitrile rubber) is not resistant to.

When these liquids or aqueous solutions are required to be used, protection should be provided by means of a cover, etc.

IMPORTANT	Our company's robot, controller and related option equipment are designed for general industrial use. Unless otherwise specified in the specifications or manuals, operations in special conditions and environments such as outdoor, X-ray environment, radiation environment, nuclear power control, aerospace equipment, public transportation, medical equipment, etc. are not assumed. Our company and its subsidiaries are not liable for any accidents, failures, etc., that may occur if the robot is used in such an environment without asking our company to do so.
IMPORTANT	Using mounting condition that does not comply with specifications may cause the robot system to malfunction or fail prematurely. In that case, robot will be out of warranty. Please understand it in advance.

■ Installation procedure

While robot moves, large reaction force is applied to the swiveling base from all directions. Consequently, the robot should be installed that the foundation endures not only the static loads but also the reaction force caused by robot movement.
Repair uneven spots, cracks, and others on the floor, and then install the robot by following to the table below. If thickness of the floor concrete is less than the needed level, an independent foundation should be constructed. Inspect the foundation prior to the robot installation, and then construct the foundation, if necessary.

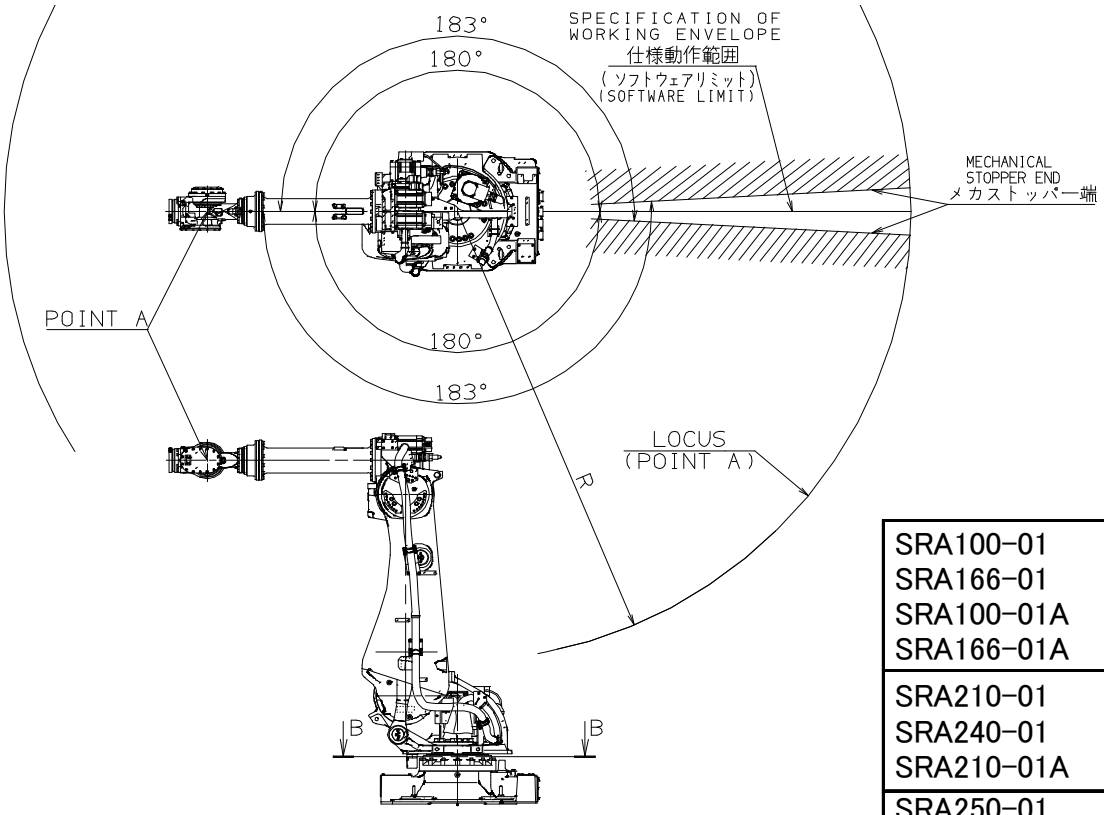
Robot Model	SRA100-01	SRA166-01 SRA133L-01	SRA210-01 SRA120EL-01 SRA166L-01	SRA240-01 SRA210L-01	SRA250-01 SRA240L-01
Thickness of floor concrete	Not less than 160 mm				
Installation parts *1	8 bolts of M20 (JIS: Strength class 12.9) not less than 65mm 8 plain washers of not less than 4.5 mm in thickness and HRC35 in hardness				
Tightening torque *2	560 ± 30 N·m				
Allowable repeated tensile *3	Approx. 18,000 N	Approx. 22,000 N	Approx. 28,000 N	Approx. 30,000 N	Approx. 32,000 N

*1 : Installation parts are not accessory of robot.
*2 : Apply a coating of lubricating oil to the threaded parts of bolts, and then tighten bolts by using torque wrench to the specified tightening torque.
*3 : This tensile is per installation bolt when robot is installed with all bolts written in table above.

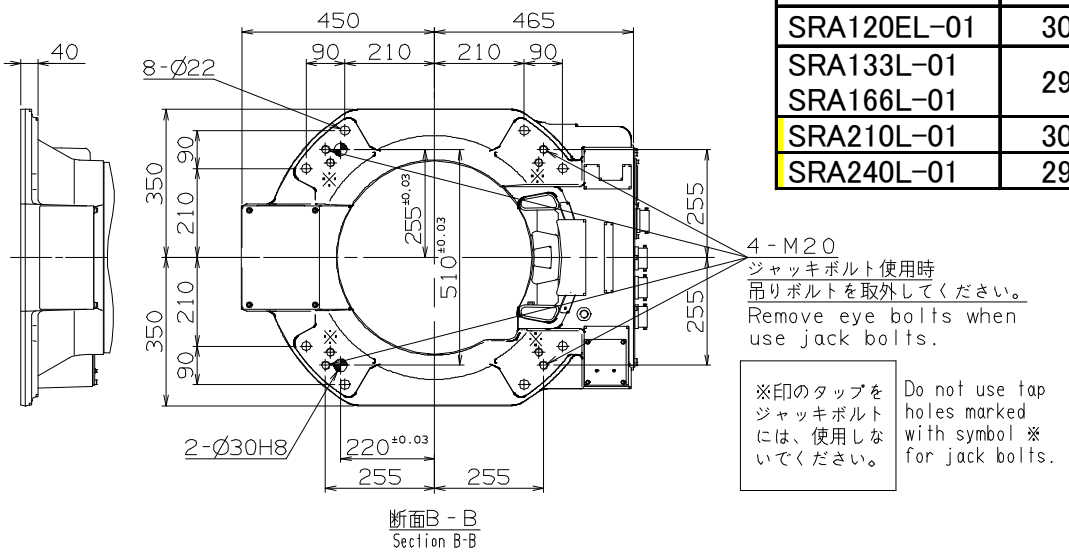
■Dimensions for installation

To install the robot, lock the swiveling base of the robot.

WARNING	The mechanical stopper end is located in a position over the specified operating range (software limit) of axis 1 by 3°. Please consider all the aspects like wrist configuration, shape of the end effecter and the drawings on this chapter to install the guard fence.
WARNING	On axis 1, 2 and 3, the robot operating range can be regulated for safety. (*This is an Optional function.) It is necessary to have optional parts (e.g. limit switches or additional stopper blocks. *Additional purchase necessary.) to regulate, so do not independently move the standard parts (e.g. stopper block).
WARNING	If mechanical stopper collides and robot stops, it's possible that some parts are already damaged, for example, mechanical stopper is spoiled or fixing bolts are broken. In this case, it is impossible to keep sufficient intensity and function. Mechanical stopper and reduction gear of collided joint are needed to be replaced to the new one.



SRA100-01 SRA166-01 SRA100-01A SRA166-01A	2654
SRA210-01 SRA240-01 SRA210-01A	2674
SRA250-01	2792
SRA120EL-01	3099
SRA133L-01 SRA166L-01	2951
SRA210L-01	3000
SRA240L-01	2901

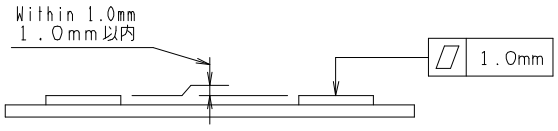


■ Accuracy of installation surface

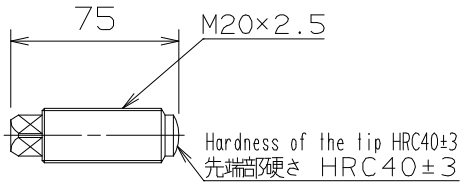
It is strictly recommended to observe precautions below to keep the swiveling base level as flat as possible to installing robot. (Not to cause dent.)

(1) Level of the flatness of 4 plates on the installation surface must be within 1.0 mm

(2) Keep the gap between the installation surface of 4 each base plates and the installation surface within 0.10 (±0.5) mm range in height.



(3) In case, if it's difficult to follow the precautions described above, please use jack bolts to make 4 plates even towards the installation surface

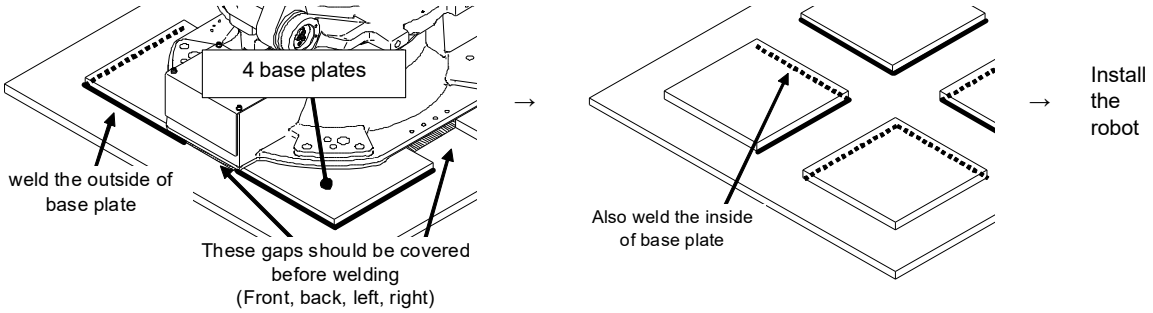


■ Welding the base plates

The internal wirings inside the robot base unit may be burned or damaged because of welding spatters or sparks. Therefore, when welding is performed, with the base plates attached to the robot base unit, please cover the gaps (4 each) shown below in advance. After welding the outer side, remove robot and weld the inner side of the base plates.

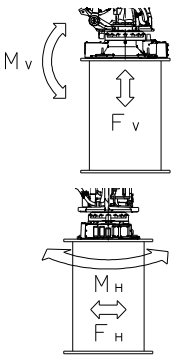
Put the robot temporary to fix its position, and weld the outside of the base plates.

Remove the robot, and weld the inner side of base plates.



■Maximum generative force of the robot

Robot Model	Max. vertical generative force F_V	Max. horizontal generative force F_H	Max. vertical generative moment M_V	Max. horizontal generative moment M_H
SRA100-01	40,400 N	29,400 N	71,400 N·m	60,900 N·m
SRA133L-01	43,500 N	31,800 N	88,200 N·m	75,700 N·m
SRA166-01	46,800 N	35,200 N	92,300 N·m	79,700 N·m
SRA210-01 SRA120EL-01 SRA166L-01	52,800 N	40,500 N	113,200 N·m	98,300 N·m
SRA240-01	56,300 N	43,700 N	122,000 N·m	106,300 N·m
SRA250-01	58,100 N	45,100 N	130,000 N·m	113,300 N·m
SRA210L-01	54,000 N	41,500 N	122,500 N·m	106,500 N·m
SRA240L-01	57,500 N	44,700 N	130,500 N·m	113,700 N·m



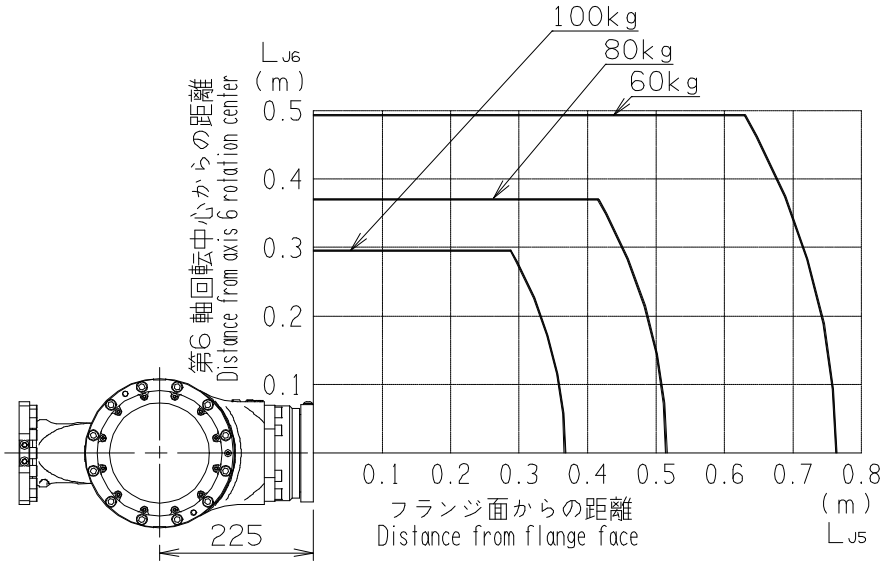
2.4 Allowable load

CAUTION	**The wrist load is regulated by “Maximum payload”, “Maximum static load torque”, and “Maximum moment of inertia”. If wrist load exceeds beyond these allowable values, WE CANNOT GUARANTEE THE FUNCTION OF THE ROBOT.** Please refer to “1.1 List of basic specifications” and following figures for detail.
CAUTION	Before using the robot, please register the "weight", "COG (center of gravity) position" and "inertia Moment" of wrist payload as the load condition. Robot is controlled to minimize the operating time according to the registered value. Therefore, even if the load condition was within the specifications, if that is incorrect, excessive acceleration will be generated, and reliability and life may be damaged. Even if the correct value is registered, vibration or servo tracking error may occur due to the insufficient rigidity of the payload. If such problem occurs, please adjust the “speed”, “acceleration” and “smoothness”. Those factors can be adjusted in every step. See the instruction manual for details. FD controller instruction manual BASIC OPERATIONS (TCFEN-002) 4.3 Teaching

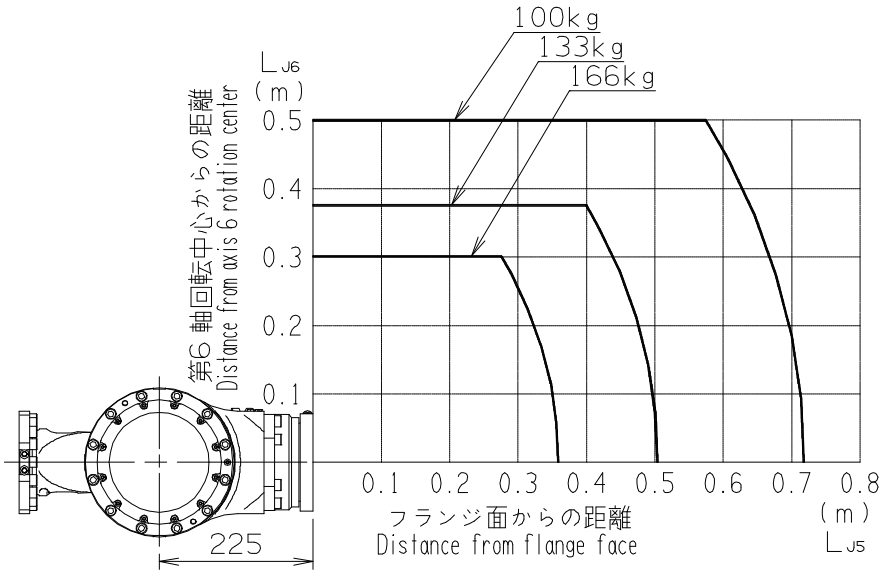
■ Torque map for the wrist load

Use the robot within the condition that COG of the wrist load stays in the range shown in the torque map.

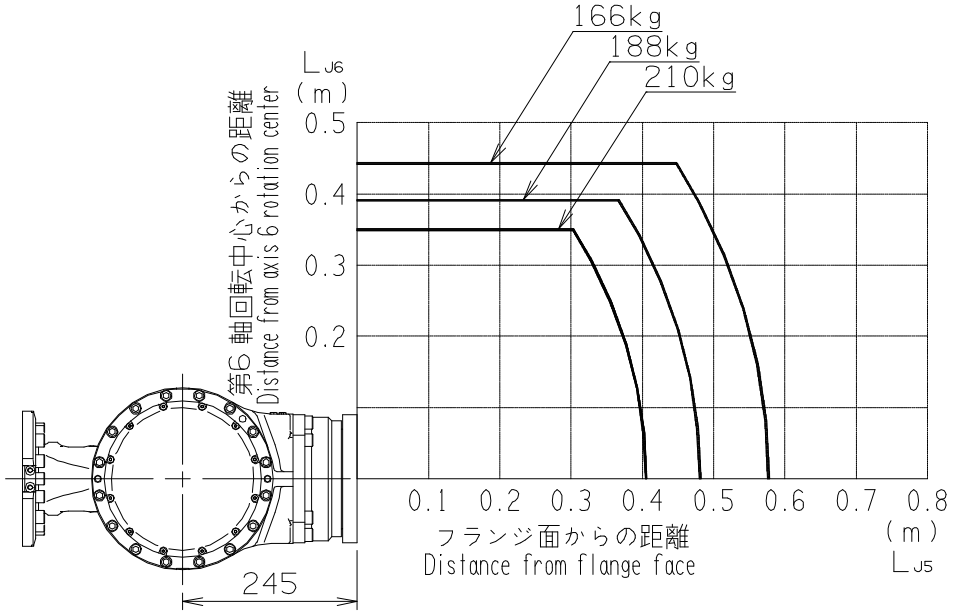
【SRA100-01】



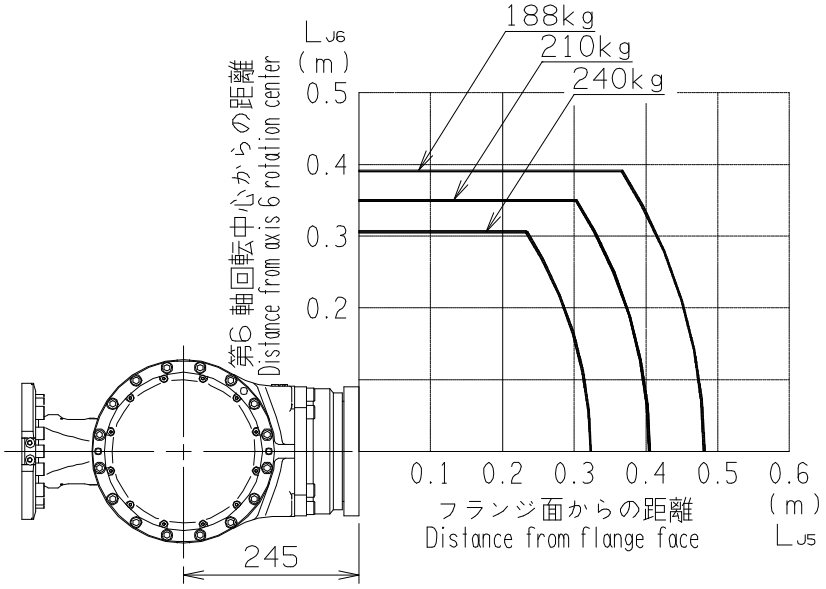
【SRA166-01】
【SRA166L-01】



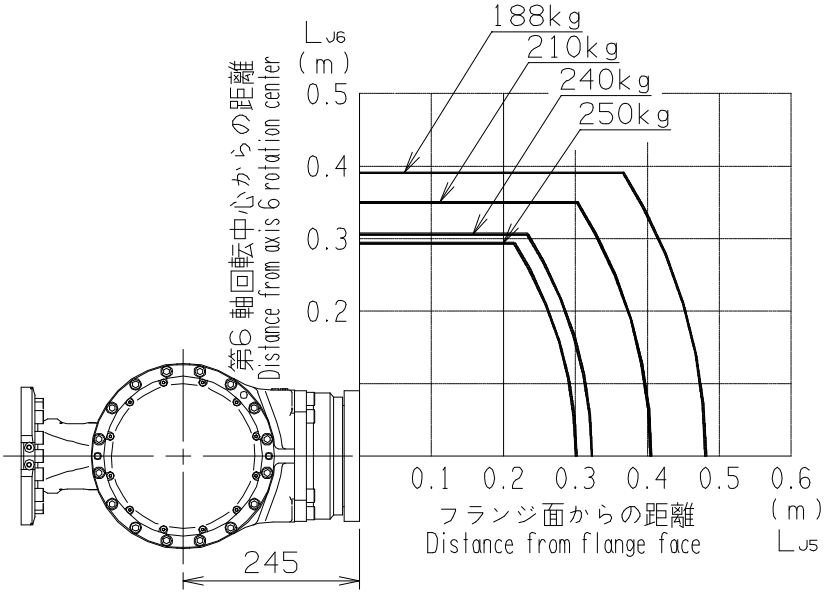
【SRA210-01】



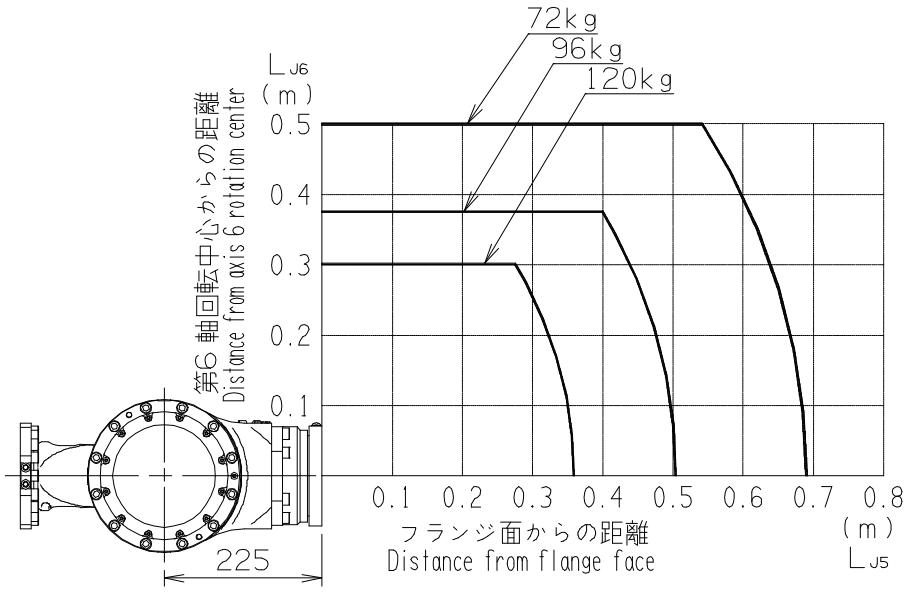
【SRA240-01】



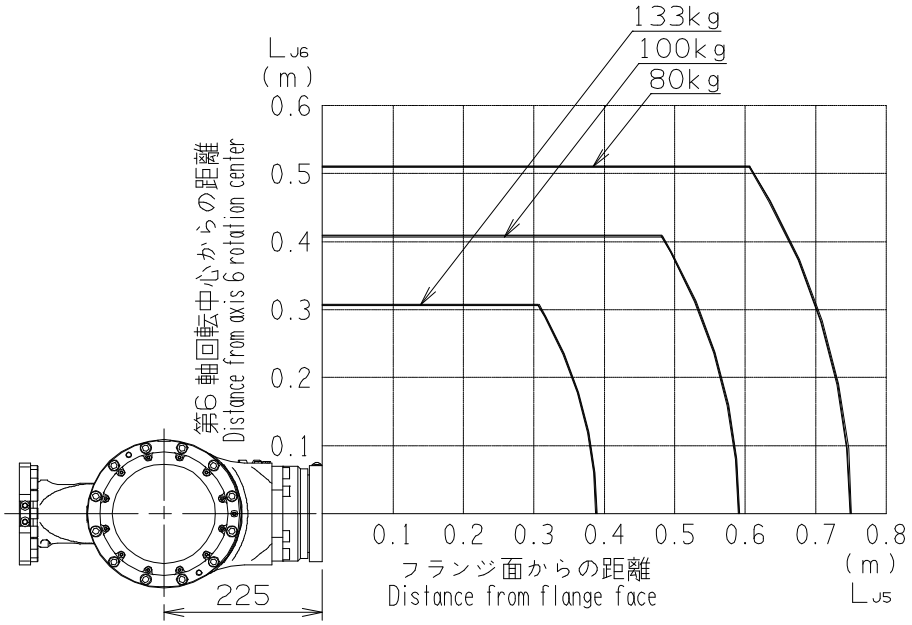
【SRA250-01】



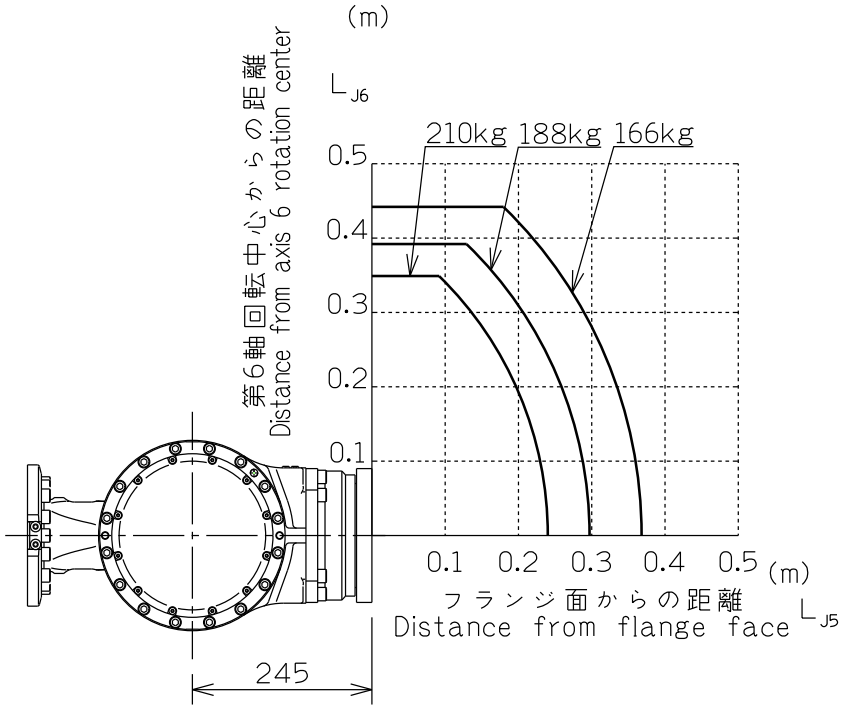
【SRA120EL-01】



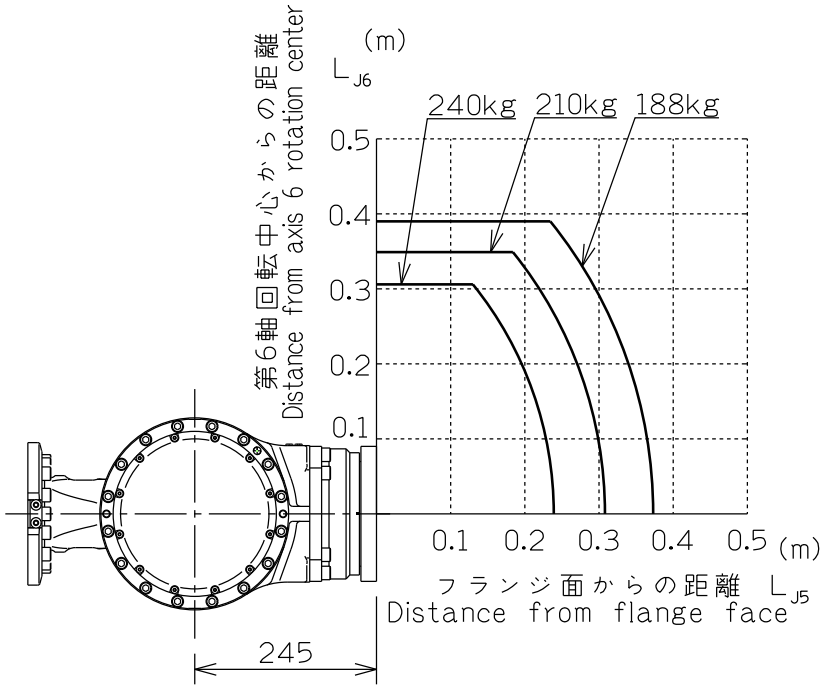
【SRA133L-01】



【SRA210L-01】



【SRA240L-01】

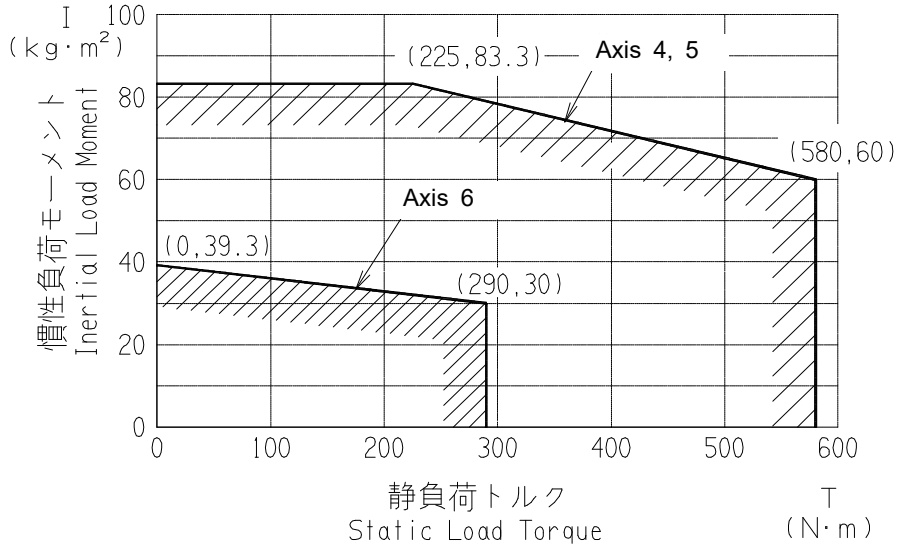


■Map of Moment of inertia map for the wrist load

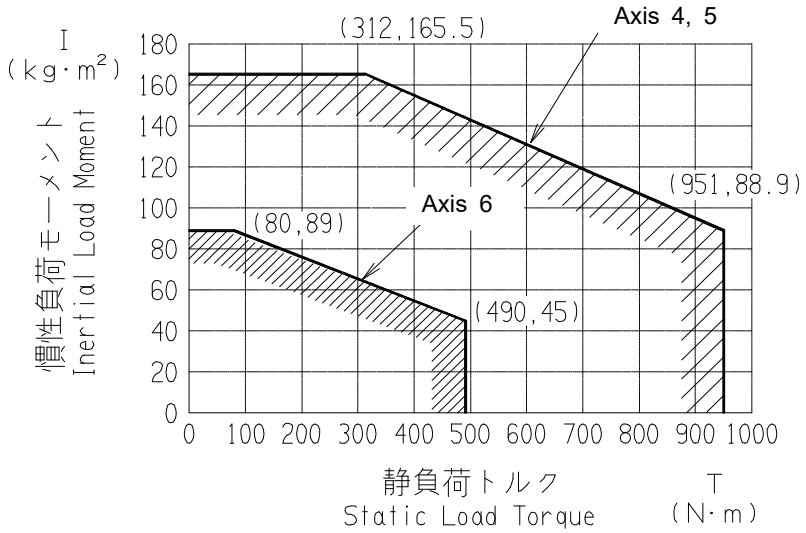
Use the robot under condition that static load torque and moment of inertia stays in the range shown in the chart below.

IMPORTANT	If the moment of inertia exceeds the specification, maximum speed is automatically limited by the software to protect the robot.

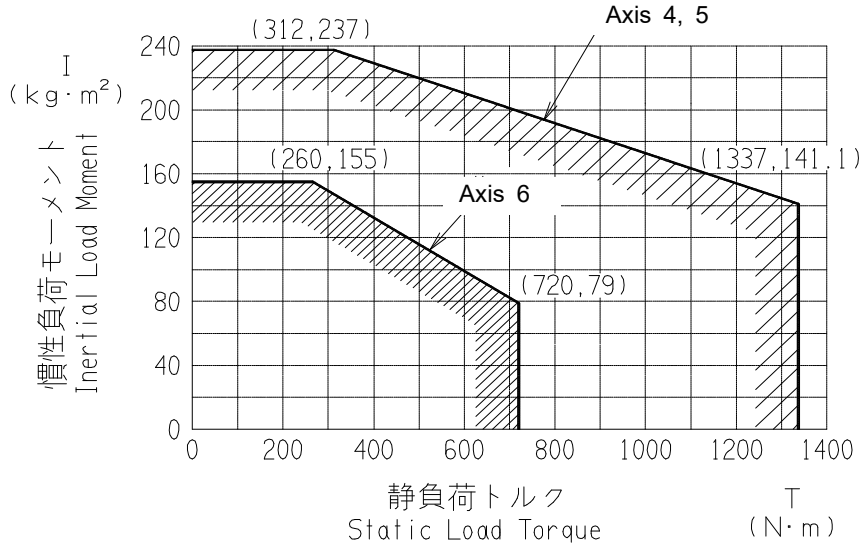
【SRA100-01】



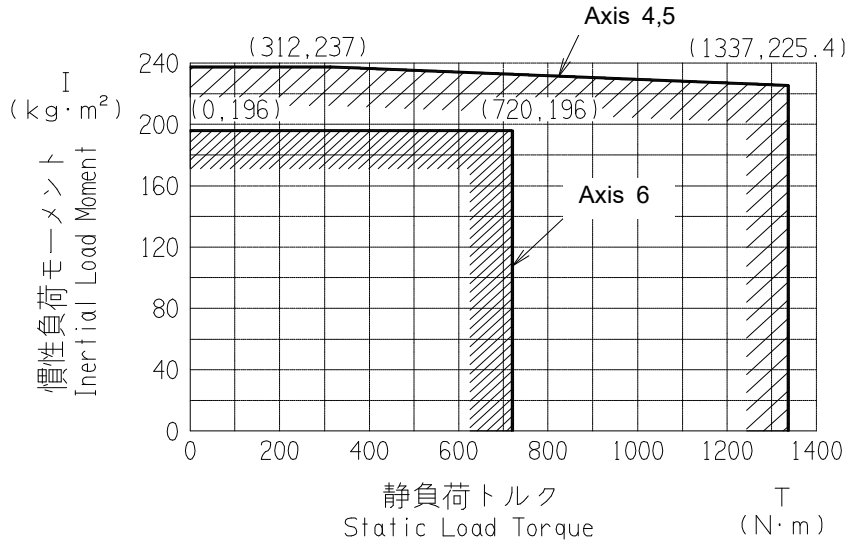
【SRA166-01】
【SRA166L-01】



【SRA210-01】
【SRA240-01】

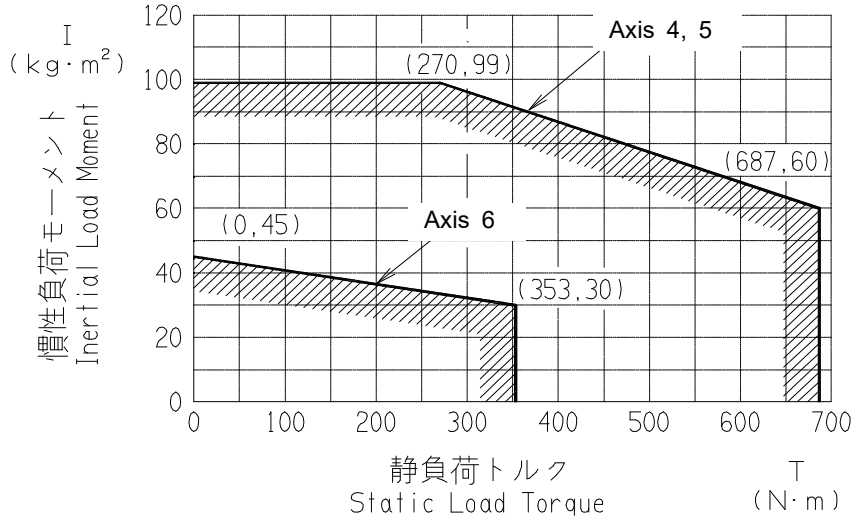


[SRA250-01]

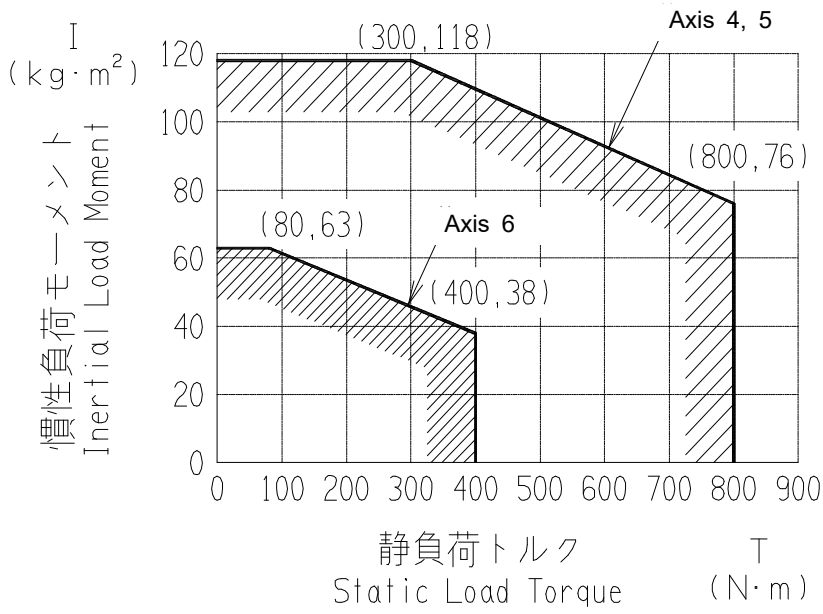


Robot speed is adequately controlled according to the inertia.

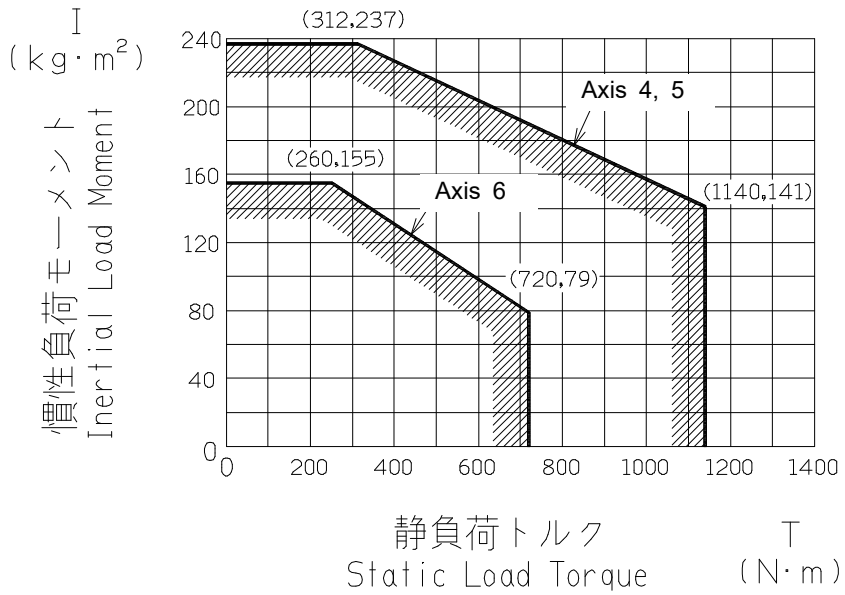
[SRA120EL-01]



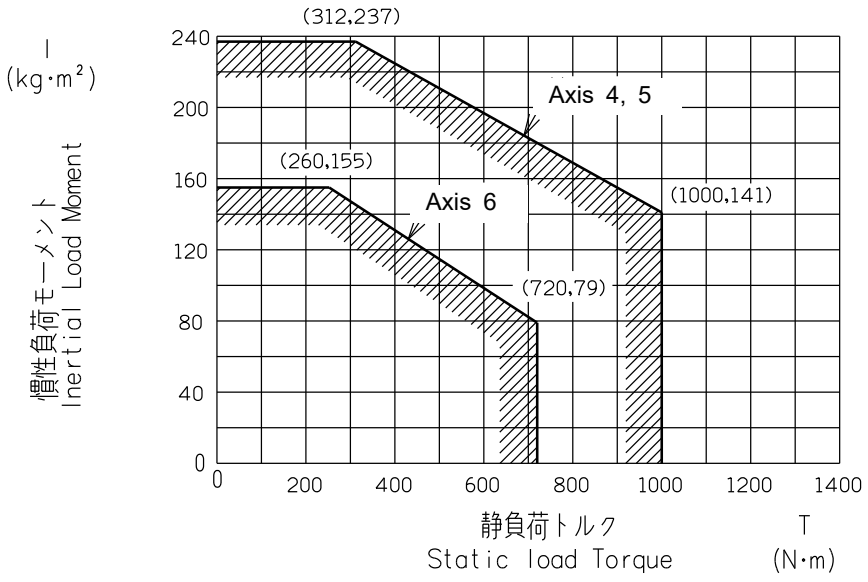
[SRA133L-01]



【SRA240L-01】



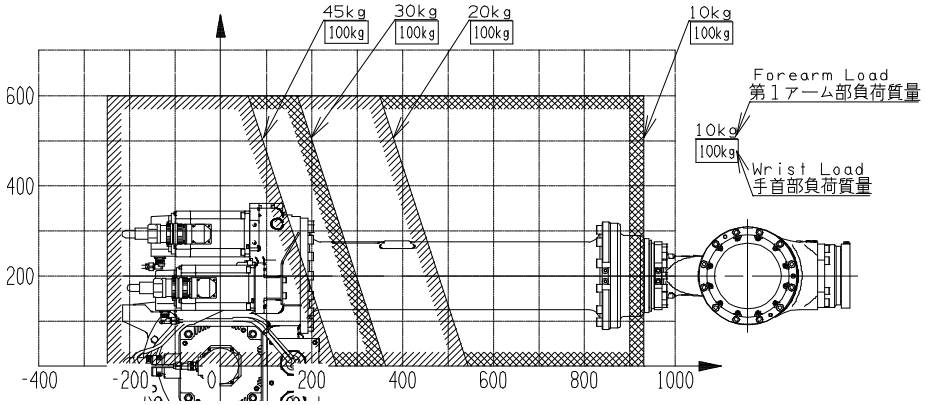
【SRA210L-01】



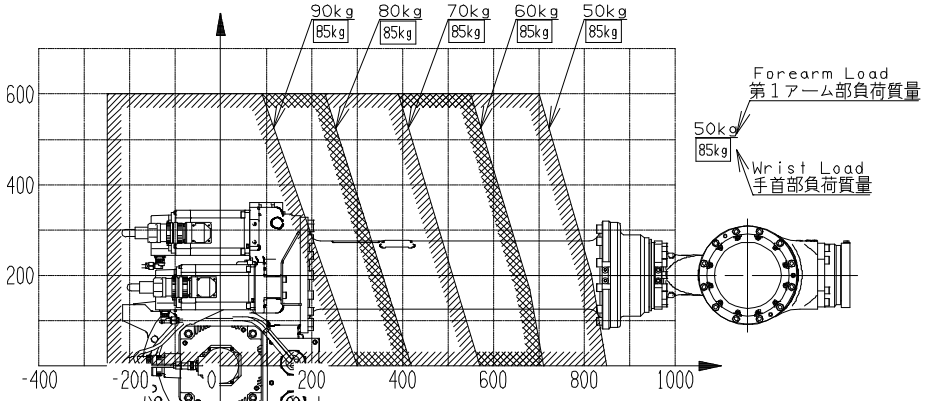
■ **Load on the forearm**

Use the robot within the condition that COG of the ancillary equipment on the forearm stays in the range shown below.

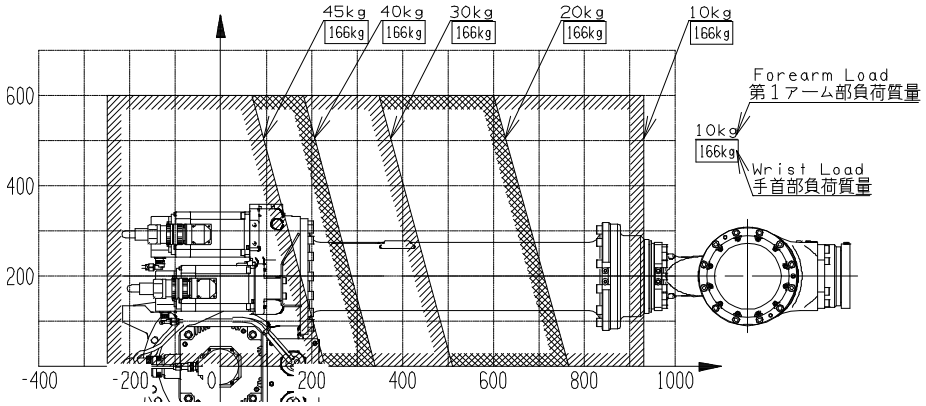
【SRA100-01】
When wrist load is 100kg



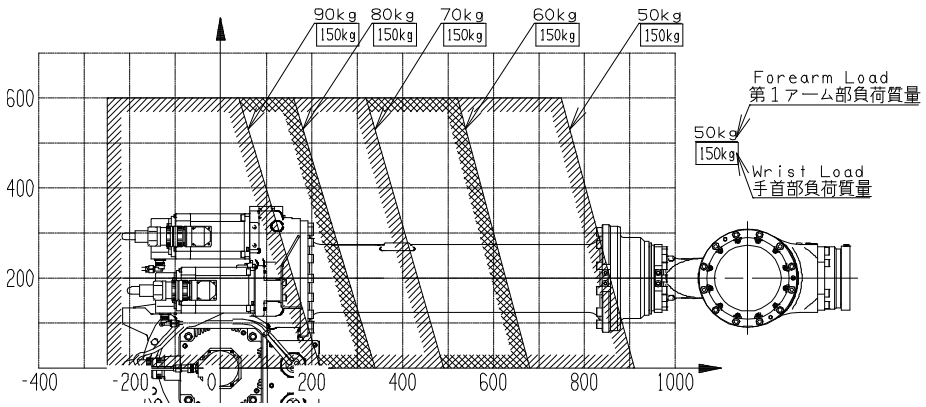
【SRA100-01】
When wrist load is 85kg



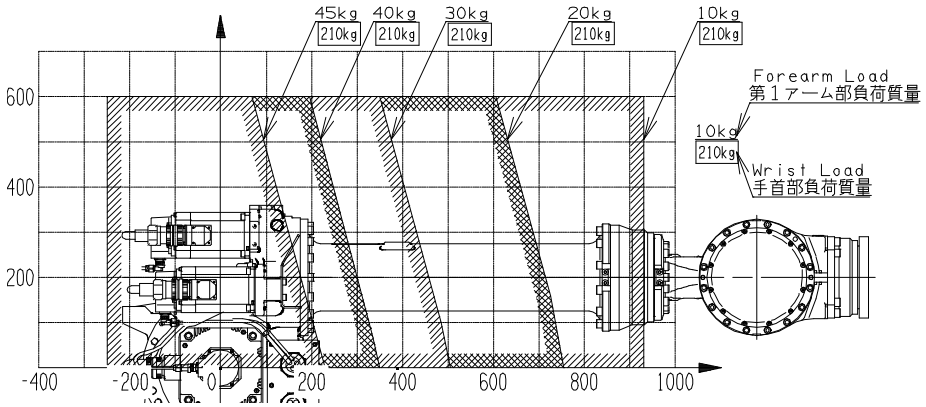
【SRA166-01】
When wrist load is 166kg



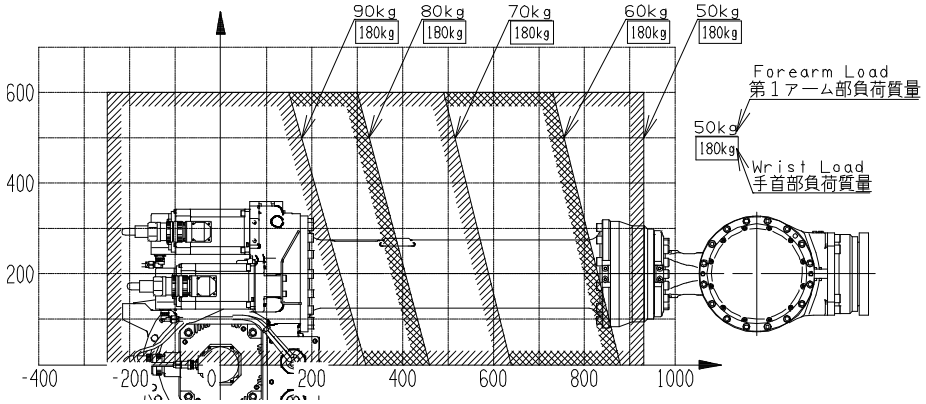
【SRA166-01】
When wrist load is 150kg



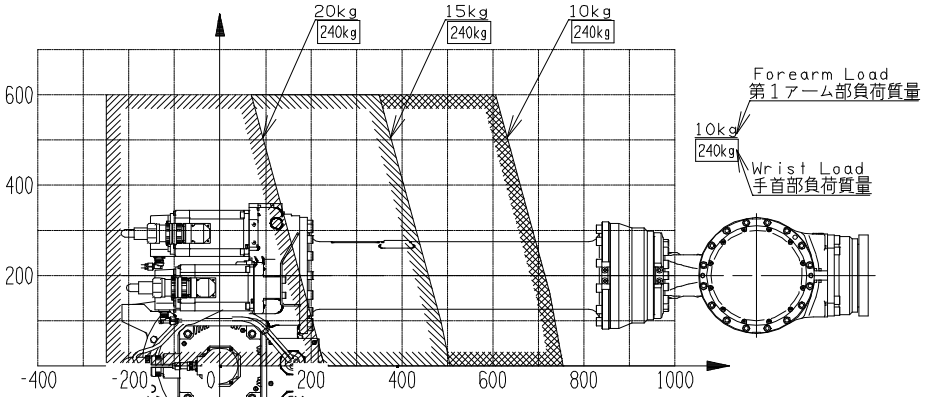
【SRA210-01】
When wrist
load is 210kg



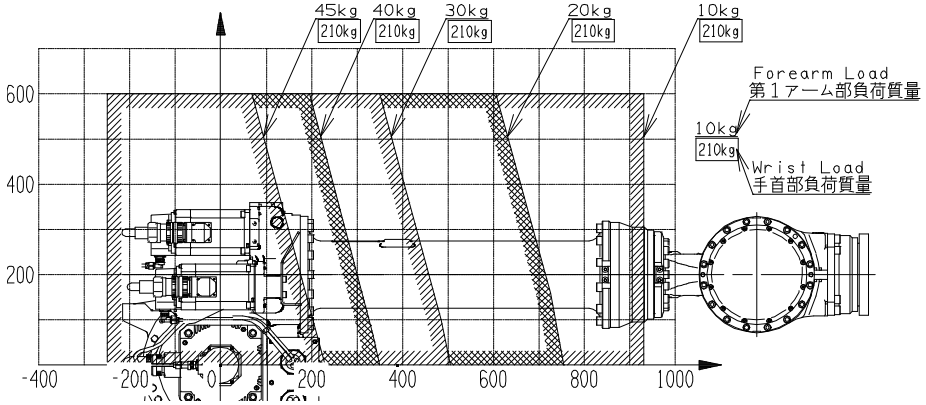
【SRA210-01】
When wrist
load is 180kg



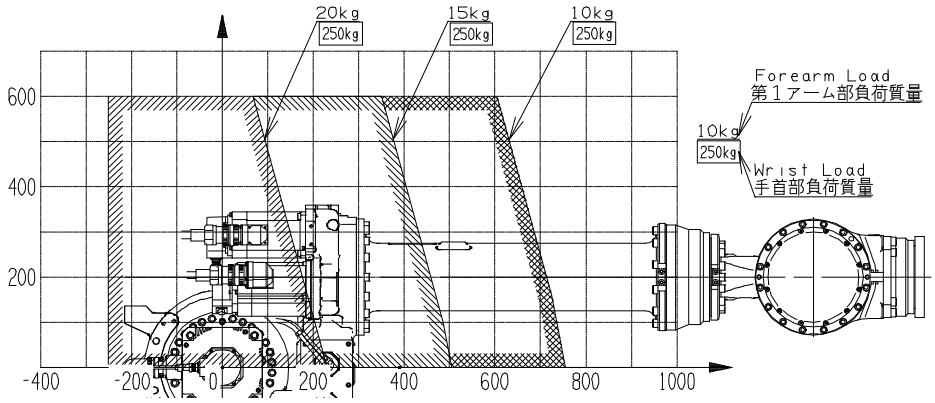
【SRA240-01】
When wrist
load is 240kg



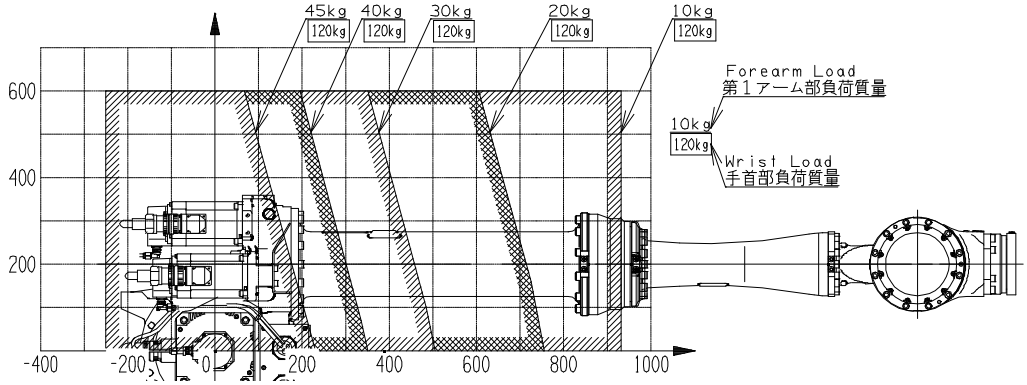
【SRA240-01】
When wrist
load is 210kg



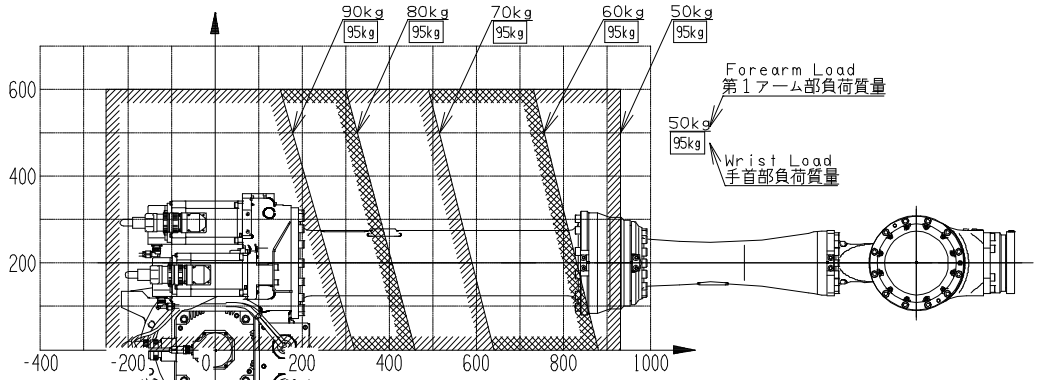
【SRA210L-01】
【SRA250-01】
When wrist load is 250kg



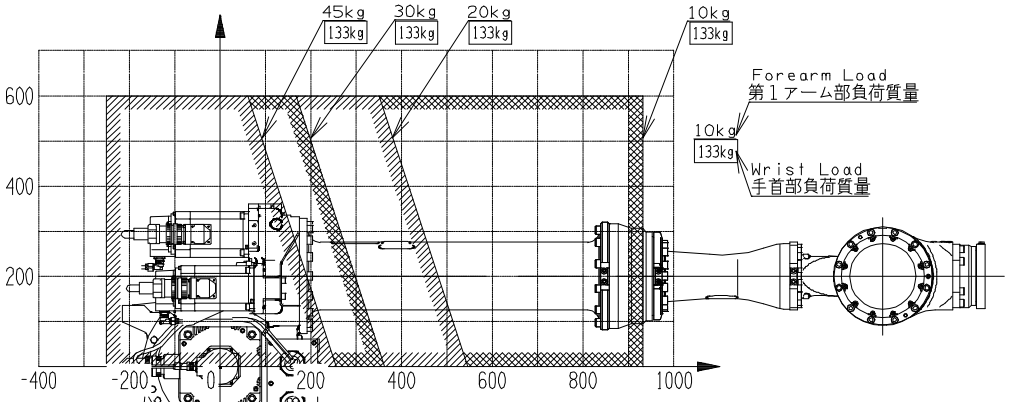
【SRA120EL-01】
When wrist load is 120kg



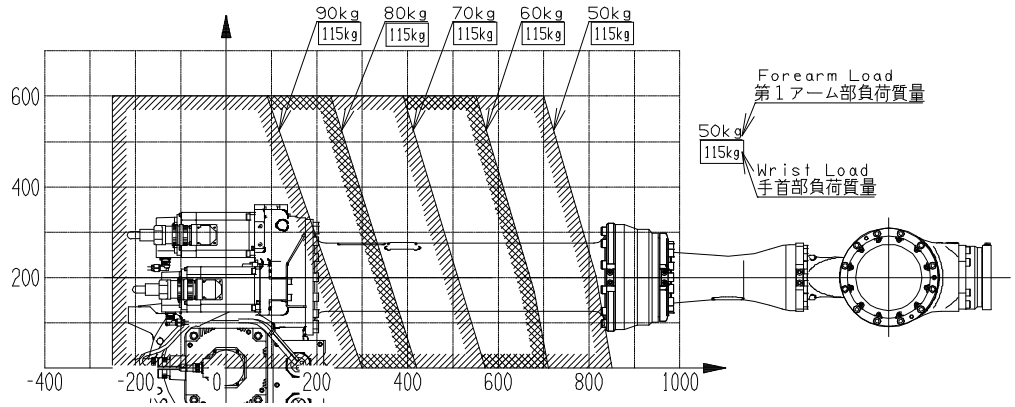
【SRA120EL-01】
When wrist load is 95kg



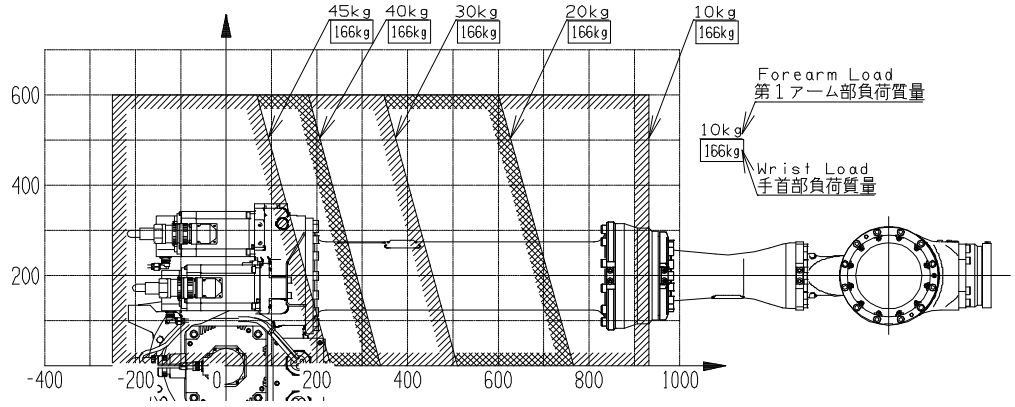
【SRA133L-01】
When wrist load is 133kg



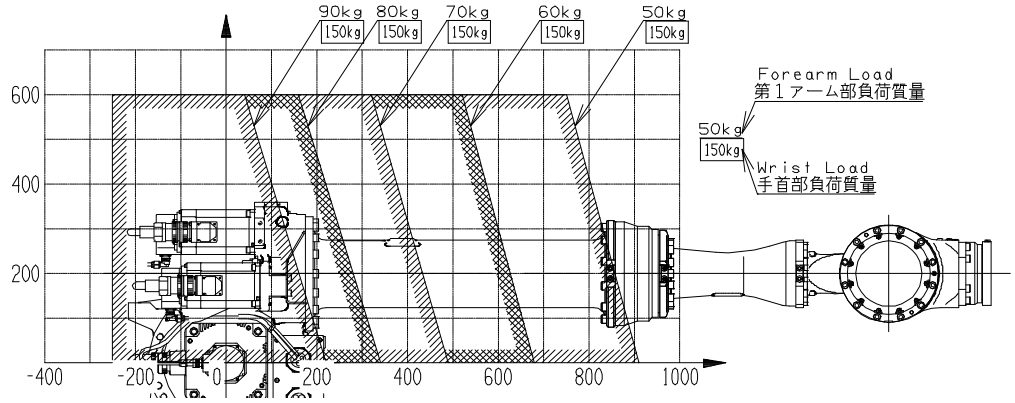
【SRA133L-01】
When wrist load is 115kg



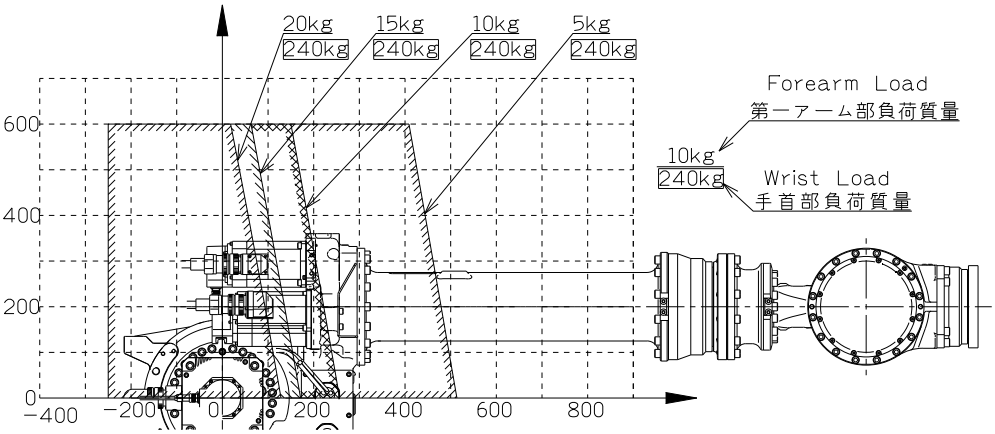
【SRA166L-01】
When wrist load is 166kg



【SRA166L-01】
When wrist load is 150kg



【SRA240L-01】
When wrist load is 240kg



2.5 Execution of encoder correction

CAUTION	At NACHI factory, encoder correction is performed under both the load condition and the robot posture specified by NACHI. It may get influenced if the load condition and robot posture differs from the reference position. **So before staring the teaching procedure, please make sure to conduct "encoder correction" FOR ALL AXES WITH ALL THE LOADS ARE EQUIPPED on the wrist and the upper arm.** (*Refer to information in "4.1.4 Encoder Correction". At this time, resetting encoder procedure is not required.) If encoder correction is carelessly performed after teaching is done, it would make a big change on T.C.P. (Tool Center Point), then all the points which you taught are needed to be modified.
CAUTION	Also encoder correction is necessary when motor / encoder is replaced. At this time, encoder correction must be performed under the **same load condition and same robot posture as the first encoder correction. (That was performed immediately after the tool were equipped.)** BECAUSE the load condition and the robot posture may have the possibilities to influence on the reference position. Therefore, the "reference posture" (where all axes are in "reference position" by using zeroing pin or etc.) is strongly recommended as the ideal posture of encoder correction. (☞ "4.1.4 Encoder Correction") Furthermore, sometimes there is a case when bigger tool is equipped (or something else.) normal encoder correction is not sufficient to recover the taught positions precisely. In such case, more accurate encoder correction procedure is recommended by referring to "4.1.5 More accurate encoder correction".

2.6 Restricting the motion range

In case that the actual robot motion range is limited, operating range of each axis can be changed from the standard range. Two methods are available to do this. Before that read through warnings.

WARNING	Do not operate the robot without stoppers on. It may cause some damages to the peripheral equipment and other kind of equipments, or leads to death or serious injury.
WARNING	Software itself can not regulate the motion range (the range which cannot go beyond, no matter what failure or miss operation occurred). Restriction of main axis needs to be changed by the mechanical stopper and over-travel limit switch (*option).
WARNING	If mechanical stopper collides and robot stops, it's possible that some parts are already damaged, for example, mechanical stopper is disfigured or fixing bolts are broken. In this case, it's impossible to keep sufficient intensity and function. Mechanical stopper and reduction gear of collided joint are needed to be replaced to the new one.

(1) Restriction of working envelope by software
Refer to "FD controller instruction manual SETUP" "Chapter 4 Setup" for this operation.

(2) Restriction of working envelope by adjustable stopper (option)
Working envelope is restricted by changing the position of mechanical stopper. Applicable axis is limited. Over-travel limit switch (another option) and software is needed to be changed at the same time. Please refer to the option manual for detail.

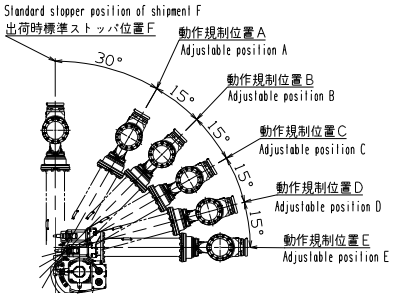


Image of "adjustable stopper"

2.7 Start to operate after the long time posing

After a long time of posing, then start to operate, abnormal sound may happen to occur sometimes from main axes (1, 2 and 3) This happens because of the condensation of additive material in grease. If abnormal sound occurred, please try the test running of corresponding axis by referring at "3.6 Grease replacement" procedure. By doing so, condensation of additive material and abnormal sound will be resolved. This test running never affects the reliability of reduction gear, so do not concerned.

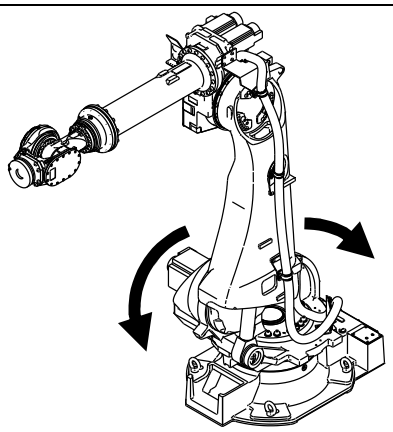
2.8 Notes for the Brake release switch

When using brake release switch for this robot series, please note the following.

WARNING

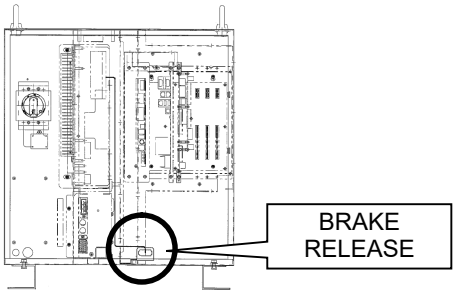
When axis 2 brake is released of this robot series, the motor brake is released and axis 2 moves either forward or backward at high speed.

As with other robot series and axes, the brake release operation must be performed with due care by securing the arm with a crane or by ensuring the safety of the surrounding area in advance. Failure to do so may result in a serious accident.



(Supplements)

[FD11 controller]
When using the portable type brake release switch box (FD11-OP90-B or FD11-OP90-E), connect the CNSW cable from the box to the "BRAKE RELEASE" connector.



FD11 controller

[FD18 controller]
Pease refer to the instruction manual "FD18 controller maintenance", (TFDEN-014) for detail.

[FD20 controller]
Pease refer to the instruction manual "FD20 controller maintenance", (FD20-EN-301) for detail.

・If there is an additional axis such as traverser (slider), use the "J7","J8" terminal for brake release operation.

・The following tools can be used to secure the arm so that it will not move when the motor is disconnected or the brake is released

KP-ZD-005 (Axis 2 arm locking fixture)

There is also a fixing jig for the third axis. Refer to Chapter 5 for details.

Chapter 3 Inspection

CAUTION	To perform daily inspection, repairing, or replacing the part of the robot, be sure to TURN OFF the power supply. Furthermore, in order to make sure that other workers not to turning on the power supply carelessly, set the warning signs such as “DON’T TURN ON” at the primary power supply switch and others.

3.1 Inspection items and periods

The inspection should be performed in order to maintain the high performance of the robot for an extended period of time. Personnel who are engaged in the inspection must create and implement the inspection program.

Furthermore, perform overhauls **every 40,000 operating hours or every 8 years, whichever comes earlier.** The inspection periods have been examined for spot welding work. For material handling application or for high duty work where the temperature in reduction gear case is higher than 55 degree, it is recommended to perform inspections **at approximately half of the periods specified.** Should you have any questions, contact your closest NACHI representative.

Inspection items and periods

Period			Inspection Item	Inspection Method	Target
Daily	Quarterly	Yearly			
○			Robot body	Confirming that playback position is same as before.	Whole body
	○		Cleaning of robot	Wiping off dirt, removing off accumulated spatter, dust, cutting chips.	Whole body
	○		Wiring	Refer to “3.2 Inspection of wirings”	Whole body
	○		Major bolts	Retightening and coating of paint lock to all of exposed bolts (refer to “Specified tightening torque” table) Also for the tool fixing bolts.	Whole body
		○	Limit switch dogs (option)	Activate and deactivate the limit switch. Retightening and coating of paint lock to the fixing bolts.	Axis 1, 2 and 3
○			Motor	Checking the abnormal heat generation and abnormal sounds	All axis
○			Brake	Confirming that robot arm and tool never drop when motor power is turned ON/OFF.	All axis
		○		Confirming that robot arm and tool never drop when the brake release switch (note) is set to OFF.	All axis
	○		Reduction gear	Confirming of no abnormal vibration, no abnormal so unds and no oil leakage.	All axis
		○	Steel dust of grease in reduction gears	Refer to “3.3 Inspection of grease”	Axis 2 and 3
		○	Balancer unit	Refer to “3.4 Inspection of balancer unit and filling gas”	
		○	Balancer fulcrum bearing		
	○		Backlash	Confirming of no backlash by pushing the tool in forward/backward, right/left, and upward/downward with hand.	Axis 4, 5 and 6

（Note）Brake release switch is option. When operating this switch to ON, robot arm or operated axis drops. Pay utmost attention when operating. Please refer to the instruction manual “Controller” for more detail.

Specified tightening torque of bolts

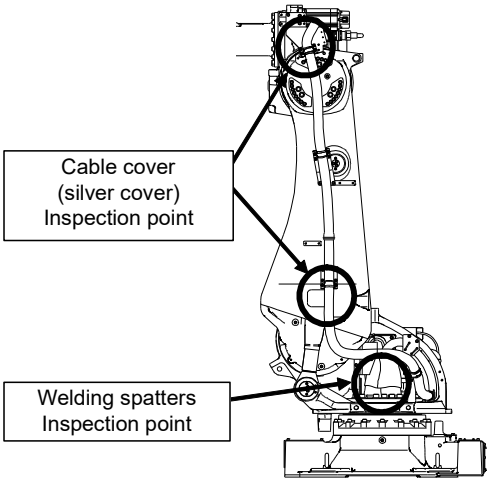
	Hexagon socket head cap screw	Hexagon socket cross recessed button head screw		Hexagon socket head cap screw	Hexagon socket cross recessed button head screw
M3	1.77 N･m		M10	67 N･m	
M4	4.0 N･m		M12	116 N･m	
M5	8.1 N･m	4.02 N･m	M16	287 N･m	
M6	13.8 N･m	9.8 N･m	M20	560 N･m	
M8	33.3 N･m	13.8 N･m	M24	804 N･m	

Tightening torque of hexagon socket head cap screw is for JIS: strength class 12.9 (up to M20) and for JIS: strength class 10.9 (M24). And tightening torque may vary according to the material and the kind of bolt. Unless specified in drawing, refer to the value in this table.

3.2 Inspection of wirings

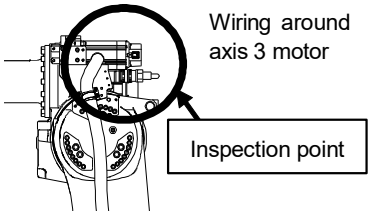
■ **Cables cover (hook tube) and clamp portion**

- Whether or not any cable cover has damages and opening of joined section. (Pay utmost care not to let any dusts get into the inside of cover.)
- Whether or not the cable clamp fixing bolts are loosened or lost. (M6 bolts; tightening torque 9.9 N・m)
- No welding spatters are found in bracket, fixing bolt and cable cover (silver cover) clearance.
- If any damage is found, repair or replace it.



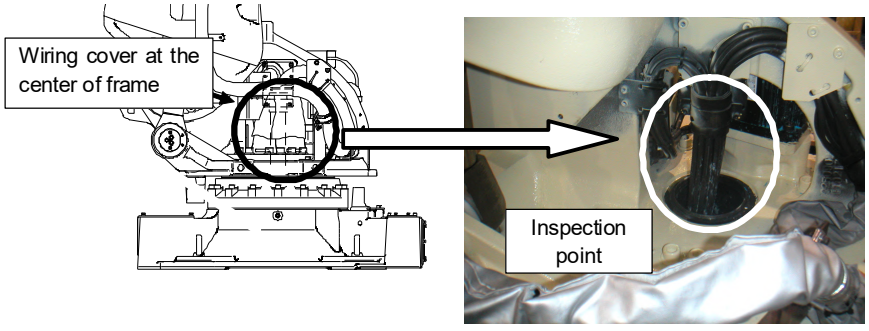
■ **Wiring around axis 3 motor**

- Whether or not any cable sharply bends over or gets crushed.
- Whether or not any cable shield has scratches or fractures.
- Whether or not any hose and cable has welding spatters or singes.
- Whether or not any cable tie is broken.
- If any damage is found, repair or replace it.



■ **Wiring around axis 1 motor**

- Open the wiring cover at the center of frame from the lower side and visually inspect the wiring inside the cover whether or not any cable cover has scratches or fractures and whether or not the clamp bolts are loosened.
- If any damage is found, repair or replace it.
- After the inspection, re-attach the cover.



CAUTION	Never attempt to use any cables other than specified by NACHI. For the replacement, order to your local service center.

3.3 Inspection of grease

Please check the density of steel dust in the grease of reduction gear every 5,000 hours or every 1 year (in case of material handling application or of high duty work that temperature in reduction gear case is higher than 55 degree, every 2,500 hours or every half year).

If the measurement result exceeds the criterion, please contact our service center for grease replacement or reduction gear replacement.

Tools required (prepared by customer)

Name	Specification	Q'ty
Grease steel dust meter	OM-810 (IDEMITSU Kosan Ltd.) is recommended	1
Seal tape	(in market)	1

CAUTION	Immediately after removing the drain plug, grease may splash, because internal pressure is still high, for example soon after robot stops.

Inspection points	Grease type	Inspection amount	Purpose	Type	Size	Tightening torque	Criterion of steel dust
Axis 2 Reduction gear	VIGO RE No.0	10 cc	Air release	Plug	Rc-1/4	29.4 N·m	less than 0.1 %
			Discharge	Plug	Rc-1/4	29.4 N·m	
Axis 3 Reduction gear	Same as above	10 cc	Air release	Plug	Rc-1/4	29.4 N·m	
			Discharge	Plug	Rc-1/4	29.4 N·m	

Density of grease: VIGO RE No.0 (Nabtesco) 0.9 g/cc
Refer to the figure of "3.5 Lubrication" for detail.

Grease inspection procedure

STEP	Required work
1	In order to prevent the grease from splashing out (this is caused by e.g. rising of internal pressure or internal temperature), unplug the air release plug in advance. When releasing the plug, loosen the plug slowly to release the remaining pressure slowly
2	Collect the grease and measure the density of steel dust by using grease steel dust meter.
3	Wipe grease running out from the lubrication port. Then, wind sealing tape around the threaded part of the socket head plug to prevent the leakage of grease, and plug it again.
4	If the grease leaks out too much when inspecting, lubricate grease. (☞ refer to "3.5 Lubrication")

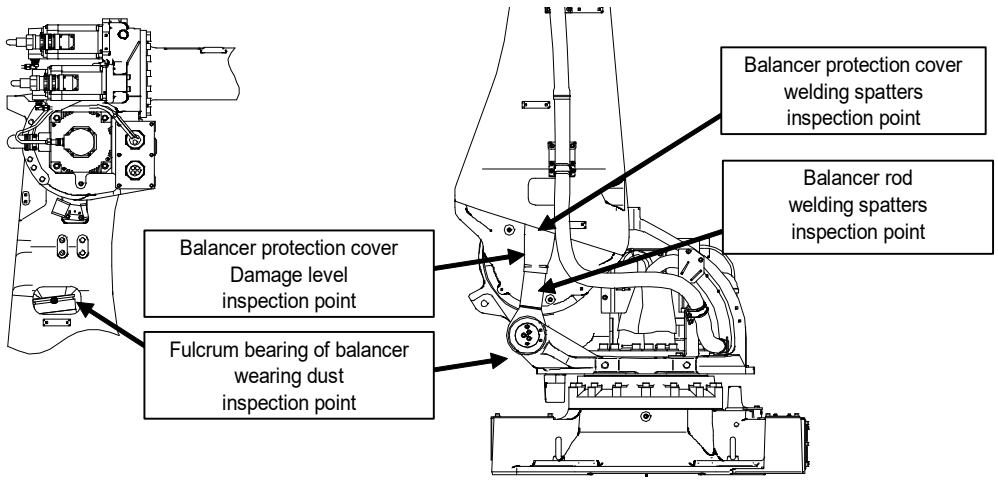
3.4 Inspection of balancer unit and filling gas

Gas balancer is installed inside the upper arm. If gas pressure in balancer unit falls, excessive stress is applied on motor, thus, results in trouble.

IMPORTANT	Inspect the gas pressure every year. If gas pressure falls, fill the gas. If gas pressure falls remarkably, balancer unit itself may be broken. Stop using robot immediately.
CAUTION	Gas has high pressure. Observe the adequate law to handle it.
CAUTION	To prepare the worst case, do not stand at the location where the gas is coming out.
IMPORTANT	Use nitrogen gas（N_2）. (Purity 99.99V/V% or more, Industrial usage compressed nitrogen gas)
CAUTION	Nitrogen is suffocation gas. Secure the working space with good ventilation system.

Inspection of balancer unit appearance

STEP	Required work
1	Check that welding spatters do not accumulate on balancer rod and no damage on it.
2	Check that balancer protection cover (silver cover) has no damage and no opening of joined section. (Pay utmost attention not to let any dusts get into the inside part).
3	Check that welding spatters do not accumulate on the clearance of balancer protection cover.
4	If any damage is found, repair or replace it. (As for the replacement of protection cover, refer to ”3.8 Balancer protection cover replacement”).
5	Check that no wearing dust is found from the fulcrum bearing of balancer.



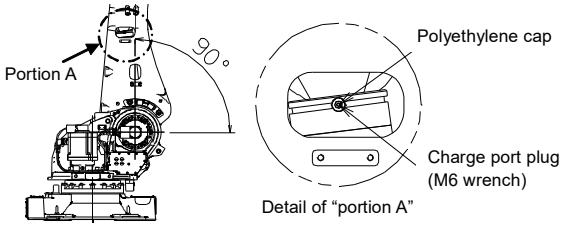
Inspection of gas pressure

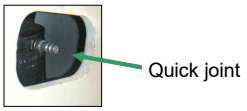
Required tools (prepared by customer)

Name	Specification (Parts No.)	Q'ty
M6 torque wrench	(in market)	1
Thermometer (to measure the atmospheric temperature)	(in market)	1
Gas inspection tool (Select one among right list)	Analog service gauge (KP-ZJ-013) Digital service gauge (KP-ZJ-014)	1

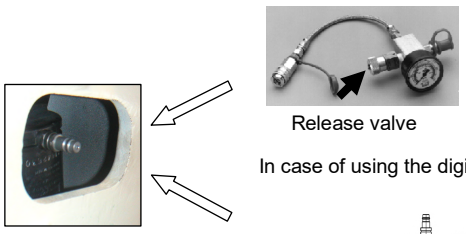
Gas inspection tool includes quick joint and analog (or digital) service gauge.

STEP	Required work
1	Move axis 2 to 90 degree position. Other axis is free (any position).
2	Push the emergency stop button to lock the robot arm.
3	Remove the polyethylene cap and charge port plug of "portion A". If gas is released continuously, please contact our service center.
4	Attach the quick joint to the place where the charge port plug was attached.
5	Connect the analog service gauge or the digital service gauge to the quick joint. At this time, confirm the click sound. Before connecting, confirm that release valve is surely closed.
6	Confirm that read pressure satisfy the criterion range written below. (at atmospheric temperature 20℃) SRA100-01, SRA166-01, SRA133L-01: 9.0±0.9 MPa SRA210-01, SRA240-01, SRA250-01, SRA120EL-01, SRA166L-01, SRA210L-01, SRA240L-01: 10.1±1.0 MPa Pressure may change according to the atmospheric temperature. Please refer to the figure below.
7	Disconnect the analog service gauge or the digital service gauge from the quick joint.
8	Remove the quick joint and attach the charge port plug and polyethylene cap.

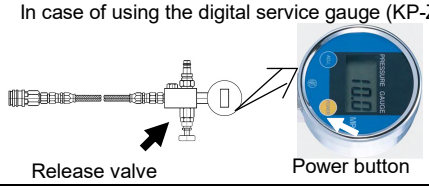




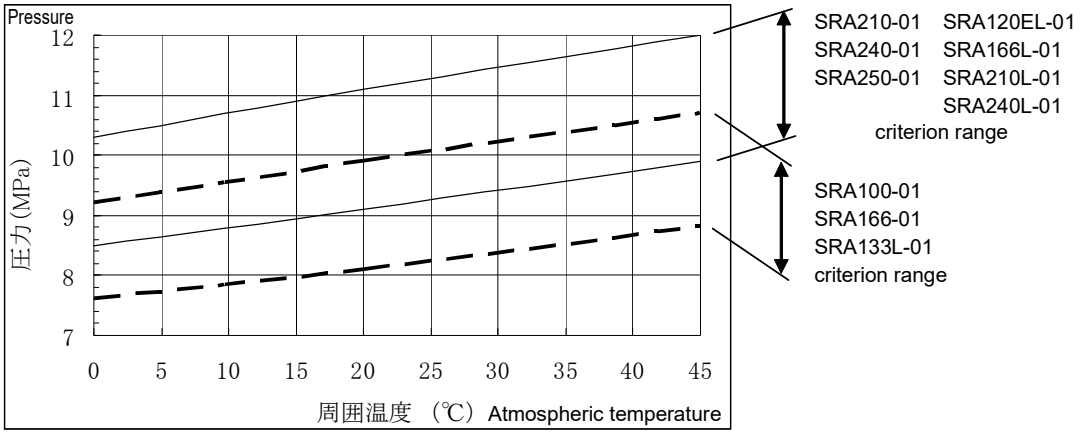
In case of using the analog service gauge (KP-ZJ-013)



In case of using the digital service gauge (KP-ZJ-014)



In case of using the digital service gauge, power switch is needed to be ON. Please refer to the manual of gauge.



If gas pressure satisfies the criterion range, proceed with next step.
If higher than criterion→ **How to release gas in case that pressure was higher than criterion range**
If lower than criterion→ **How to fill gas in case that pressure was lower than criterion range**

How to release gas in case that pressure was higher than criterion range

STEP	Work performed
1	Operate the release valve to adjust the gas pressure. For the settlement of gas pressure, wait for 2 or 3 minutes before reading the pressure. After gas pressure satisfies the criterion range, proceed with next step.
2	Remove the quick joint and attach the charge port plug and polyethylene cap.

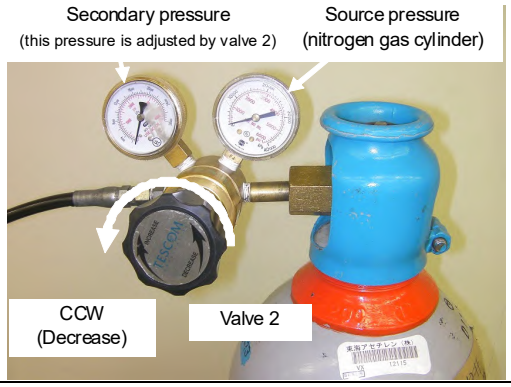
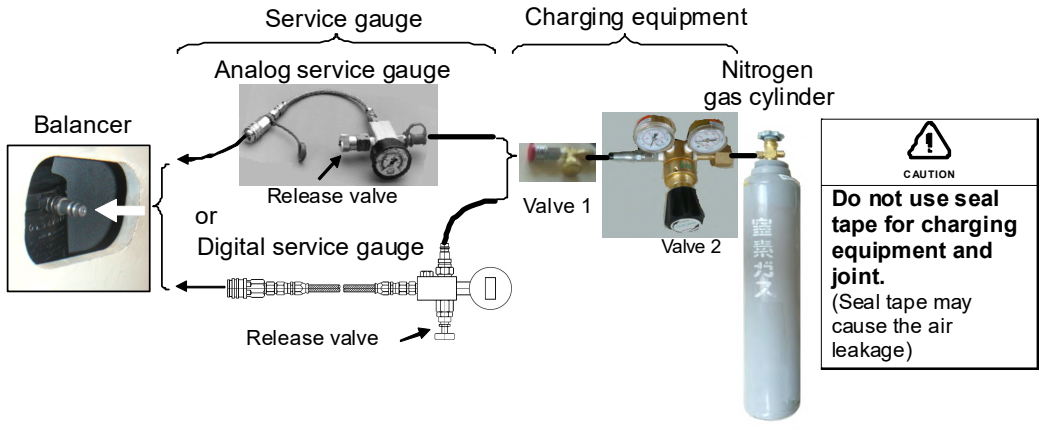
How to fill gas in case that pressure was lower than criterion range

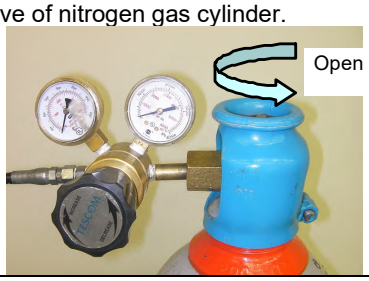
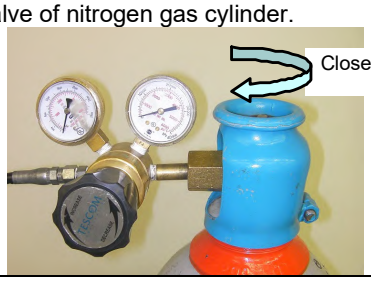
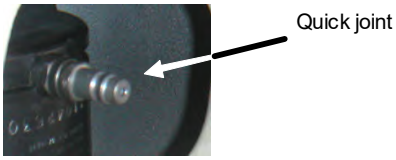
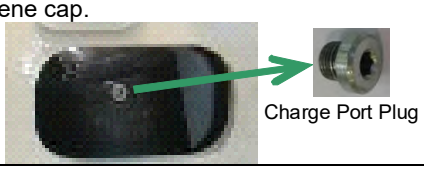
Required tools (prepared by customer)

Name	Specification (Parts No.)	Q'ty
Nitrogen gas cylinder	Recommended cylinder: 10L 1.5m^3 cylinder (Purity 99.99V/V% or more, Industrial usage compressed nitrogen gas)	1

Select one "Charging equipment" among following list depending on the diameter of gas cylinder

Diameter of gas cylinder	Specification (Parts No.) of Charging equipment	Q'ty
W22, pitch 14, Male Right screw, Metal contacts	KP-ZJ-015 (W22, pitch 14, Female, Right screw, Metal contacts)	1
W22, pitch 14, Female Right screw, Metal contacts	KP-ZJ-015 + KP-ZJ-019 (W22, pitch 14, Female, Right screw, Metal contacts) + (Female->Male joint)	
W23, pitch 14, Female Right screw, Metal contacts	KP-ZJ-016 (W23, pitch 14, Male, Right screw, Metal contacts)	

STEP	Required work	Checkpoints
1	Confirm valve position of the charging equipment. Valve 1 is CW (close) direction Valve 2 is CCW (decrease) direction And connect the charging equipment to nitrogen gas cylinder. 	Select the charging equipment according to the size of nitrogen gas cylinder. **Check list before connection** (charging equipment) ☐Valve 1 = CW (close) ☐Valve 2 = CCW (decrease) (service gauge) ☐Release valve 1 = CW (close)
2	Attach the charging equipment to analog (or digital) service gauge. 	CAUTION **Do not use seal tape for charging equipment and joint.** (Seal tape may cause the air leakage)

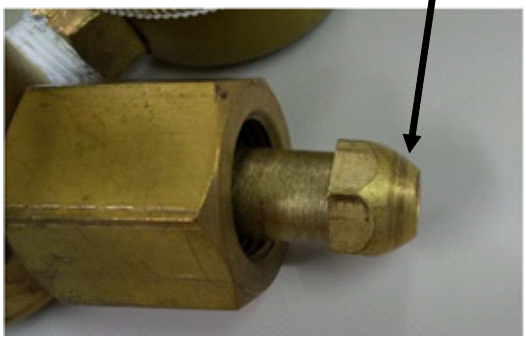
STEP	Required work	Checkpoints
3	Open the valve of nitrogen gas cylinder. 	
4	Operate the valve 2 of the charging equipment to CW (increase) direction and set the pressure a little higher than the specified pressure. 	
5	Open the valve 1 of the charging equipment slowly to CCW (open) direction and fill gas of the analog service gauge or the digital service gauge a little higher than the specified pressure.	
6	Close the valve 1 and wait for 2 or 3 minutes for the settlement of gas pressure.	
7	Check whether or not gas pressure satisfies the criterion range. If pressure is higher than the criterion range, release valve to adjust gas pressure. If pressure is lower than the criterion range, fill the nitrogen gas again.	
8	Close the valve of nitrogen gas cylinder. 	
9	Disconnect the analog service gauge or the digital service gauge from the quick joint. 	Inside the balancer is already high pressure, so you can hear the air leak sound and it is difficult to disconnect the gauge. Do not fall down by pulling reaction.
10	Remove the quick joint and attach the charge port plug and polyethylene cap. 	If polyethylene cap is forgotten, it is possible that charge port plug can not been removed.
11	Open the valve 1 and valve 2 of the charging equipment to release gas from the hose. Then remove the charging equipment from the cylinder.	

If gas leakage occurs from the connection of charging equipment and nitrogen gas cylinder

When gas leakage occurs from the connection of charging equipment and nitrogen gas cylinder, check the shipping time from the shape of the connecting portion.
If connecting portion is hemispherical, it was shipped prior to January 2020. If connecting portion is flat, it was shipped February 2020 or later.

Connecting portion with gas cylinder is hemispherical

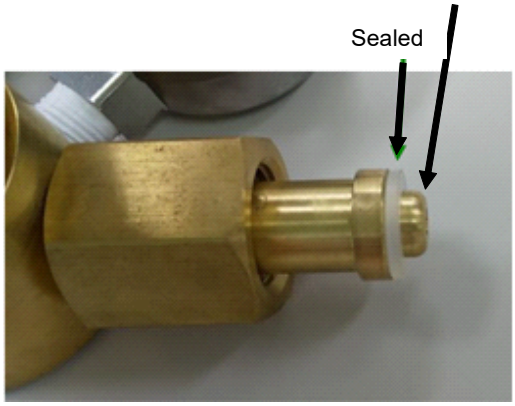
No need to seal



Charging equipment
shipped prior to January 2020

Connecting portion with gas cylinder is flat

Sealed



Charging equipment
shipped on February 2020 or later

Charging equipment shipped on February 2020 or later has a seal on the connection portion of the charging equipment and nitrogen gas cylinder.
This seal is consumable. If the seal degradation or comes off, it may cause a gas leak from the connection part with nitrogen gas cylinder, so it is necessary to replace the seal.
If you would like to purchase a replacement seal, please contact our company Service Department with the product number below.
Charging equipment shipped prior to January 2020 does not require a seal.

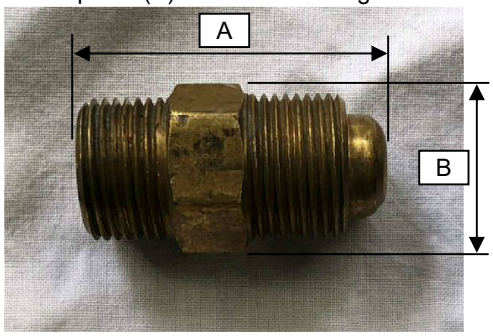
Name	Parts No.	Specification
Seal	NCJ-W22-SEAL	Seal for replacing connection part of charging equipment

Seal is fixed by double side adhesive tape. When replacing the seal, remove the old tape and fix the new tape firmly to the Charging equipment (double side adhesive tape is an accessory of the new seal).

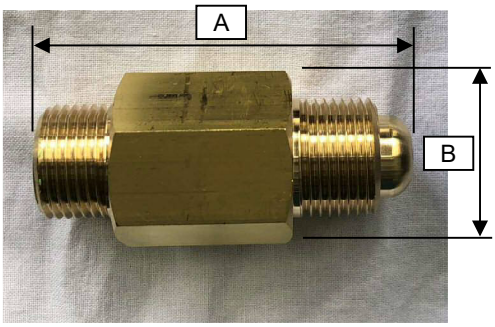
If the charging equipment was shipped prior to January 2020 or if gas leakage can not stop even after seal was replaced to the new one on the charging equipment shipped February 2020 or later,
it's possible that the charging equipment itself has failure or the connecting portion of the nitrogen gas cylinder is damaged.
Please replace the charging equipment or nitrogen gas cylinder, and check for gas leakage.

Charging equipment (Part No. KP-ZJ-019 female to male conversion joint) varies in shape depending on the time of shipment.

Length (A) 51mm ⇒ change to 73mm
Antipode (B) 23mm ⇒ changed to 30mm



Female to male conversion joint
shipped prior to January 2023



Female to male conversion joint
shipped February 2023 or later

3.5 Lubrication

CAUTION	For lubrication and grease replacement, **never use grease other than specified type**. Specified type of grease is written in this manual.
IMPORTANT	If grease other than specified type is used, chemical reaction with original grease occurs and grease will change in quality. Insufficient lubricating efficiency may cause the unexpected shortening of robot life time.
CAUTION	Periodical lubrication is needed for some portion and grease replacement is needed for other portion. Please do the correct maintenance (lubrication and grease replacement) by referring to this manual.
CAUTION	In order to prevent the internal pressure from rising due to pressure caused by the lubrication, unplug the air vent plug. Its location is written in this manual.

Please lubricate every 5,000 hours or every 1 year (in case of material handling application or of high duty work that temperature in reduction gear case is higher than 55 degree, every 2,500 hours or every half year). No lubrication is required for any points other than those specified.

Tools required (prepared by customer)

Name	Specification	Q'ty
Grease gun	with a nozzle of not more than 17 mm in diameter	1
Seal tape	(in market)	1

IMPORTANT	**Use a grease gun** with a nozzle of not more than 17 mm in diameter. Note that lubricating grease more than the recommended amount may result in leakage of grease or faulty robot locus. When making up the grease, feed the same amount of grease as the leaked one. When replacing the grease or lubrication, feed the specified amount of grease.
CAUTION	Immediately after removing the drain plug, grease may splash, because internal pressure is still high, for example soon after robot stops.

Lubrication point	Lubrication port	Applicable Grease	Lubrication amount	Remark
Bearing of balancer upper portion	Balancer upper fulcrum	U4623	10^{+1}_{0} cc	
Bearing of balancer lower portion	Balancer lower fulcrum	Same as above	Same as above	
Axis 4 reduction gear	Lower part of forearm on the front side	Long Time PD2	3^{+1}_{0} cc	
Axis 5 reduction gear	Lower (rear) part of the wrist	Same as above	Same as above	
Axis 6 reduction gear	Lower (rear) part of the wrist	Same as above	Same as above	

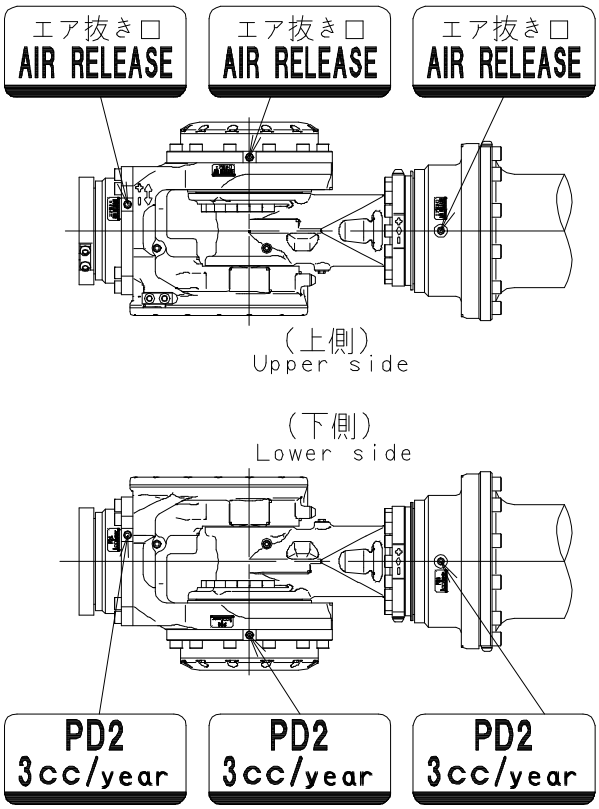
Refer to the figure on next page for detail.

Lubricating procedure

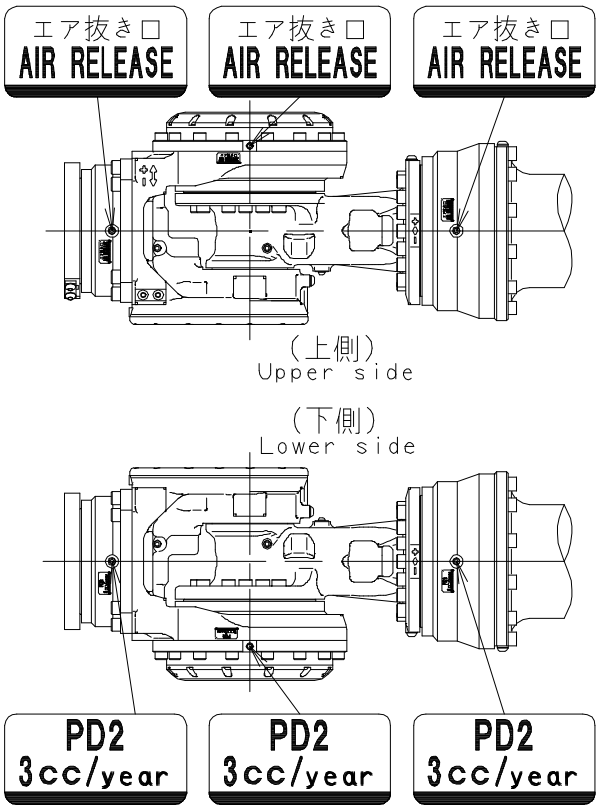
STEP	Required work
1	In order to prevent the internal pressure from rising due to pressure caused by the lubrication, unplug the air vent plug. If the pressure caused by the lubrication is applied to the oil seal part, leakage of grease will result.
2	Lubricate using grease gun. In case of axis 4, 5 and 6 reduction gear, unplug the socket head plug and then mount a grease nipple Rc-1/8 (☞ refer to "3.6 Grease replacement") that is mounted to the frame to lubricate the points.
3	Wipe grease running out from the lubrication port. Then, wind sealing tape around the threaded part of the socket head plug to prevent the leakage of grease, and plug it again. (Tightening torque of socket head plug: Rc-1/8 : 12.7 N·m)

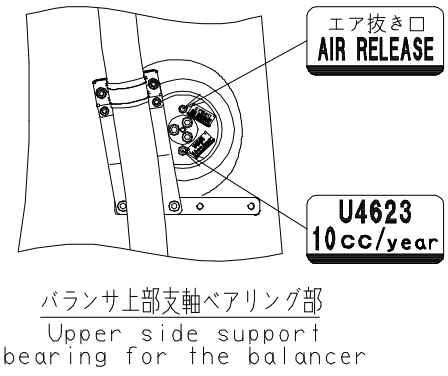
Lubrication port (and air release position)

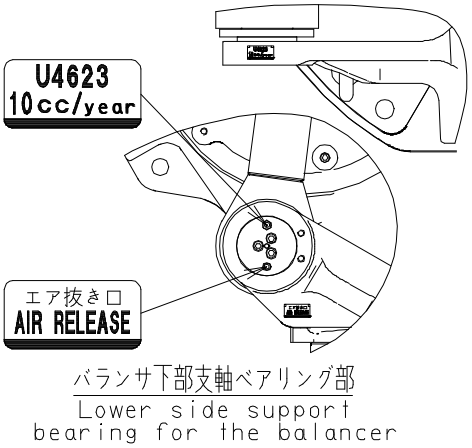
[SRA100-01][SRA166-01]
[SRA120EL-01] [SRA133L-01] [SRA166L-01]



[SRA210-01] [SRA240-01] [SRA250-01]
[SRA210L-01] [SRA240L-01]







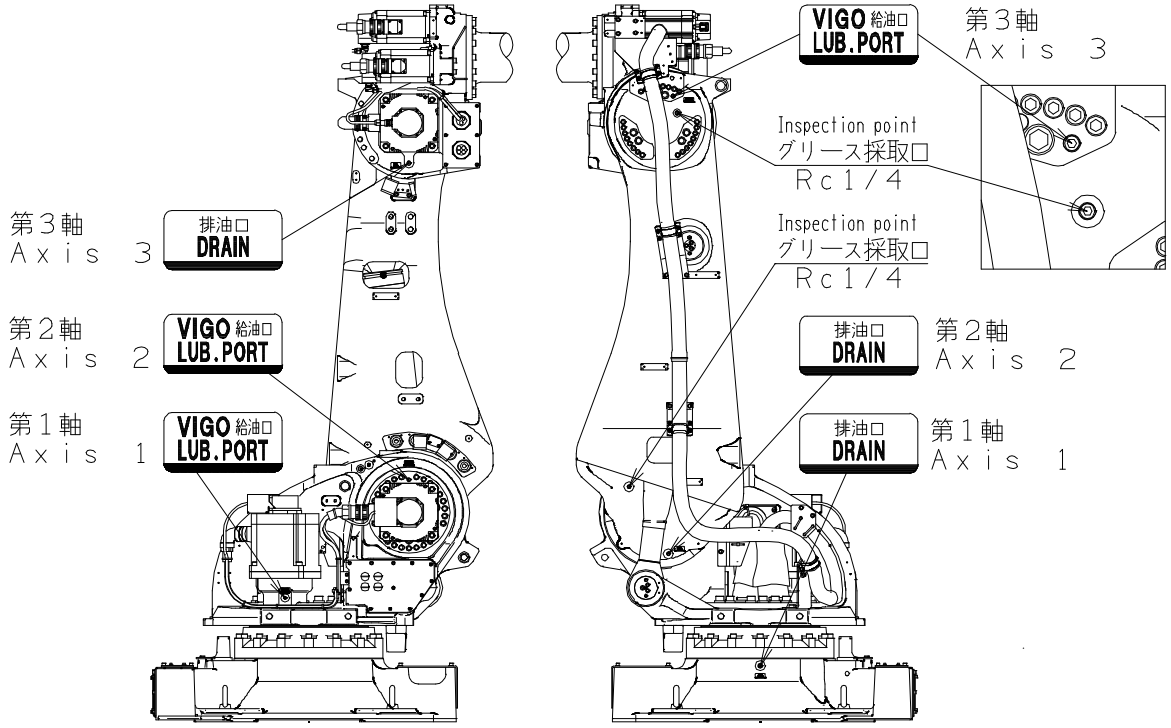
CAUTION	■ Robot shipped prior to Oct. 2016; At balancer fulcrum lubrication port, grease label is printed “PD2”, but be sure to lubricate “U4623” grease. “PD2” and “U4623” grease can be mixed. PD2 10cc/year ■ Robot shipped Nov. 2016 or later; At balancer fulcrum lubrication port, grease label is printed “U4623”. Be sure to lubricate “U4623” grease. “PD2” grease can not be used.
CAUTION	When lubricating grease, surplus grease may come out from the oil seal, please wipe it off and carry out the following measure. ■ Robot shipped prior to Jul. 2018; It is unnecessary to refill the grease, because extra grease is already filled when shipped. Designated amount of grease needs to be added at the periodical maintenance. ■ Robot shipped Aug. 2018 or later; Refill the grease with the same amount as leaked. Also designated amount of grease needs to be added at the periodical maintenance.

Location of grease inspection, lubrication and grease replacement (1)

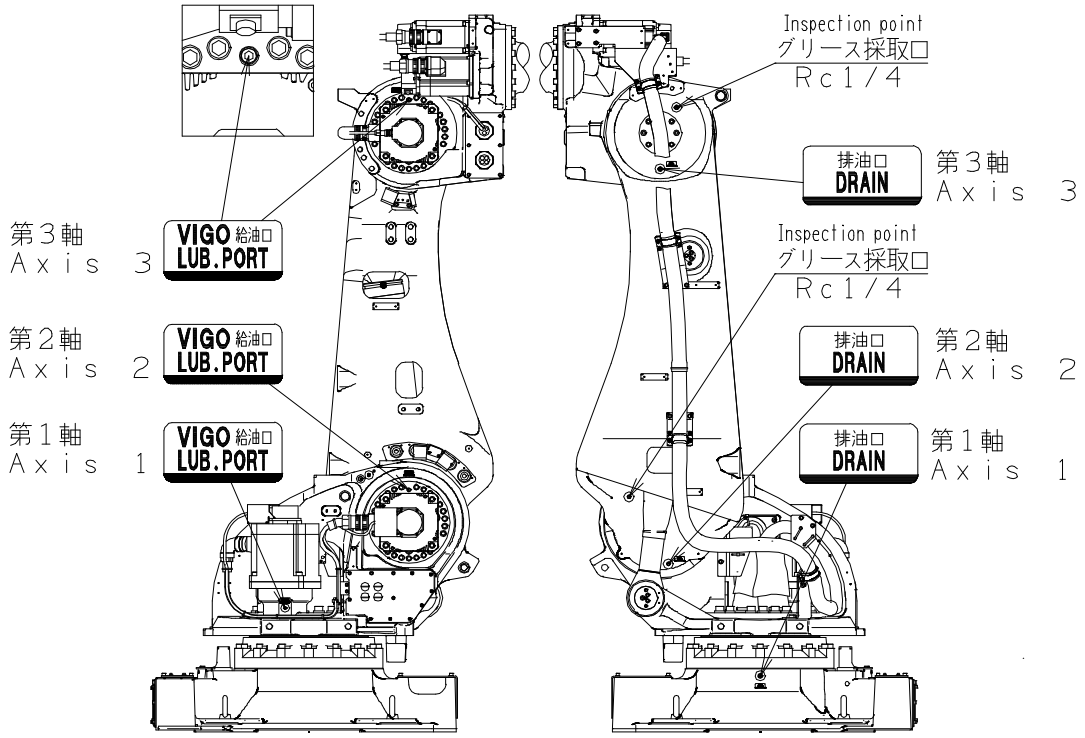
Grease replacement port (and drain port)
Grease inspection port (and air release position)

For grease inspection, open “VIGO 給油口/LUB.PORT” and inspection point, and then collect grease. Now, air is released from “VIGO 給油口/LUB.PORT”.

[SRA100-01] [SRA166-01] [SRA210-01] [SRA240-01]
[SRA120EL-01] [SRA133L-01] [SRA166L-01]



[SRA250-01] [SRA210L-01] [SRA240L-01]



Location of grease inspection, lubrication and grease replacement (2)

3.6 Grease replacement

CAUTION	For lubrication and grease replacement, **never use grease other than specified type**. Specified type of grease is written in this manual.
IMPORTANT	If grease other than specified type is used, chemical reaction with original grease occurs and grease will change in quality. Insufficient lubricating efficiency may cause the unexpected shortening of robot life time.
CAUTION	Periodical lubrication is needed for some portion and grease replacement is needed for other portion. Please do the correct maintenance (lubrication and grease replacement) by referring to this manual.
CAUTION	Lubricating work must be done keeping the feeding speed to 40cc per 10 seconds or less. If lubricating is done rapidly, the oil seal may be broken and grease leakage may occur because of rise of pressure inside robot.

Please replace grease every 20,000 operating hours or every 4 years (in case of material handling application or of high duty work that temperature in reduction gear case is higher than 55 degree, every 10,000 operating hours or every 2 years).

Tools required (prepared by customer)

Name	Specification	Q'ty
Grease gun	with a nozzle of not more than 17 mm in diameter, with lubrication amount counter	1
Drain connector	Rc-1/4,φ12	1
Drain hose	φ12X9 0.2m	1
Air precision regulator	Maximum 0.2Mpa and adjustable every approx. 0.01Mpa SMC "PRECISION REGULATOR IR2000-02BG-X1" is recommended	1
Air supply source	(in market)	1
Weight meter	which can measure the weight of ejected grease + container	1
Seal tape	(in market)	1

IMPORTANT	**Use a grease gun with lubrication amount counter**, with a nozzle of not more than 17 mm in diameter. If such grease gun can not be prepared, measure the weight of the grease can before/after the lubrication work to confirm the amount. Note that lubricating grease more than the recommended amount may result in leakage of grease or faulty robot locus. When making up the grease, supply the same amount of grease as the leaked one. When replacing the grease or lubrication, supply the specified amount of grease.
CAUTION	Immediately after removing the drain plug, grease may splash, because internal pressure is still high, for example soon after robot stops.
WARNING	In case that robot operation with slow speed playback or teaching operation is necessary, never get into the robot moving envelope while playback. And perform above procedure with two persons one pair. One person keeps to be ready to push the emergency button anytime, other person operates the robot paying much attention. Please ensure the escape route in advance.

Replacement point	Applicable grease	Lubrication amount	Application	Lubrication port	Size	Tightening torque
Axis 1 reduction gear	VIGO RE No.0	More than 3,400 cc	Lubrication	Plug	Rc-1/4	29.4 N·m
			Drain	Plug	Rc-1/4	29.4 N·m
Axis 2 reduction gear	Same as above	More than 1,500 cc	Lubrication	Plug	Rc-1/4	29.4 N·m
			Drain	Plug	Rc-1/4	29.4 N·m
Axis 3 reduction gear	Same as above	More than 1,000 cc 1,500 cc *1	Lubrication	Plug	Rc-1/4	29.4 N·m
			Drain	Plug	Rc-1/4	29.4 N·m

Density of grease : VIGO RE No.0 0.9 g/cc
*1 only SRA250-01, SRA210L-01 and SRA240L-01

Grease replacement procedure

STEP	Required work
1	Move the robot to the adequate posture for the work. (refer to the figures on next page)
2	Place a container to receive grease ejected under the drain port *1.
3	Unplug the socket head plug [Rc-1/4] from the drain port. To prevent the robot from getting dirty, attach a drain connector [Rc-1/4, φ12] and a drain tube [φ12×9, maximum length is 0.2m]
4	Unplug the socket head plug from the lubrication port *1, and attach the grease nipple [Rc-1/4].
5	Use a grease gun to feed grease. At this time, operation must be done **keeping the feeding speed to 40cc per 10 seconds or less.** Keep the operation until the grease color that is pushed out from the drain port change to a color of new grease.
6	When the lubricated amount reaches the specified amount, confirm lubricated amount and ejected amount. Lubricated amount can be calculated by comparing the grease can's weight before and after the lubrication work or checking the counter display on the grease gun. Ejected amount can be calculated by measuring the weight of the container.
7	If lubricated amount is larger than ejected amount, too much (surplus) grease remains inside the gear box. To make them same, use air to push the grease out. Supply air from the lubrication port and eject the surplus grease from the drain port. Be sure that the air pressure should be kept **under 0.025Mpa by using precise regulator.** If only air comes out from the drain port and grease does not come out, move the target axis slowly referring to the figure while supplying air, and push the grease out.
8	If lubricated amount is less than ejected amount, grease is lacked inside the gear box. To make them same, swap the inlet and outlet, and feed the lacked amount of grease from the drain port.
9	Wrap seal tapes on socket head plug [Rc-1/4] and attach to the lubrication port. Wrap seal tapes on socket head plug [Rc-1/4] and attach to the drain port.

*1: Refer to the figure of "3.5 Lubrication" for detail of lubrication port and drain port.

10

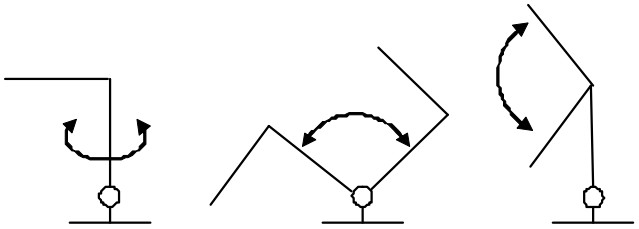
After grease replacement, abnormal sound may occur sometimes. If abnormal sound occurs, please perform running for grease by following to the procedure written below.

Running program
- Only target axis moves between 2 steps
- Travel distance ; Appx. 100 degree
- Speed ; 40 to 60%
- Operating time ; Appx. 1 hour

If sufficient travel distance is difficult to keep, make operating time longer.
(Ex; if distance is half, operating time should be 2 times longer than above value.)

Running program example

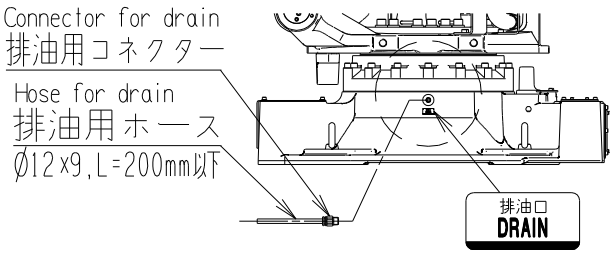
	Speed	Interpolation	ACC	Angle of Target axis	Angle of other than target axis
Step 1	40%	JOINT	1	(*)	any
Step 2	40%	JOINT	1	(*)	any
Step 3	DELAY [0.5]		FN50 Timer		
Step 4	END		FN92 Program End		



Axis 1 moves between 2 steps (*) -50° ~ +50°

Axis 2 moves between 2 steps (*) +30° ~ +130°

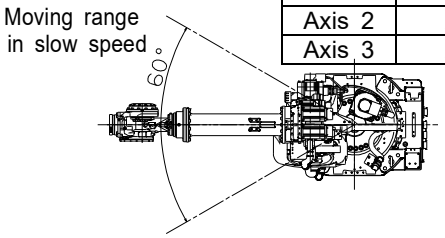
Axis 3 moves between 2 steps (*) -60° ~ +40°



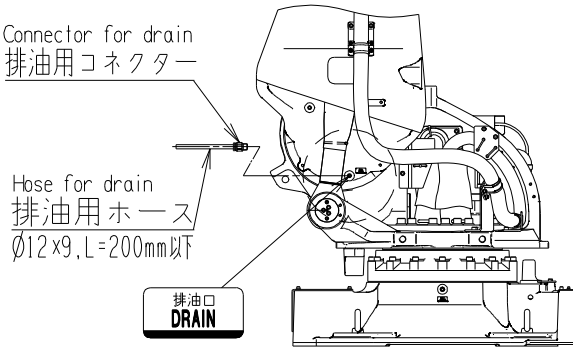
Axis 1 Connection of drain hose and connector

Recommended posture

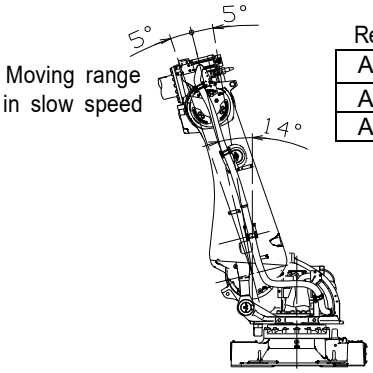
Axis 1	-90°
Axis 2	Any
Axis 3	Any



Axis 1 Recommended posture and moving range



Axis 2 Connection of drain hose and connector

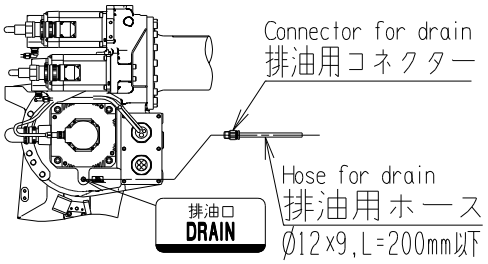


Recommended posture

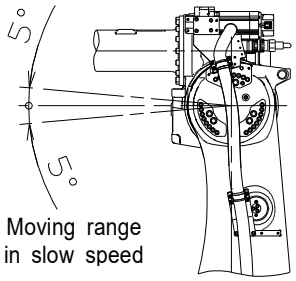
Axis 1	Any
Axis 2	76°
Axis 3	Any

Axis 2 Recommended posture and moving range

[SRA100-01] [SRA166-01] [SRA210-01] [SRA240-01]
[SRA120EL-01] [SRA133L-01] [SRA166L-01]



Axis 3 Connection of drain hose and connector

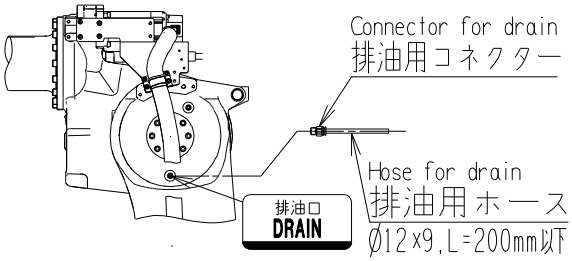


Recommended posture

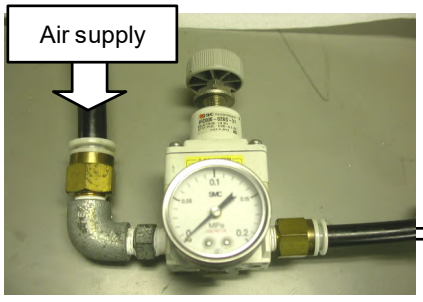
Axis 1	Any
Axis 2	90°
Axis 3	0°

Axis 3 Recommended posture and moving range

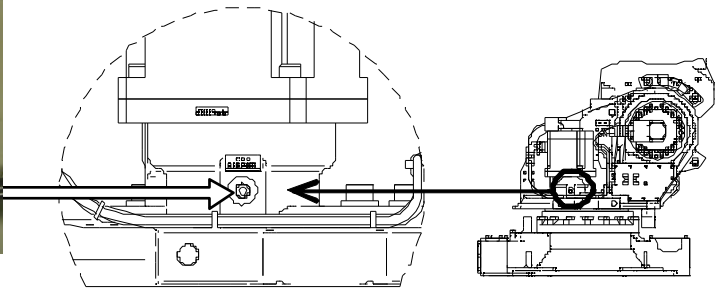
[SRA250-01] [SRA210L-01] [SRA240L-01]



Axis 3 Connection of drain hose and connector



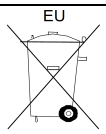
Air precision regulator



Pushing out the surplus grease using air pressure

3.7 Battery replacement

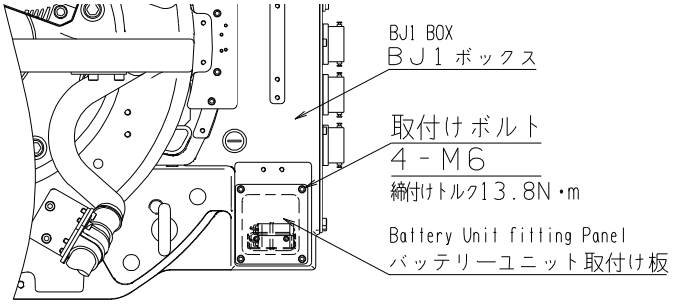
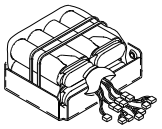
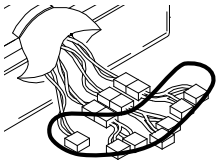
The robot uses lithium batteries for the backup of encoder data. If the battery voltage drops below the given limit, the data will not be kept normal.

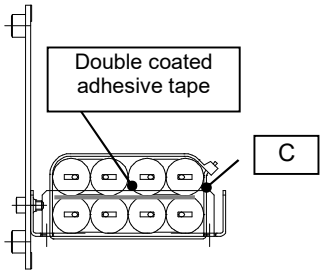
IMPORTANT	Replace the batteries **every 8 years**. (Under a condition of 8 hours ON and 16 hours OFF every day)
IMPORTANT	The replacement period varies with use environments (mainly temperatures). Furthermore, if the battery voltage drops below the given limit, an error indicating the voltage drop will be displayed on the controller. In this case, be sure to replace the battery corresponding to the error displayed.
IMPORTANT	Replace the batteries with controller power ON. Replacing the battery with controller power OFF can result in encoder data error, thus requiring the resetting of the encoder.
IMPORTANT	Do not store the batteries in places with high temperature and high humidity. Store them in well-ventilated places to avoid dew condensation. It is recommended to store the batteries in places with less temperature changes at ambient temperatures (20±15°C) and relative humidity of not more than 70%.
IMPORTANT	Discarding lithium batteries according to your local trash separation rule When discarding used lithium batteries, insulate the electrical terminals. And then follow the respective trash separation rules in your local district and discard them separately as “Used lithium batteries”. 

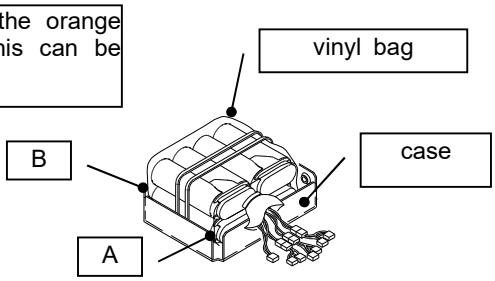
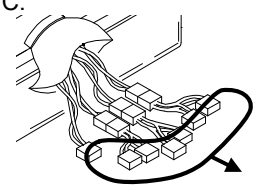
Tools required (prepared by customer)

Name	Specification	Q’ty
Torque wrench for M6	Tightening torque 13.8 N・m	1
Double coated adhesive tape	(in market)	1
Nipper	(in market)	1
Cable tie	(in market)	1

Battery replacement procedure

STEP	Required work
1	**Turn ON** the controller power.
2	Lock the robot by pressing the emergency stop button.
3	Remove the bolts of the battery unit fitting panel on BJ1 BOX left side. 
4	Pull out the battery unit from the BJ1 BOX.  Battery Unit KP-ZA-011
5	Disconnect the connecters. Although a warning message (encoder battery voltage down) is displayed, there is no problem. Please proceed with the next procedures. 

<table>
<tr><th>STEP</th><th colspan="2">Work performed</th></tr>
<tr><td>6</td><td colspan="2">Remove the cable tie C to remove the battery unit from the case.
 

Do not cut the orange cable tie. This can be used again.
 
</td></tr>
<tr><td>7</td><td colspan="2">Attach the new battery.</td></tr>
<tr><td>8</td><td>To replace battery unit
Connect 7 connectors.
Install the battery unit to the case with cable tie C.
 
To robot side (CNBAT1～7)</td><td>To replace the respective batteries one by one
(1) Replace the concerned battery to a new one.
(2) Fix each battery with double coated adhesive tape.
(3) Put the battery in the vinyl bag and fasten cable tie A.
(4) Fasten the vinyl bag with cable tie B.

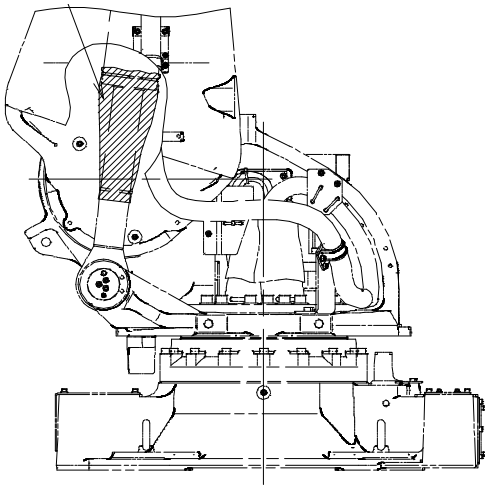
Finally, install the battery unit to the case with cable tie C.</td></tr>
<tr><td>9</td><td colspan="2">Place the battery unit fitting plate to the original position and fix it with bolts.
If the battery unit fitting plate is damaged, please replace it.</td></tr>
<tr><td>10</td><td colspan="2">Turn OFF the controller power and ON again.</td></tr>
</table>

3.8 Balancer protection cover replacement

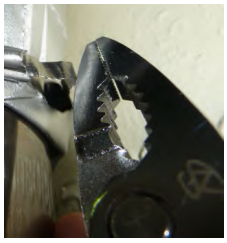
Protection cover (silver cover) is used to protect the balancer shaft from the damage and the accumulating of welding spatters or cutting dusts.

If any loosening or transformation is found in inspection, please correct it. And if remarkable damage is found, please replace it.

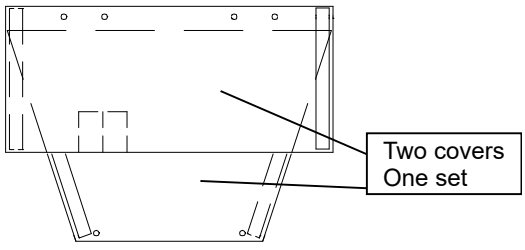
Balancer protection cover
SP-CS-011



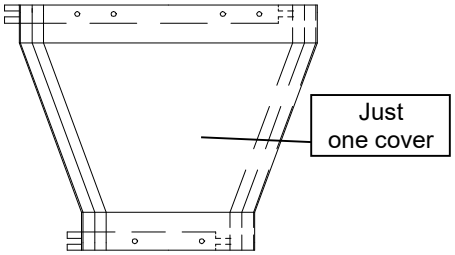
Tools required (prepared by customer)

Name	Purpose	Q'ty	Remarks
Nippers	To cut the steel band	1	(Get this in the market)
Pliers 	To fasten / flat the steel band	1	(Get this in the market) Please prepare one that can hold the steel band tightly.
Scale	To determine the installation position of the cover	1	150mm or more (Get this in the market)
Parts cleaning spray (Degreaser) ***E.g. "ThreeBond 2706"***	To clean the balancer rod and inner surface of the protection cover.	1	(Get this in the market)
Agent for penetrative lubrication (spray) ***"ThreeBond 1801B"*** 	To lubricate / rustproof the rod surface and the lip of the scraper part.	1	(Get this in the market)

Robots shipped prior to February 2021 and robots shipped March 2021 or later has different shape and replacement procedure of their balancer protection cover. Please check their shape and refer to the adequate procedure written below.

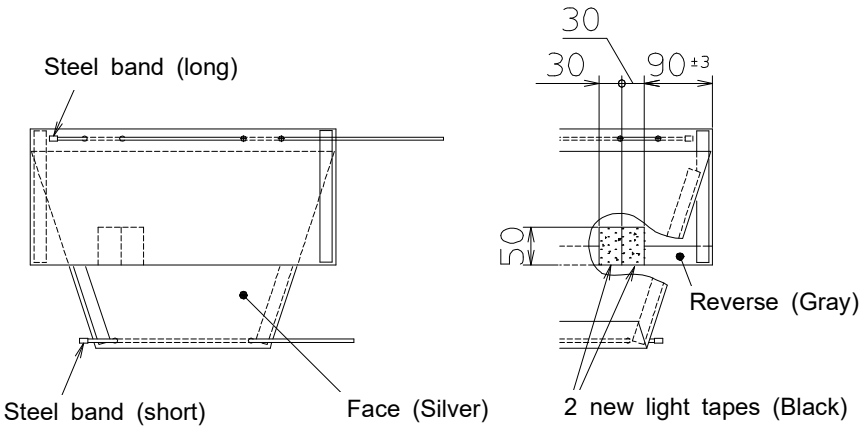
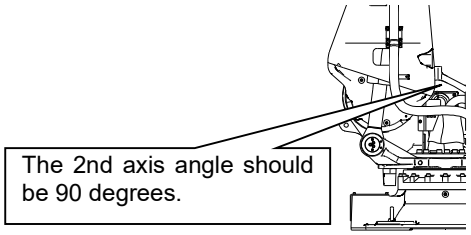
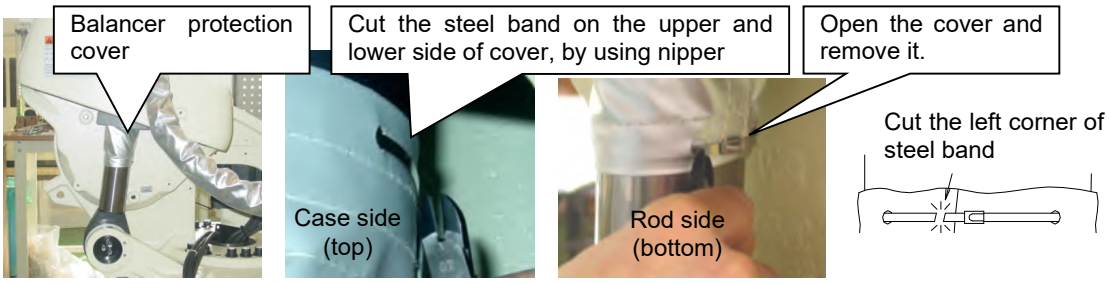
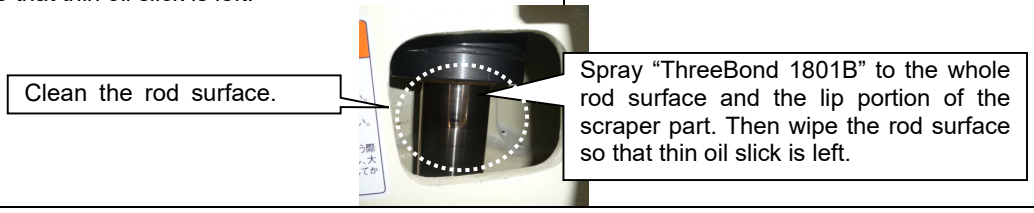


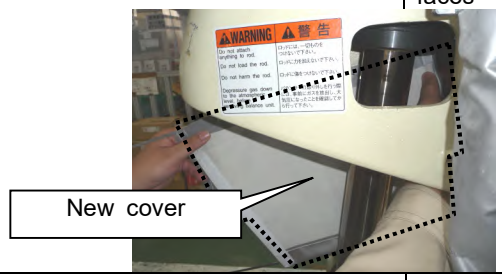
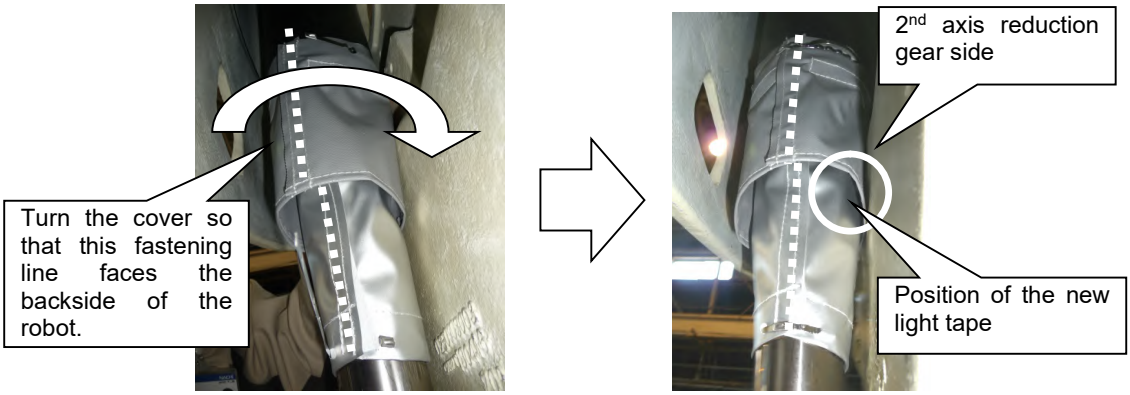
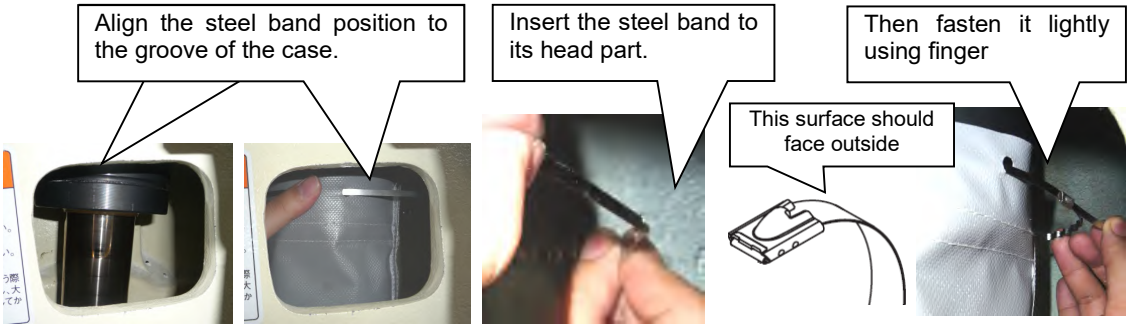
Balancer protection cover shipped prior to February 2021

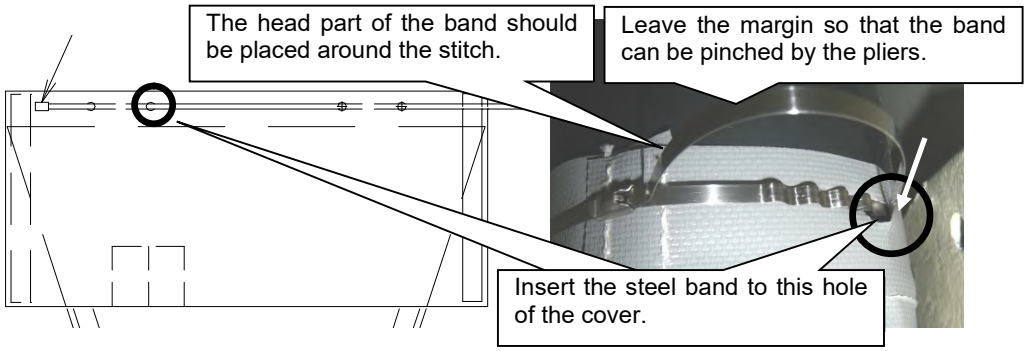
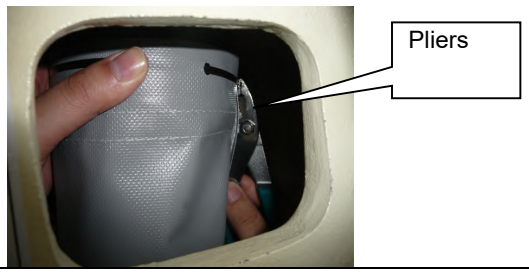
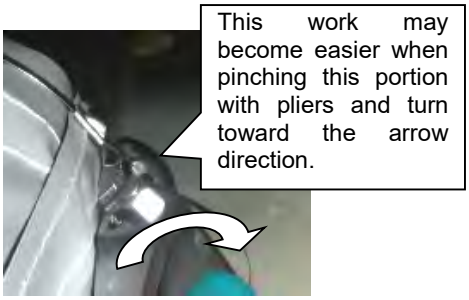
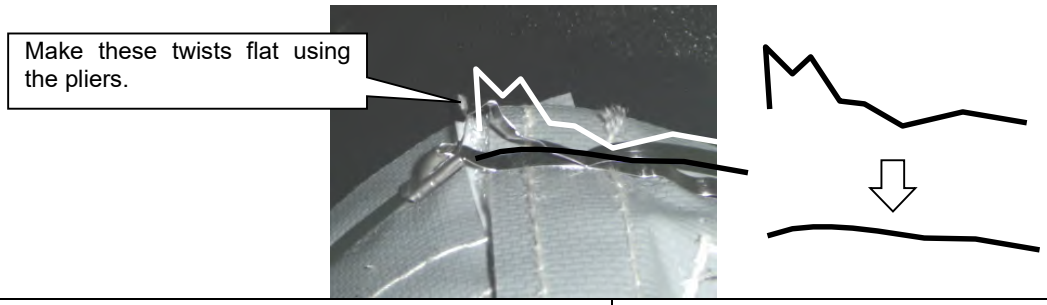
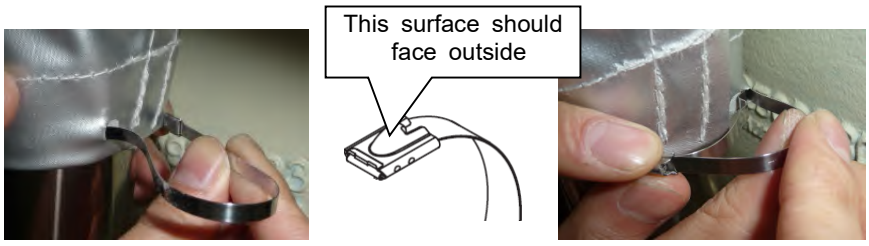


Balancer protection cover shipped March 2021 or later

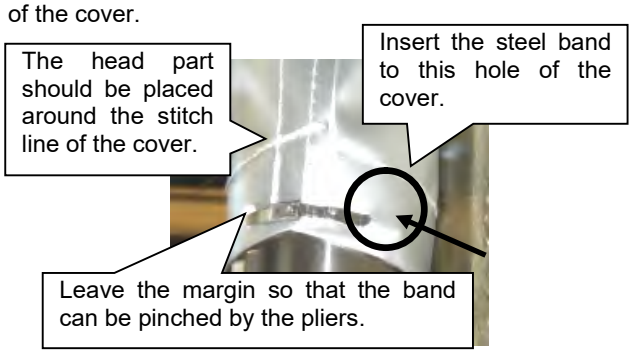
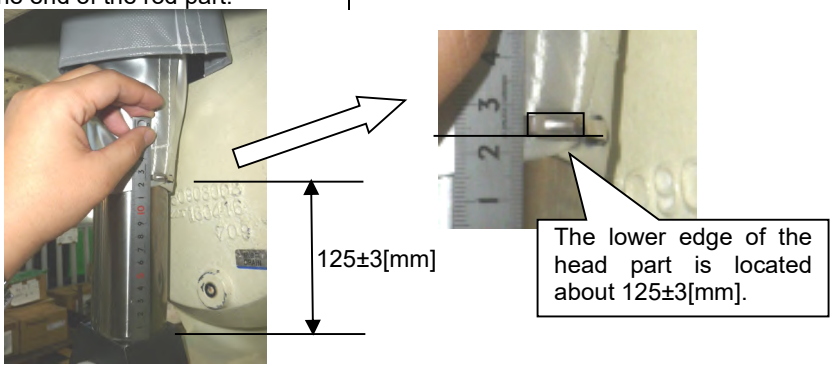
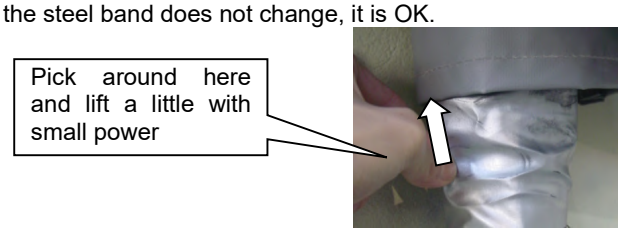
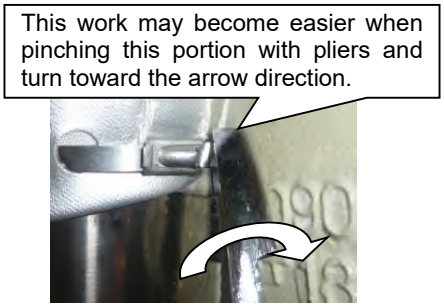
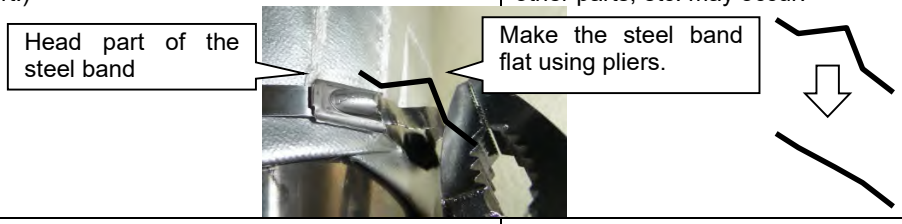
Balancer protection cover replacement procedure (Shipped prior to February 2021)

STEP	Required work	Point
1	Install 2 steel bands to the new protection cover by referring to the following picture.	The position of the steel band should be left side.
2	Stick the 2 new light tapes onto the backside of the gray cover by referring to the following picture. 	Before sticking the new light tapes, wipe and clean the reverse side of the cover.
3	Set the 2nd axis of the robot to 90 degrees and then turn OFF the controller power OFF. 	This is only to keep the enough work space. The angle of other axes does not matter.
4	Remove the cover in the following order. 1. Cut the steel band on the upper and lower side of cover, by using nipper. 2. Remove cover. 	Steel band edge is very sharp. Be careful to handle it.
5	Wipe and clean the balancer rod surface. Use a parts cleaner spray (degreaser) and clean wiping cloth. After that, spray “ThreeBond 1801B” to the whole rod surface and the lip portion of the scraper part. Then wipe the rod surface lightly so that thin oil slick is left. 	If dusts remain on the surface, the seal part of the unit may be damaged and cause oil leakage etc. And, pay attention not to damage the rod surface.

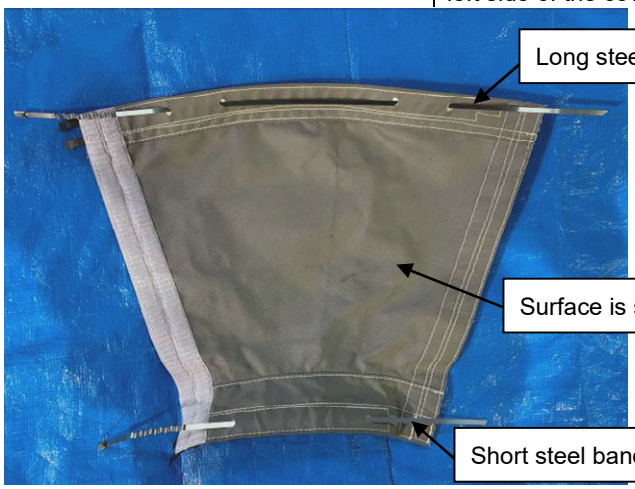
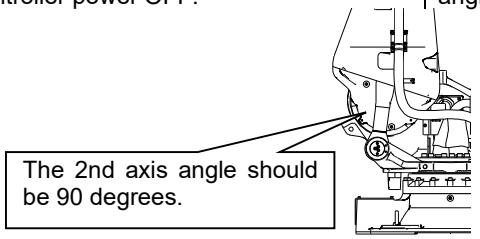
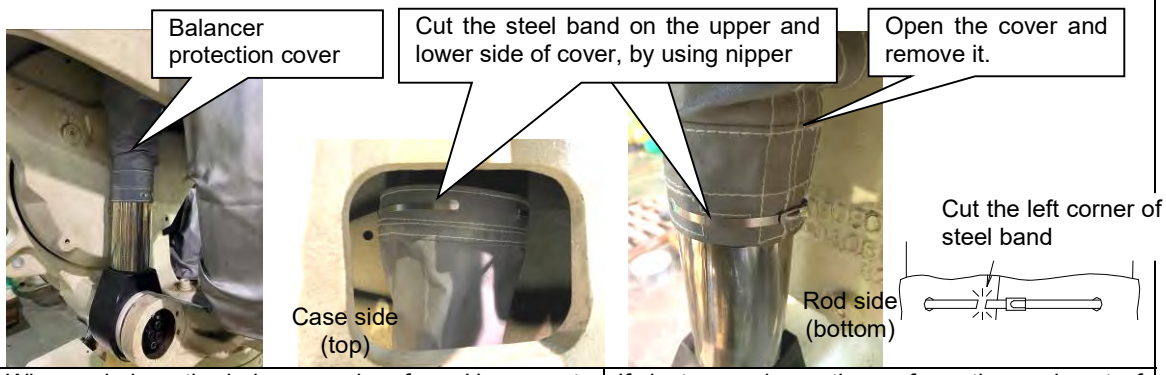
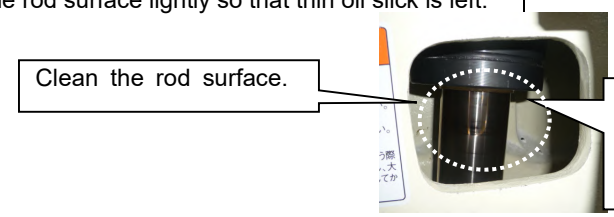
STEP	Required work	Point
6	Roll and attach the new cover onto the balancer unit. 	Attach the cover so that its silver surface faces
7	Fit and close the magic tape of cover in the following order. 1. Rod side (lower side) cover (silver) 2. Case side (upper side) cover (gray) 	Please pay attention not to make wrinkles on the magic tape when closing it.
8	Turn and adjust the position of the magic tape fastening line so that its position faces the back side of the robot. (To avoid the welding spatter, cutting dusts etc. that come from the front side of the robot)  (Back side view of the balancer unit)	At this time, the new light tapes face the 2nd axis reduction gear side of the robot. (This is to soften the friction between the upper cover and the lower cover around the 2nd axis reduction gear side.)
9	Align the steel band position to the groove of the balancer unit case and then fasten the steel band lightly using finger. 	Pay attention to the surface/backside of the head part of the steel band. The tip of the band comes out from the cover.

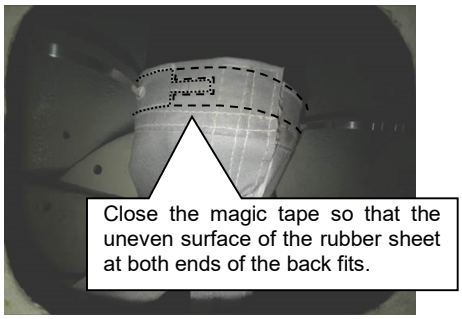
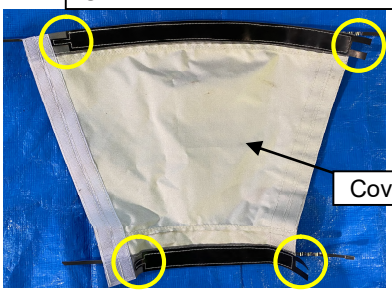
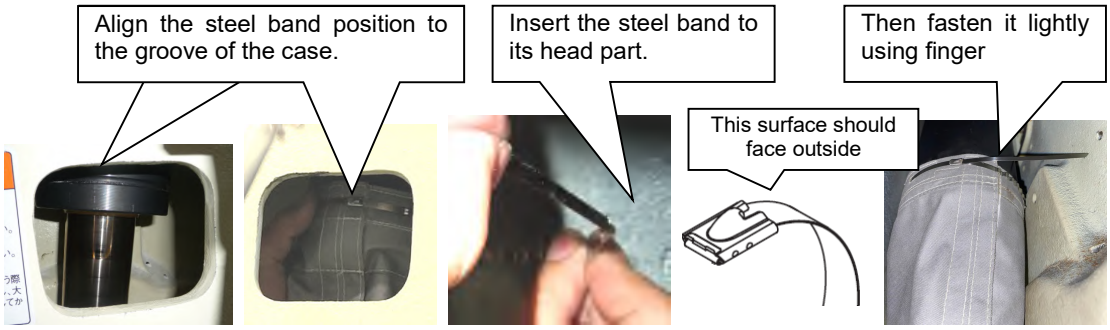
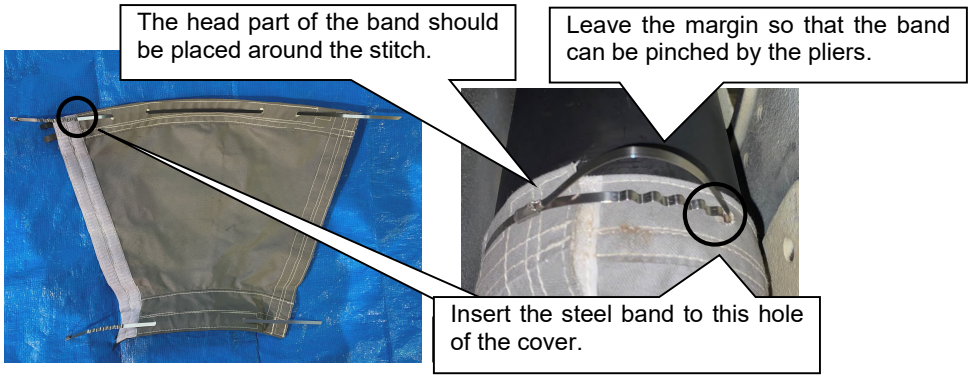
<table>
<tr><th>STEP</th><th>Required work</th><th>Point</th></tr>
<tr><td>10</td><td>Before fastening the steel band tightly, adjust the position of the head part. The head part should be placed around the stitch line of the cover. Insert the steel band in the hole of the cover.
 
</td><td>If the head part's position is not adjusted, the tip of the band cannot be inserted to the hole. If the tip of the band comes out, it scratches the surface of the cast part and the band will be broken.</td></tr>
<tr><td>11</td><td>Fasten the steel band tightly using pliers. After fastening, please confirm that the cover does not turn or come out by shaking it
 
</td><td>Fasten the band paying attention not to change the position of the head part.
 
</td></tr>
<tr><td>12</td><td>Fix the twist of the steel band and make it flat.
(Make surface of the band become lower than the top edge of the head part.)
 
</td><td>If the twist is too large, the portion may scratch the surface of the cast part of the robot and cause a steel band's breakage, scratch noise, etc.</td></tr>
<tr><td>13</td><td>Next, fasten the lower steel band (rod side) lightly using finger.
 

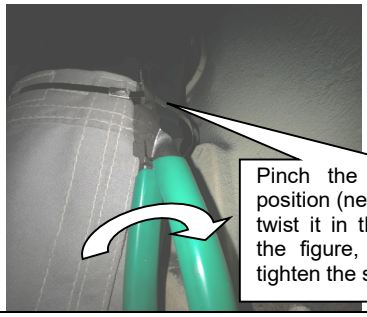
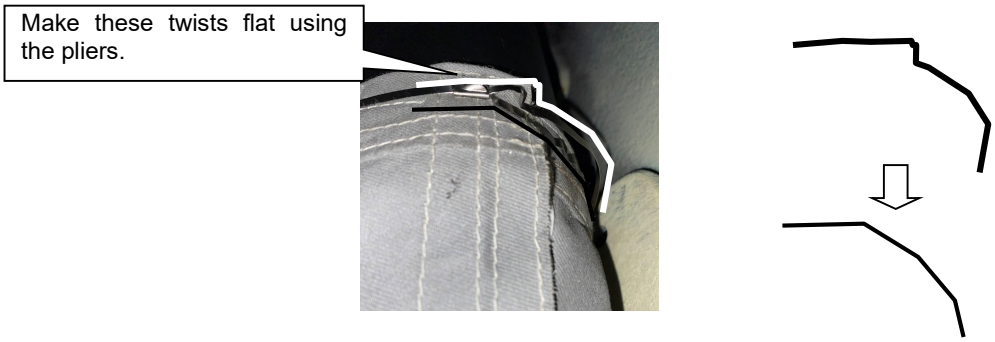
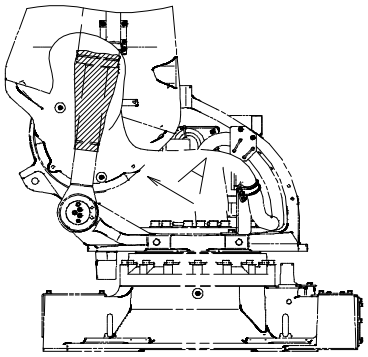
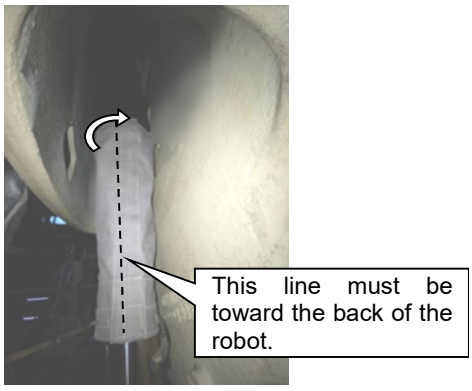
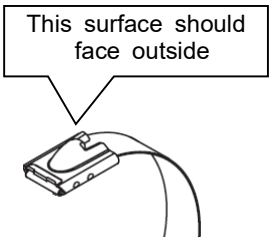
(1) Insert the steel band to its head. (2) Then fasten it lightly using finger.</td><td>Pay attention to the surface/backside of the head part of the steel band. The tip of the band comes out from the cover.</td></tr>
</table>

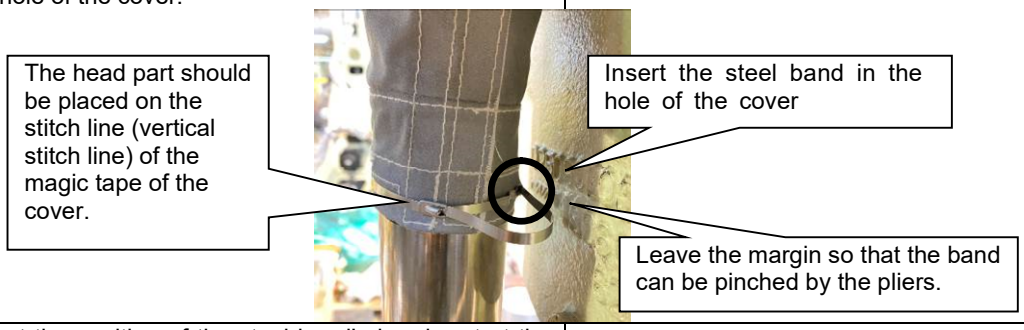
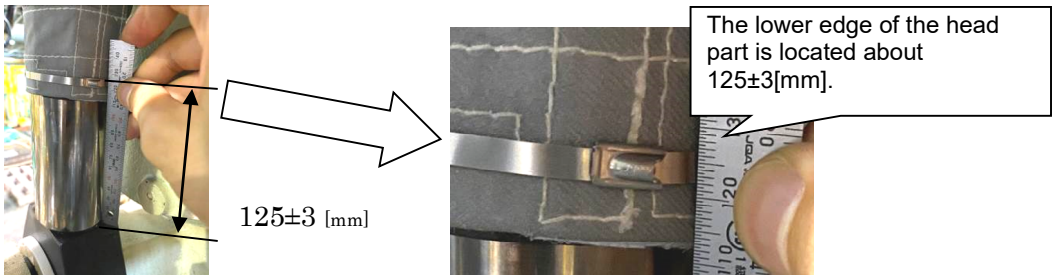
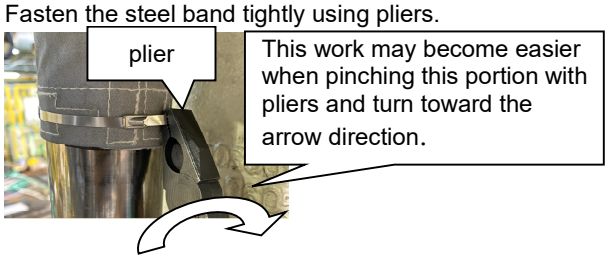
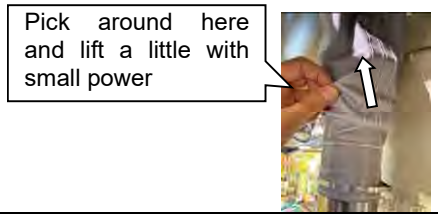
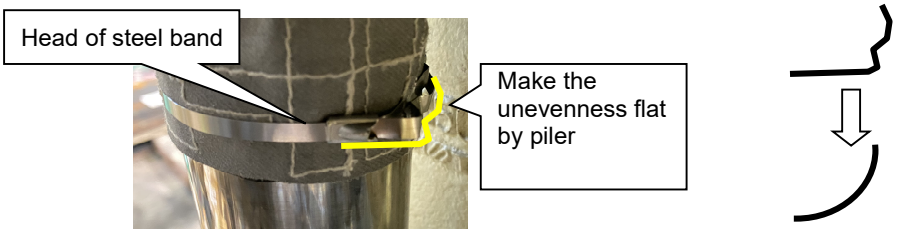
STEP	Required work	Point
14	Before fastening the steel band tightly, adjust the position of the head part. The head part should be placed around the stitch line of the cover. Then insert the steel band in the hole of the cover. 	This work should be done before fastening the steel band tightly. (After fastening the band tightly, this work will become difficult.) 
15	Adjust the position of the steel band's head part at the position of 125±3[mm] from the end of the rod part. 	
16	Fasten the steel band tightly using pliers.  Pick at the cover around the position shown in the picture and then lift it with small power (0.1 – 0.2kgf). If the position of the steel band does not change, it is OK. 	This work may become easier when pinching the portion around the head part with pliers and turn toward arrow direction.  If the steel band is fastened too much or the band is pinched with the cover, it becomes difficult to adjust the position of the steel band. In a case like that, cut the steel band and replace it with new one.
17	Fix the twist of the steel band and make it flat. (Make surface of the band become lower than the top edge of the head part.) 	If big twists are left, a cover breakage, interference between the steel band and other parts, etc. may occur.
18	Turn ON the robot controller power and move the robot manually. Please check there is not interference, scratch sound, etc.	Check that the steel band does not get loose or scratch the cover or the robot surface.

Balancer protection cover replacement procedure (Shipped March 2021 or later)

<table>
<tr><th>STEP</th><th>Required work</th><th>Point</th></tr>
<tr><td>1</td><td>Install 2 steel bands to the new protection cover.
 
</td><td>Install the steel band so that its head is on the left side of the cover surface (Gray).</td></tr>
<tr><td>2</td><td>Set the 2nd axis of the robot to 90 degrees and then turn OFF the controller power OFF.
 
</td><td>This is only to keep the enough work space. The angle of other axes does not matter.</td></tr>
<tr><td>3</td><td>Remove the cover in the following order.
1. Cut the steel band on the upper and lower side of cover, by using nipper.
2. Remove cover.
 
</td><td>Steel band edge is very sharp. Be careful to handle it.</td></tr>
<tr><td>4</td><td>Wipe and clean the balancer rod surface. Use a parts cleaner spray (degreaser) and clean wiping cloth. After that, spray “ThreeBond 1801B” to the whole rod surface and the lip portion of the scraper part. Then wipe the rod surface lightly so that thin oil slick is left.
 
</td><td>If dusts remain on the surface, the seal part of the unit may be damaged and cause oil leakage etc. And, pay attention not to damage the rod surface.</td></tr>
</table>

STEP	Required work	Point
5	Attach the new cover onto the balancer unit.  	Attach the cover so that its silver surface faces.
6	Close the magic tape of cover.   	Please pay attention not to make wrinkles on the magic tape when closing it. Close the magic tape so that the uneven surface of the rubber sheet at both ends of the back fits.
7	Align the steel band position to the groove of the balancer unit case and then fasten the steel band lightly using finger.  	Pay attention to the surface/backside of the head part of the steel band. The tip of the band comes out from the cover.
8	Before fastening the steel band tightly, adjust the position of the head part. The head part should be placed around the stitch line of the cover. Insert the steel band in the hole of the cover.  	If the head part's position is not adjusted, the tip of the band cannot be inserted to the hole. If the tip of the band comes out, it scratches the surface of the cast part and the band will be broken.

STEP	Required work	Point
9	Fasten the steel band tightly using pliers. After fastening, please confirm that the cover does not turn or come out by shaking it  	Tighten the steel band so that the position on the head of it does not slip off. Grasp the steel band near the head (root of the band tip) with pliers and twist it in the direction shown in the figure for easy tightening.
10	Fix the twist of the steel band and make it flat. (Make surface of the band become lower than the top edge of the head part.)  	If the twist is too large, the portion may scratch the surface of the cast part of the robot and cause a steel band's breakage, scratch noise, etc.
11	In order to prevent foreign matters entering from the front of robot, such as sputtering or chip, adjust the position of magic tape so that it is behind robot.   View of A	
12	Next, fasten the lower steel band (rod side) lightly using finger.   Insert the steel band into the head, and fasten it lightly using finger	Pay attention to the surface/backside of the head part of the steel band. The tip of the band comes out from the cover.

STEP	Required work	Point
13	Before fastening the steel band tightly, adjust the position of the head part. The head part should be placed on the stitch line (vertical stitch line) of the magic tape of the cover. Then insert the steel band in the hole of the cover. 	This work should be done before fastening the steel band tightly. (After fastening the band tightly, this work will become difficult.)
14	Adjust the position of the steel band's head part at the position of 125±3[mm] from the end of the rod part. 	
15	Fasten the steel band tightly using pliers.  Pick at the cover around the position shown in the picture and then lift it with small power (0.1 – 0.2kgf). If the position of the steel band does not change, it is OK. 	This work may become easier when pinching the portion around the head part with pliers and turn toward arrow direction. If the steel band is fastened too much or the band is pinched with the cover, it becomes difficult to adjust the position of the steel band. In a case like that, cut the steel band and replace it with new one.
16	Make the unevenness of steel band flat. Its unevenness must be thinner than the thickness of the head. 	If the unevenness was big, it will cause the cover breakage

NOTE

Chapter 4 Troubleshooting

■Troubleshooting procedures

When any abnormality occurs during robot movement or operation, if there is no problem with controller, then it is due to the damage of mechanical parts. To solve troubles promptly, it is necessary to have a grasp of symptoms, and then judge which part is defective to cause the trouble.

Step 1: Which axis has caused the abnormality?

First, judge which axis has caused the abnormal symptom. If abnormality doesn't appear with movement and hard to judge, then check abnormal sounds, heat and backlash to find it.

Step 2: Which part has damages?

If the abnormal axis is found out, examine what part is the cause. You might find several causes to one symptom.

Step 3: Steps for defective parts

If the defective parts are found, please fix them. Some can be fixed by customers, but for difficult tasks, please contact NACHI Service Department.

Defective Part \ Trouble symptom	Overload	Displacement	Abnormal sound	Shaking while in operation	Sway when stopped	Irregular twitching	Abnormal deviation	Gravity drop of axis	Abnormal heat generation	Malfunction	Counter-measure
Encoder		○			○	○	○			○	・Please replace the encoder, in case there are some points in which position data shows irregular change, and there is no problem with wirings. ・When the drive unit is replaced with another controller and symptom is transferred, replace the drive unit.
Brake	○		○					○	○		・Turn motors off, and check, whether or not the brake makes "click sound" by operating the brake release switch *1 (option) ON/OFF. If no click sound, brake line (wiring) may be broken. Manipulator wiring needs to be replaced. Please contact our Nachi Service Department ・If click sound is heard, replace the motor since brake is inside the motor body.
Motor	○	○	○	○	○	○	○		○	○	・Check whether or not abnormal vibration or heat or sound occurs while robot moves. If some abnormality is found, check the density of steel dust in the grease of reduction gear (refer to "3.3 Inspection of grease") If density exceeds the criterion, reduction gear needs to be replaced. Please contact our Service Department. ・If density has no problem, replace the motor. If abnormality occurs in axis 2, balancer unit and their bearings need to be checked also by referring to the explanation written below. ・If possible, set the brake release switch (option) to ON and check, whether or not you can sense the abnormality by pushing robot arm with your hand. If you can sense some abnormality, replace the motor. ・If trouble can not solved by replacing motor, reduction gear needs to be replaced. Please contact our Service Department.
Reduction gear	○	○	○					○	○		
Balancer bearing	○		○	○	○		○	○	○		・Check the pressure of nitrogen gas in balancer unit. If the pressure is out of criterion range, nitrogen gas needs to be filled or released. If the pressure is within criterion range, replace the motor or the reduction gear. If the pressure does not raise up sufficiently, balancer unit itself needs to be replaced. Please contact our Technical Department. (Refer to "3.4 Inspection of balancer unit and filling gas") ・Check whether or not abnormal vibration or sound occurs from the bearings of balancer unit. If some abnormality is found, bearings or balancer unit itself needs to be replaced. Please contact our Service Department.
Installation plate, Raiser		○	○	○	○						・Check whether or not fixing bolts are loose. If they are loose, tight them with proper torque. Check whether or not foreign obstacles are caught in swivel base or base plates. If some parts are found, remove them. Check whether or not base plates have unevenness. If found, correct them within the criterion level. (Refer to "2.3 Installation procedure"). ・Check whether or not floor/raiser have any unevenness. If that stiffness is not enough, replace the floor/raiser or modify the robot teaching program, i.e., "Reduce the step speed" or "Record smooth parameter". (Refer to "Basic Operations manual" "Chapter 4 Teaching")
Tool					○						・If the tool is not stiff enough, tool itself may repeat vibrate near the stop position. In this case, robot teaching program is needed to be modified. For example, "Reducing the step speed" or "Recording smooth parameter". (Refer to "Basic Operations manual" "Chapter 4 Teaching") ・Examine the weight, COG and inertia of the tool. If one of them does not meet the specification, reduce the load of the tool. Also if one of them does not match with tool parameter, modify tool parameter.

*1 <Caution> When using the brake release switch, never forget that robot arm must be held using a crane, chain hoist or other ways before releasing. If brake release switch is operated without supporting robot arm, in case of axis 2, forearm will fall down to the front or back (:*Due to the payload and robot posture.) In case of axis 3, forearm will fall down. In case of wrist axes, wrist and tool will fall down or rotate quickly. All these possibilities can lead to serious injuries.

4.1 Motor replacement

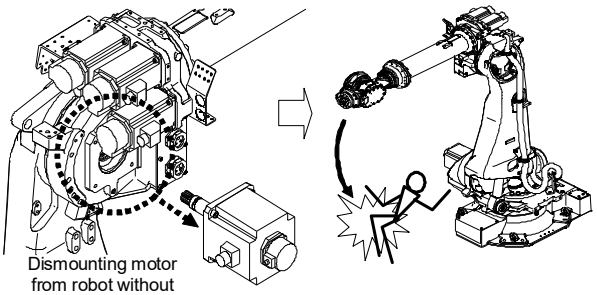
WARNING

Never forget to **hold robot arm or wrist/tool** in advance. If motor is disengaged without supporting them, forearm will fall down to the front or to the backwards. (due to the payload and robot posture) in case of axis 2, forearm will fall down in case of axis 3, wrist and tool will fall down or will rotate quickly in case of wrist axes, possibly resulting in serious injury.

To hold robot arm, use a crane or chain block etc (*). To hold axis 2 and 3, wooden blocks or fixing jig set (option) can be used.

Note that zeroing pin and block are not for supporting arm.

Furthermore, Never attempt to hold robot arm with hands.



CAUTION

When touching the motor immediately after robot stop operating, be sure that motor is NOT HOT and then touch it with attention.

CAUTION

The motor mass is listed below. Because of its weight, handle the motor with full attention.

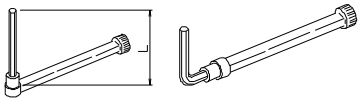
Robot type	Axis 1,2 and 3	Axis 4, 5 and 6
All	20.7 kg	6.3 kg

CAUTION

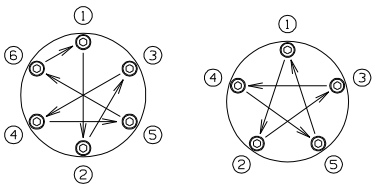
This work includes some jobs that should be conducted with motors ON. Consequently, be sure to conduct the work at least by a pair of two persons. One person must be ready to press an Emergency Stop button at any time, while the other person must promptly finish the work paying enough attention to the robot operating area. Furthermore, before starting to work, confirm evacuation route.

(*) Please use a crane or chain block, which can endure the weight including robot body, end effecter, work piece and all other loads.

Tools required (*Customer preparation required.)

Part name	Axis	Part No. (Model)
Torque wrench  Torque wrench L type Torque wrench	Axis 1	M3 torque wrench
	Axis 1, 2 and 3	M5 torque wrench (Long type L>=200 mm) Or M5 L type torque wrench
	Axis 4, 5 and 6	M4 torque wrench
	Axis 4, 5 and 6	M5 torque wrench
	Axis 1, 2 and 3	M12 torque wrench (Long type L>=280 mm)
	Axis 4, 5 and 6	M8 torque wrench (Long type L>=280 mm)
Locking agent	Axis 4, 5 and 6	ThreeBond 1374
Grease	Axis 4, 5 and 6	LONGTIME PD2 (Compatible; ALVANIA RA-J)
	Axis 1, 2 and 3	VIGO grease RE No.0
Lubrication	Axis 1, 2 and 3	ThreeBond 1801B
DV24V power supply	Axis 2 and 3	(purchase in market)
Dial gauge	Axis 2 and 3	(purchase in market)

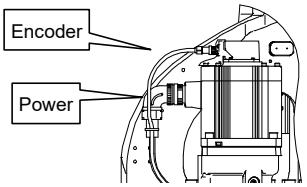
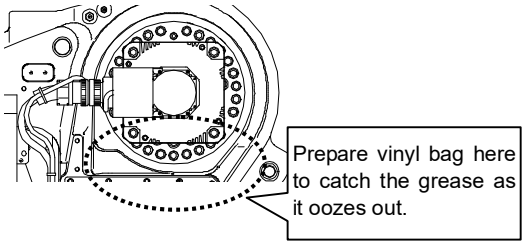
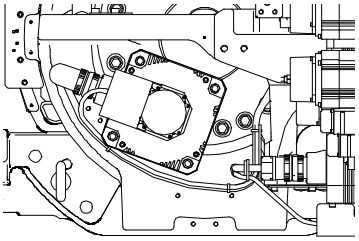
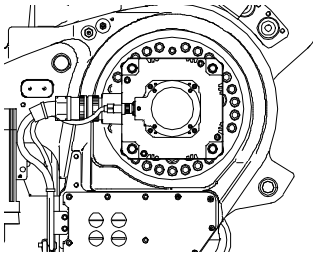
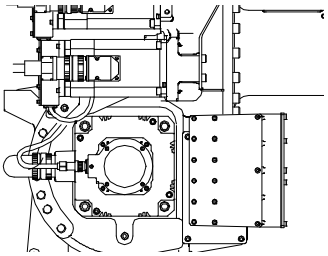
Be absolutely sure to use the torque wrench to tighten the bolts with the specified torque.
In case of tightening the bolts on circumference, tighten them equally and gradually.



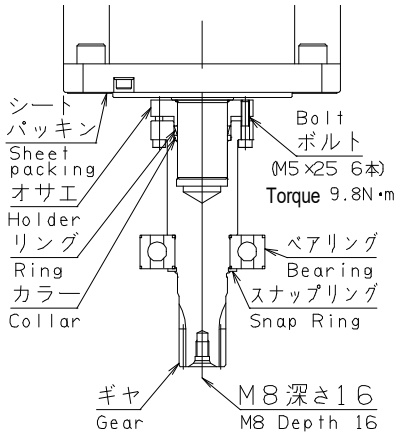
Order to tighten bolts

To enable quick replacement, “Coupling gear set” is prepared as a spare part.
“Coupling gear set” includes motor fixing bolts and sheet packing. When replacing a motor and using this “Coupling gear set”, replace all the old bolts, O-rings and sheet packing to new ones in spite of their damage level.(*Those are included in this set.)

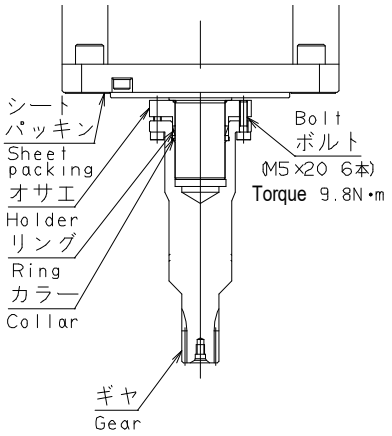
4.1.1 Motor replacement (Axis 1, 2 and 3)

STEP	Required work	Checkpoints
1	If possible, operate the robot arm manually to the reference position and insert zeroing pin. ☞ Refer to “4.1.4 Encoder correction”	If zeroing pin is inserted in advance, there is some case that the work after replacement is easier.
2	Hold the arm using a crane, chain block or other ways.	
3	Turn off the controller power.	
4	Disconnect the connectors (encoder and power) from the motor. 	・Remember that the encoder data will be lost when the encoder connector is disconnected. ・Do not push the encoder connector with high pressure. If that happen, the connector might break.
5	Case of axis 2 and 3; put a vinyl bag to catch the grease under the motor. 	・Case of axis 2 or 3, grease will come out when the motor is removed. ・Fix the vinyl bag firmly by using adhesive tape or some other ways.
6	Loosen the motor fixing bolts and disconnect the motor from the robot.  Axis 1 motor fixing bolts 4-M12X35 (Tightening torque: 116 N・m)  Axis 2 motor fixing bolts 4-M12X35 (Tightening torque: 116 N・m)  Axis 3 motor fixing bolts 4-M12X35 (Tightening torque: 116 N・m)	・Before disconnecting motor, be sure that NO STRESS ON ROTATING DIRECTION OF MOTOR while attachment bolts are loosened. If motor can not be rotated by hand, this shows that there are some pressures around the motor. In this case, motor will rotate in such high speed as soon as attachment bolts are removed, and might RESULT IN SERIOUS INJURY. Double check the way of holding robot arm. ・Do not apply excessive force on the motor shaft. ・Be sure not to damage lip of the oil seal by the gear attached to the motor shaft.

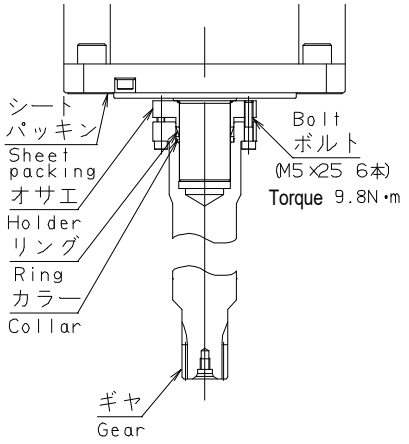
STEP	Required work	Checkpoints
7	Remove the encoder plug cover, if necessary. Refer to “4.2 Encoder replacement”	
8	Remove the gear assembly from the motor shaft. (a) Loosen the fixing bolts and remove the gear. (b) Remove the collar, ring X2 and holding plate. *In case of axis 1: Bearing needs to be removed at first, if M5 long type torque wrench is used.	・Do not apply excessive force on the motor shaft. ・In case of removing bearing, remove snap ring first then, using pulley remover in market to remove bearing. (By knocking the bearing to remove might cause damages on bearing. So hook the pulley remover finger to the inner side of bearing)



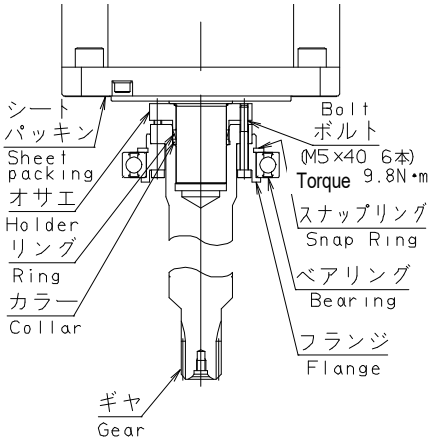
Axis 1 Gear assembly



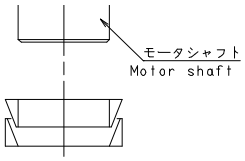
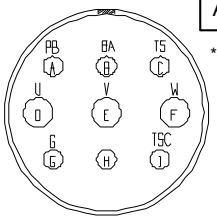
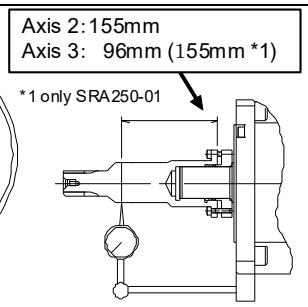
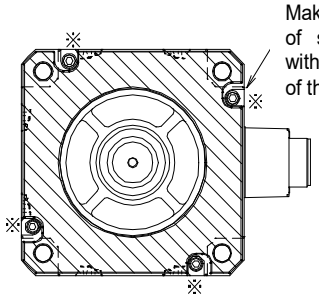
Axis 3 Gear assembly



Axis 2 Gear assembly
(in case of KP-ZH-145,149,151 and 154)



Axis 2 Gear assembly
(in case of KP-ZH-188,189,190 and 191)

STEP	Required work	Checkpoints
9	Attach the removed gear assembly to the new motor. (a) Attach the holding plate, ring X2 and collar. (b) Attach the gear.  Direction of ring *In case of axis 1; When using M5 long type torque wrench, set up bearing after setting up gear assembly. **In case of axis 2 and 3** After (a) &(b), check fluctuation of the gear. If the fluctuation exceeds more than 0.1 mm, loosen the gear fixing bolts and repeat the steps from (b)	・Apply a thin coating of ThreeBond 1801B to the shaft of the new motor and two rings in advance. ・Do not apply excessive impact to the motor shaft. ・Pay attention to the direction of ring. ・The bearing should be installed by pushing the inner side ring using collar or etc. If the outer ring is pushed, the bearing might break.
	<How to measure the fluctuation tolerance> ・It is necessary to release the brake inside the motor and rotate gear by hand. To release the brake, supply DC24V voltage between pin A and pin B in the CNMB* connector. (A:+24V, B:0V) ・The fluctuation should be measured using a dial gauge by referring to this drawings.  CNMB* connector  	
10	Attach the encoder plug cover if you have one. Refer to “4.2 Encoder replacement”	
11	Attach the sheet packing on the motor flange, and then engage the motor to the robot. Only for axis 1 sheet packing, locate it carefully by referring to the following figure.  Make sure to set 4 cut holes of sheet packing matches with the spot facing notches of the motor. (※marked)	・Be sure to use torque wrench to tighten bolts. Tightening should be done equally and gradually. ・Be sure not to damage the gear surface when attaching the motor. ・Replace sheet packing to the new one. (Refer to “5 Recommended spare parts and special maintenance tools for maintenance“.)
12	Connect the connectors (encoder and power) to the motor.	
13	In case of replacing the motor of axis 2 or 3, supply the amount of grease as same as the lost grease. (VIGO grease RE No.0)	
14	Turn on the controller power.	
15	Perform encoder reset of the replaced motor. Refer to “4.1.3 Encoder reset”	
16	Perform encoder correction of the replaced motor. Refer to “4.1.4 Encoder correction”	
17	Remove the zeroing pin. Make sure that there is no problem with the robot operation.	・If axis is operated without removing zeroing pin by mistake, then pin and pin hole may be disfigured. And furthermore, it becomes impossible to remove zeroing pin and perform encoder correction properly in the future.

4.1.2 Motor replacement (Axis 4, 5 and 6)

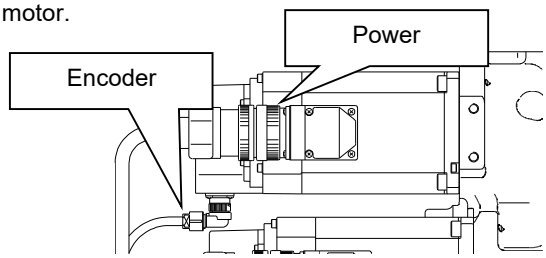
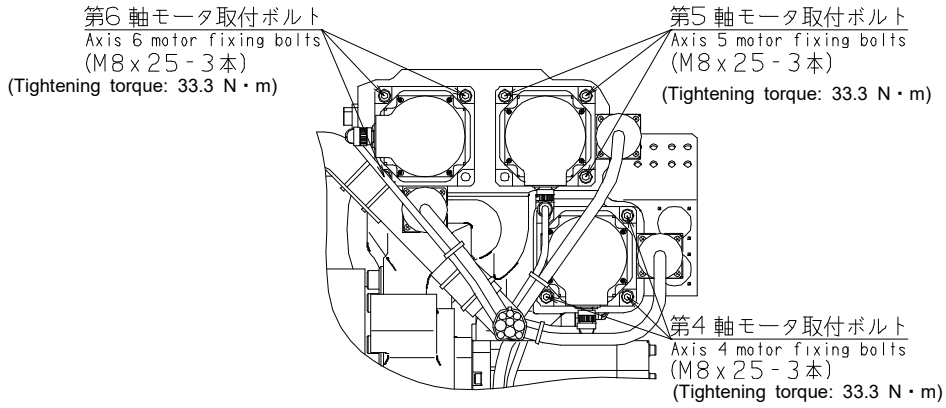
CAUTION	**Axis interference of wrist axis (axis 4,5 and 6)** "Axis interference" exists due to the structure of the wrist on this robot. When conducting encoder correction of axis 5, axis 4 must be in reference position. Similarly, when conducting encoder correction of axis 6, axis 4 and 5 must be in reference position. (As for axis 4 or axis 5 which is affecting other axis, it is enough to be in reference position. It is unnecessary to conduct their encoder correction.)

CAUTION

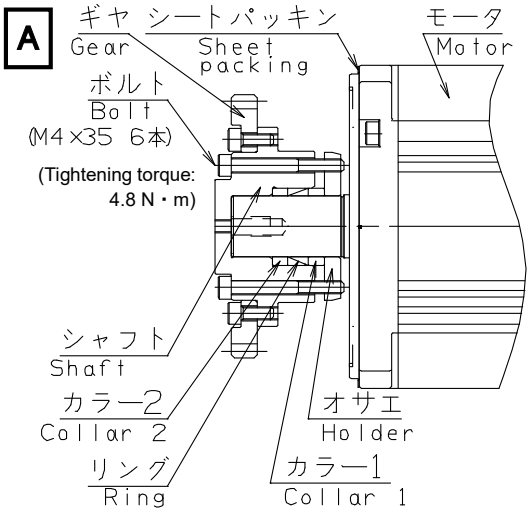
There ere 2 types of wrist motor gear assembly according to the shipped date.

Motor gear assembly	Shipped date	How to identify
Type A	Prior to 2016 April	Two collars
Type B	2016 May or later	One collar

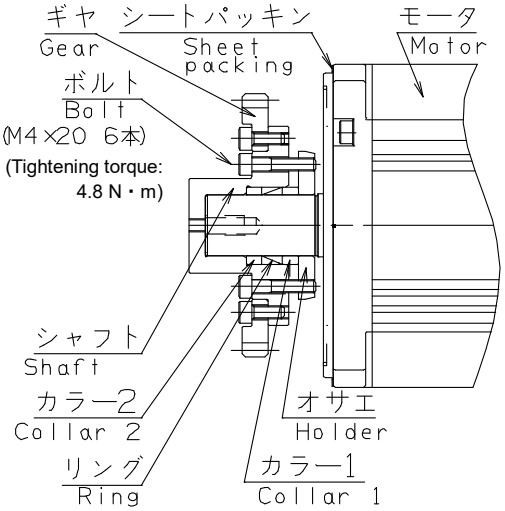
・On 2016 May or later, only type B is delivered as a spare part.
・Type A and type B is compatible (both upper and lower) as an assembly. So it is possible to exchange to the different type when replaced.
・Type A and type B is not compatible as an individual part. **Never mix parts** between type A and B. Please follow the procedure marked A when replacing type A. Please follow the procedure marked B when replacing type B.

STEP	Required work	Checkpoints
1	If possible, operate the robot arm manually to the reference position and insert zeroing pin. Refer to "4.1.4 Encoder correction"	If zeroing pin is inserted in advance, work after replacement would be easier in some cases.
2	Hold the wrist and tool using a crane, chain block or other ways.	
3	Turn off the controller power.	
4	Disconnect the connectors (encoder and power) from the motor. 	・Remember that the encoder data will be lost when the encoder connector is disconnected. ・Do not apply high pressure onto the encoder connector. If high pressure is applied, the connector might break.
5	Loosen **three motor fixing bolts** and disengage the motor from the robot. 	・Do not apply excessive force to the motor shaft.

STEP	Required work	Check points
6	Remove the gear assembly from the motor shaft. In case of type A (a) Loosen the fixing bolts, and remove shaft. (b) Remove collar x 2, ring x 2 and holder. In case of type B (a) Loosen the fixing bolts, and remove shaft. (b) Remove collar, ring x 2 and holder.	・Do not to apply excessive force to the motor shaft. ・Type A and type B is not compatible as an individual part. Never mix parts between type A and B. Replace it as an assembly of holder, ring and collar.

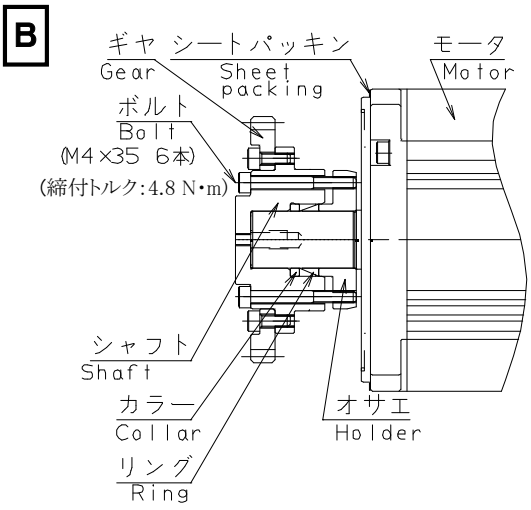


Axis 4 and 5 Gear assembly

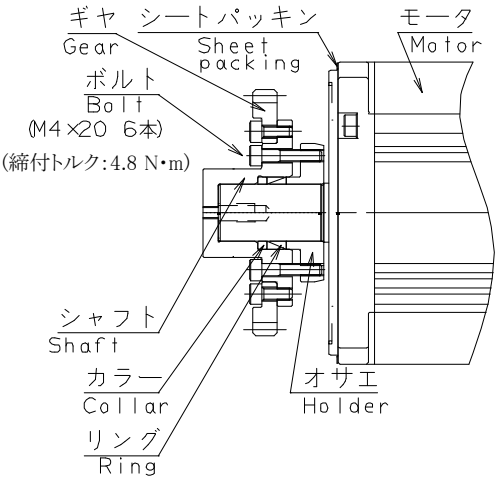


Axis 6 Gear assembly

Shipped on 2016 April or before



Axis 4 and 5 Gear assembly



Axis 6 Gear assembly

Shipped on 2016 May or later

IMPORTANT	Shaft of axis 6 gear is different from that of axis 4, 5. Pay extra attention when assembling it. (see Step 5)

STEP	Required work	Check points
7	Attach the removed gear assembly to the new motor. In case of type A (a) Attach holder, ring x 2 and collar x 2. (b) Attach the shaft with fixing bolts. In case of type B (a) Attach holder, ring x 2 and collar. (b) Attach the shaft with fixing bolts.	・Clean the shaft of new motor. (Remove dusts, redundant oil, etc.) ・Type A and type B is not compatible as an individual part. Never mix parts between type A and B. Replace it as an assembly of holder, ring and collar.
8	Attach the sheet packing on the motor flange. Apply the appropriate amount of grease (LONGTIME PD2) to the gear teeth (enough to cover the teeth), and set the motor to the robot.	・When setting the motor, not to damage the gear teeth. ・Replace sheet packing to the new one. (☞ Refer to “5 Recommended spare parts and special maintenance tools for maintenance“.) ・Although ALVANIA RA-J grease is filled in the gear box, LONGTIME PD2 can be used because it has the same lithium soap base and the same consistency.
9	Connect the connectors (encoder and power) to the motor.	
10	Turn on the controller power.	
11	Perform encoder reset of the replaced motor. ☞ Refer to “4.1.3 Encoder reset”	
12	Perform encoder correction of the replaced motor. ☞ Refer to “4.1.4 Encoder correction”	
13	Remove the zeroing pin. Make sure that there is no problem with the robot operation.	・If axis is operated without removing zeroing pin by mistake, pin and/or pin hole may be deformed and it’ll be impossible to remove zeroing pin and perform encoder correction properly in the future.

Base oil may leak from the motor fitting face due to position slippage of attaching sheet packing or of attaching motor. However, if it is a small amount, it will not affect the performance of the robot. Grease can be added later.
If base oil leakage is a concern, the base oil leakage will be solved by doing the following work when replacing the motor. These works are not mandatory.

- On STEP 8, before installing the sheet packing, apply the weak adhesive spray glue (Ex; Admate S-01, etc.) to the motor fitting face of the sheet packing.
- On STEP 8, before attaching the motor to the robot, apply the liquid gasket (ThreeBond 1110 F) on the motor fitting face of the robot.

4.1.3 Encoder reset

This procedure is to initializing the internal memory in encoder itself.
This procedure is absolutely necessary for the recovery after encoder is replaced, encoder connector/batteries are disconnected or error 0030 (:encoder absolute data error) has been occurred.

No special tools are required for encoder reset procedure.
Please refer to the instruction manual "SETUP", "4.3.3 Encoder reset and encoder correction".

4.1.4 Encoder correction

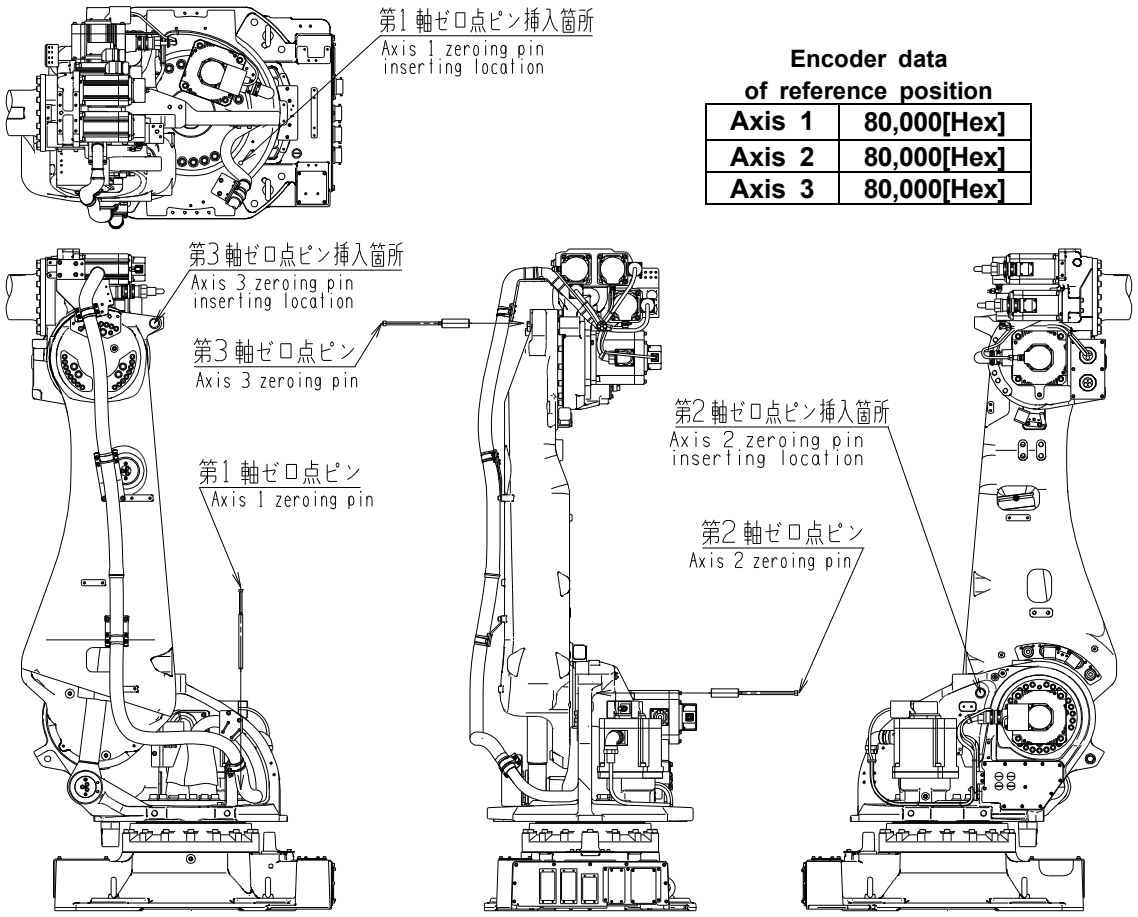
This procedure is to registering the "encoder correction data" so that encoder data becomes the "pre-determined value" at the "pre-determined position". This position is called "**Reference position"**. Zeroing pin and blocks are used to make this posture.
After performing encoder reset, THIS PROCEDURE MUST BE PERFORMED.
Because the load condition and robot posture may have influence on the reference position, perform encoder correction for all axes **after all of the load are equipped on wrist and upper arm AND before staring the teaching procedure.** (There is no need for encoder resetting procedure.)

(1) For this procedure, following tools are required.
zeroing pin and block (OP-T2-*** ; option)
Please prepare these tools by referring to "Chapter 5 Recommended spare parts and special tools for maintenance".
(2) By referring to the drawings on next page, move the robot (target axis) to the reference position with manual operation (speed 2 or 3)
As for axis 1, 2 and 3: The zeroing pin is inserted at the reference position.
As for axis 4, 5 and 6: After attaching zeroing block, insert zeroing pin at the reference position.
(3) Register the encoder correction data by referring to the instruction manual "SETUP", "4.3.3 Encoder reset and encoder correction".
(4) Confirm that current position data matches with "Encoder data of reference position". Current position data can be read in <Service utilities> [4 Monitor 2] [2 Axis Position].
(5) Make sure to remove the zeroing pin (and block).
And confirm that there is no problem with the robot operation.

	When motor is replaced, it's possible that software stroke error occurs and robot can not reach the reference position. Because the software functions to control the motion range even the position data is not correct. In this case, conduct the encoder correction in that (not correct) position. Then, turn the motor power on again and move the robot to the correct reference position. (Now the motion range is reestablished.) And then, conduct the encoder correction again.
	**Axis interference of wrist axis (axis 4,5 and 6)** "Axis interference" exists due to the structure of the wrist on this robot. When conducting encoder correction of axis 5, axis 4 must be in reference position. Similarly, when conducting encoder correction of axis 6, axis 4 and 5 must be in reference position. (As for axis 4 or axis 5 which is affecting other axis, it is enough to be in reference position. It is unnecessary to conduct their encoder correction.) In case that all wrist axes need encoder correction, for example replacing wrist unit, encoder correction must be conducted in the order of 4, 5 and 6 axes certainly. If encoder correction has not been conducted in this order, the zero points of the wrist axes will not be set correctly, as a result robot won't move properly.
	If robot is operated without removing zeroing pin, pin itself or pin hole may be disfigured. If robot is operated without removing zeroing block, parts where block is equipped, arm and tool may be seriously damaged because zeroing block interferes with arm and/or tool. Be sure to remove zeroing pin and zeroing block before starting operation.

IMPORTANT	Reference position and its encoder data are showed at following drawings. These encoder data are very important to confirm the successful procedure of encoder correction.

■ **Reference position (Zeroing pin insertion portion) of Axis 1, 2 and 3**

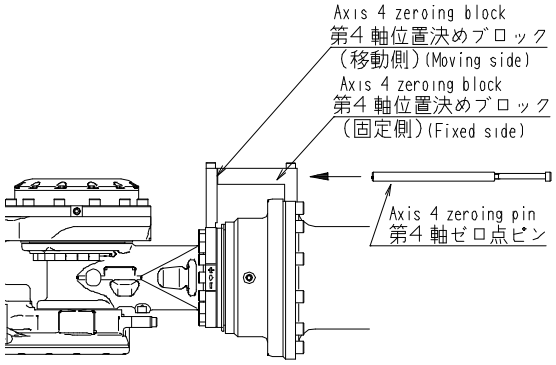


Encoder data of reference position

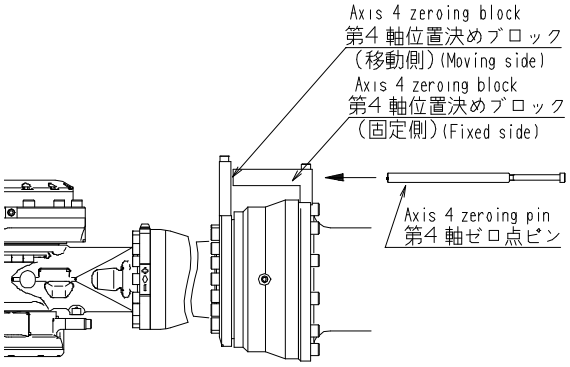
Axis 1	**80,000[Hex]**
Axis 2	**80,000[Hex]**
Axis 3	**80,000[Hex]**

■ Reference position (Zeroing pin insertion point) of Axis 4

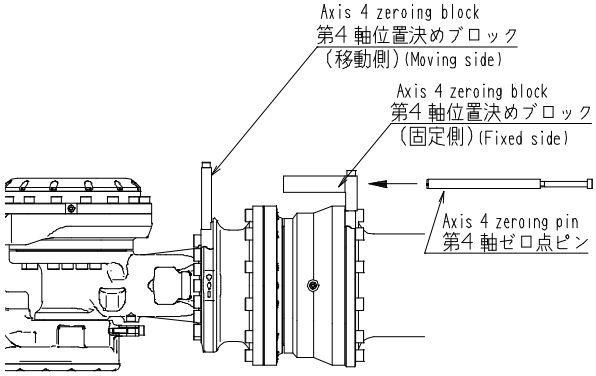
[SRA100-01] [SRA166-01]
[SRA210-01] [SRA240-01] [SRA250-01]



[SRA120EL-01] [SRA133L-01] [SRA166L-01]
[SRA210L-01]

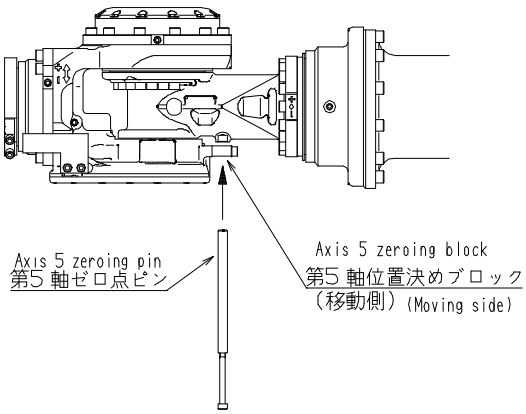


[SRA240L-01]



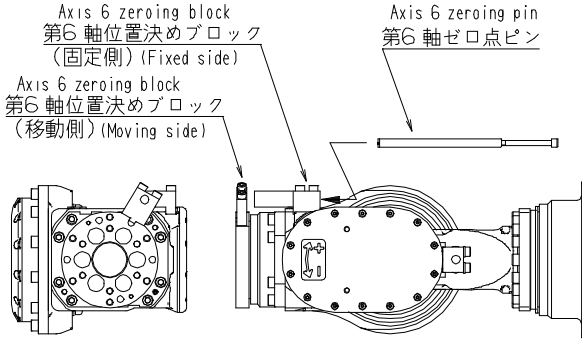
■ Reference position (Zeroing pin insertion point) of Axis 5

All robot type

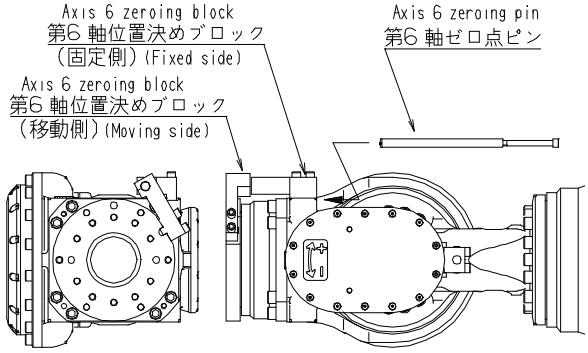


■ **Reference position (Zeroing pin insertion point) of Axis 6**

[SRA100-01][SRA166-01]
[SRA120EL-01] [SRA133L-01] [SRA166L-01]



[SRA210-01] [SRA240-01] [SRA250-01]
[SRA210L-01] [SRA240L-01]



	Encoder data of reference position
Axis 4	**80,000[Hex]**
Axis 5	**80,000[Hex]**
Axis 6	**80,000[Hex]**

4.1.5 More accurate encoder correction

Sometimes normal encoder correction (using zeroing pins and blocks) is not sufficient to recover the taught positions precisely especially; bigger tool is equipped and so on. In such case, modify (re-calculate) the encoder correction value by following procedure.

Required tools;

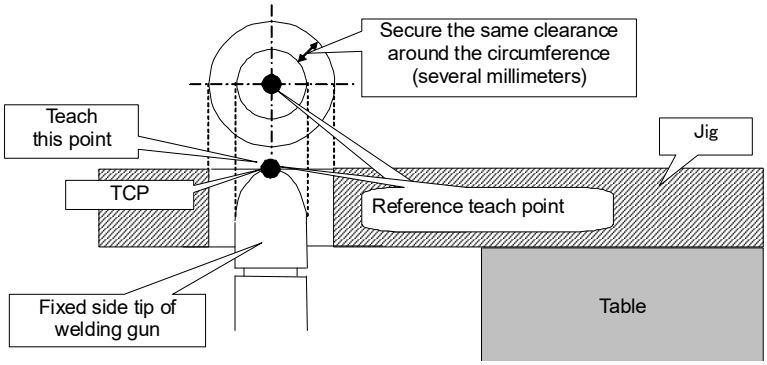
・Jig that can fixed on the ground or on the table for “Reference teach point”
・Calculator (Needed to re-calculate the encoder correction)

Preparation

1 **Making a program of “Reference teach point”**

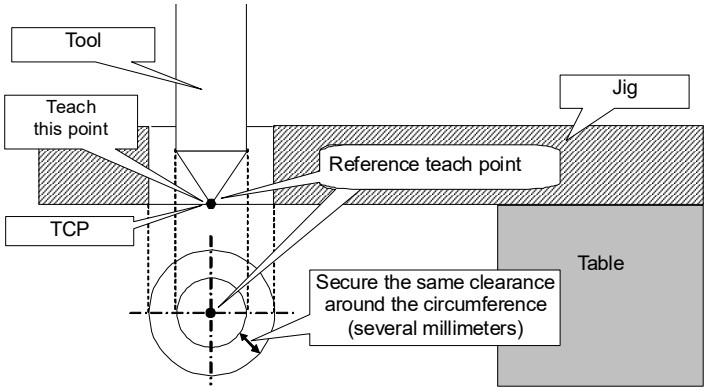
Within the robot motion range, install the **jig for “Reference teach point” that is fixed on the ground or on the table**. Make a program including a step where robot TCP is precisely match with the “Reference teach point”. This step is called **“Step of reference teach point”** here in after. This procedure must be done before the teaching operation is started.

(Example 1)



Notes: In case of welding gun, precise “Step of reference teach point” can not be obtained when worn tip is used or tip is not pushed in enough.

(Example 2)



More accurate encoder correction

CAUTION	In case that motor / encoder is replaced or encoder reset is performed at a same time for many axes, position recovery by this procedure would be very difficult. This procedure must be performed for only one axis (one by one).

Case of axis 1. (As one example.)

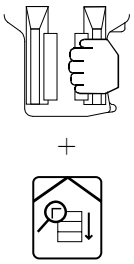
1 **Perform standard encoder reset and normal encoder correction**

Perform standard encoder reset and normal encoder correction by following to

"4.1.3 Encoder reset" and/or

"4.1.4 Encoder correction"

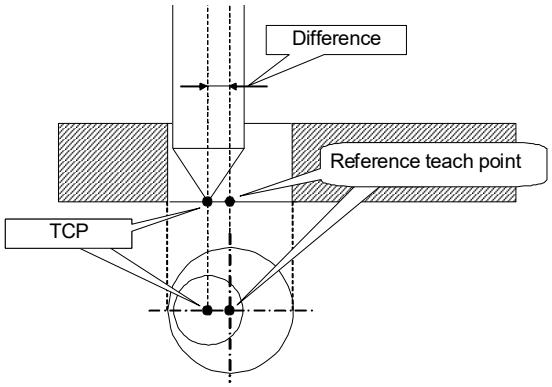
(Before proceeding, switch the operator class to ***EXPERT*** or higher)



2 **Check the difference with "Reference teach point"**

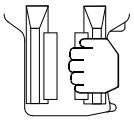
By check GO operation, move the robot to the "Step of reference teach point" and stop the robot in status that align with the axis. (Cursor line changes to yellow in the display).

If the distance from TCP and "Reference teach point" are acceptable range for work, then procedures after this is not required. If it's not acceptable, please modify the encoder correction value of target axis by following the procedure next.



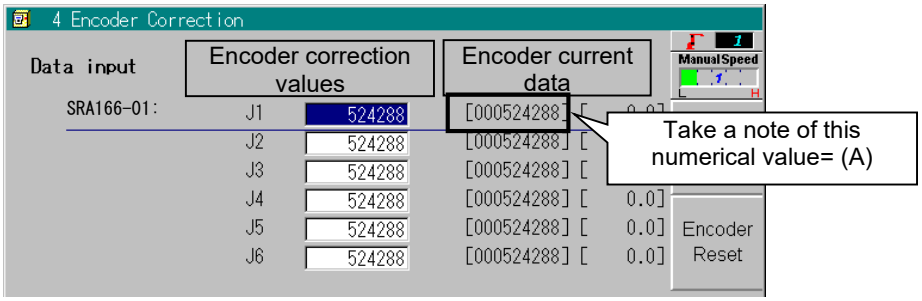
(Caution)

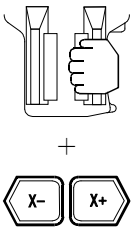
*Check GO operation must be started from the position where it doesn't interfere with the jig.



3 **Take a note of encoder current data (A)**

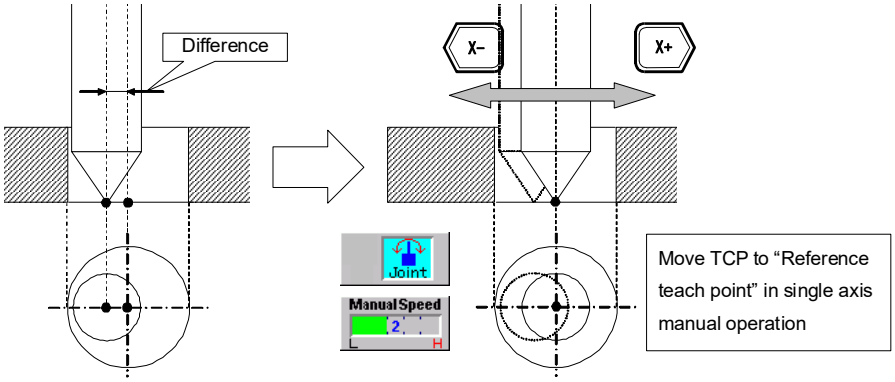
While holding the enabling switch, open <Constant setting> [3 Machine constants] – [4 Encoder correction]. Then read the "Encoder current data" in [Data input] screen and take a note. Consider this numerical value as (A).





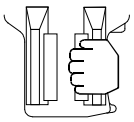
4 **Move TCP to “Reference teach point” in manual operation**

Move the robot by manual operation for **the target axis of encoder correction** (J1 axis in this case.) with 2 or 3 slow speeds to make sure that TCP matches with “Reference teach point”.



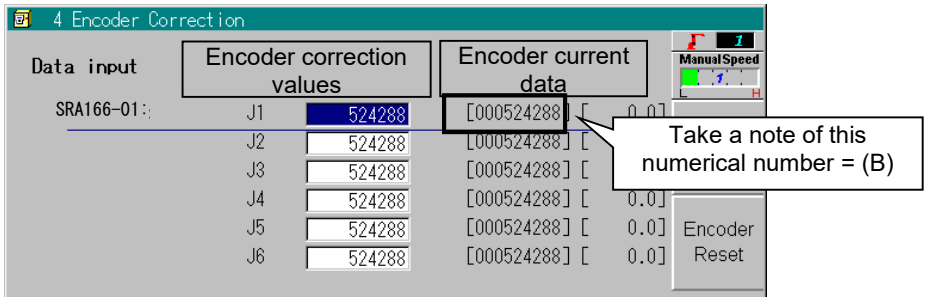
(Supplement)

If the axis that has no concern with the target axis was moved by mistake, please retry the procedure from step 2.



5 **Take a note of encoder current data (B) after TCP is moved**

While holding the enabling switch, open again <Constant setting> [3 Machine constants] – [4 Encoder correction]. Then read the “Encoder current data” at [Data input] screen and take a note. Let’s consider this numerical value as (B).



6 Press the Emergency Stop button to turn the motor power OFF.

(At this time, enable switch can be released.)

7 **Re-calculate the encoder correction value**

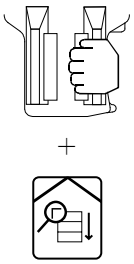
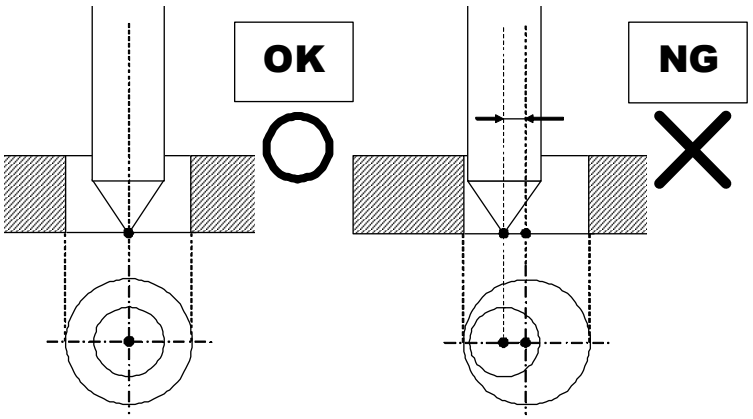
Calculate

(Encoder correction value) – ((A) – (B))

Calculate by calculator and put the result to the edit box of “Encoder correction values” at the same screen. (*Utilize the table of next page for your convenience.)

8 Press f12 [Complete].
>> The adjusted encoder correction value is saved in the internal memory.
(*Caution!)
***Remember, until you press [Complete] key, the encoder correction value WILL NOT BE SAVED into the internal memory.**

9 Turn right the Emergency Stop button to release, and turn the motor power ON again.

	10	By check GO operation, move the robot again and confirm that TCP surely aligns with “Reference teach point”. If not, new encoder correction value calculated in step 7 is wrong. Try the calculation again.  (Supplement) Target of this procedure is to get the encoder correction value so that TCP aligns with “Reference teach point” at high accuracy. Therefore, it is possible that, Instead of doing step 2 to 6, changing (adjusting) the encoder correction value manually little by little while checking the TCP position visually.
	11	If necessary, try check GO operation of work program and confirm the positioning accuracy of taught points.

(Reference) Use this table to calculate encoder correction

Axis	Encoder current data where TCP doesn’t align with “Reference teach point” (A)	Encoder current data after moved (where TCP aligns with “Reference teach point”) (B)	Original encoder correction value (C)	Re-calculated encoder correction value (C)-((A)-(B))
Axis 1				
Axis 2				
Axis 3				
Axis 4				
Axis 5				
Axis 6				

Register this value as the “new encoder correction value”

(Example)

Axis	Encoder current data where TCP doesn’t align with “Reference teach point” (A)	Encoder current data after moved (where TCP aligns with “Reference teach point”) (B)	Original encoder correction value (C)	Re-calculated encoder correction value (C)-((A)-(B))
Axis 1	522027	522017	520249	520249 - (522027 - 522017) = 520239

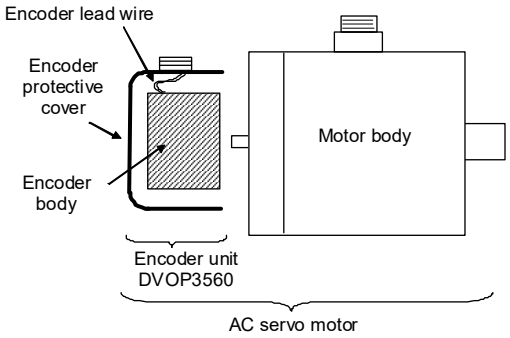
4.2 Encoder replacement

Since encoder is separated from motor on all axes of this robot, the encoder is replaceable.
This section describes the procedure when the robot is in good posture where encoder can be replaced.

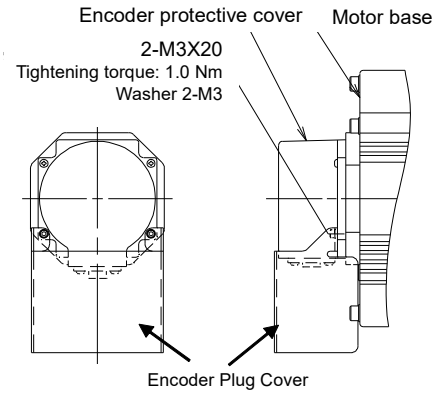
Tools required (*Customer preparation required.)

Part name	Axis	Part No. (Model)	Remark
Torque screwdriver	Axis 1	M3 torque wrench	
	All axes	M3 torque screwdriver	which meets the tightening torque of 0.59 to 0.88 N·m
		M3 setscrew torque screwdriver	which meets the tightening torque of 0.59 to 0.88 N·m
Locking agent		Threebond 1374	

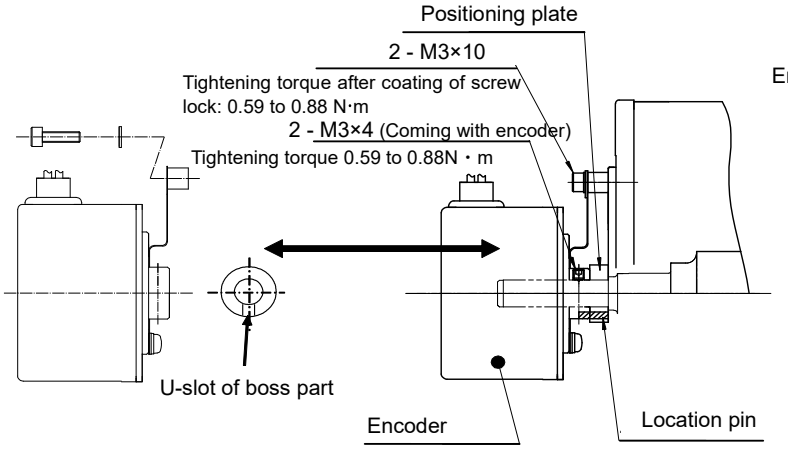
If encoder protective cover is damaged, the whole of motor & encoder unit needs to be replaced because encoder body and motor connecting portion may be damaged already.
In case of encoder replacement, “Encoder unit” is replaced. (Encoder unit includes “Encoder body”, “Encoder protective cover” and “Encoder lead wires”.)
It is rarely difficult to insert tool due to the robot posture. In this case, replace the whole of motor & encoder unit also.



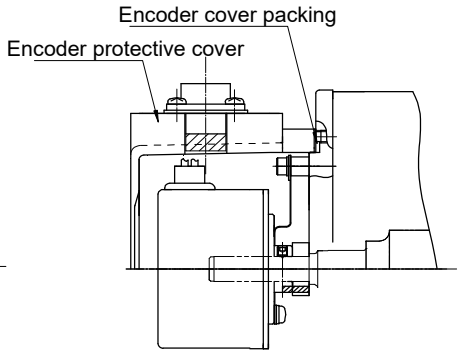
Encoder replacement procedure (common for all axes)

STEP	Required work	Check points
1	If possible, operate the robot arm manually to the reference position and insert zeroing pin. ☞ Refer to “4.1.4 Encoder correction”	If zeroing pin is inserted in advance, there is some case that the work after replacement is easier.
2	Turn off the controller power.	
3	If the encoder plug cover is attached, remove it. 	Encoder plug cover; Axis 1 and 2: standard Axis 3: optional
4	Disconnect the encoder connectors.	
5	Disconnect the encoder from the motor. (a) Loosen the fixing bolts and remove the encoder protective cover. (b) Remove the two bolts that fix the encoder fixing spring. (c) Remove the two set screws that fix the encoder boss part, and then pull out the encoder assembly from the motor shaft.	・At this time, do not pull the encoder lead wire, when you take off the encoder protective cover.

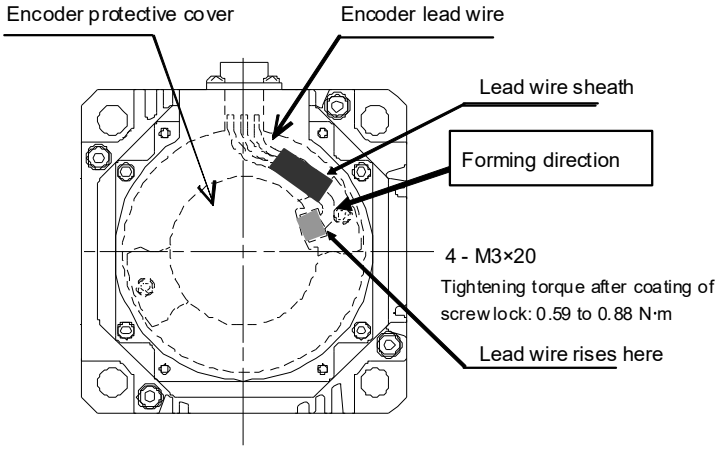
STEP	Required work	Check points
6	Mount the new encoder to the motor. (a) Insert the encoder so that the U-slot of the encoder boss part is aligned with the location pin on the motor side. (b) Insert the encoder until the encoder boss part hits the positioning plate of the motor shaft, and then tighten the set screws of the boss part (c) Tighten the encoder fixing spring by fixing bolts. (d) Organize the lead wire riser so that the encoder lead wire will go along with the circumference of the outer protective cover. Then, bring the sheath of lead wire close to the side of lead wire riser. Next, put the encoder protective cover in place. Then, tighten the fixing bolts.	Clean the shaft and the installation surface carefully in advance. ・Use the new setscrews (*with screw lock) that comes with the encoder. ・Apply one or two drips of locking agent to the bolts at this time. ・At this time, apply one or two drips of locking agent to the bolts. ・At this time, put the encoder packing in place.



Dismounting of encoder unit



Cross-section of encoder cover



Outline figure of encoder

STEP	Required work	Check points
7	Attach the removed encoder plug cover.	
8	Connect the connector to the encoder unit.	
9	Turn on the controller power.	
10	Perform encoder reset of replaced encoder. ☞ Refer to “4.1.3 Encoder reset”	
11	Perform encoder correction of replaced encoder. ☞ Refer to “4.1.4 Encoder correction”	
12	Remove the zeroing pin. Make sure that there is no problem with the robot operation.	

4.3 Wrist unit replacement

CAUTION

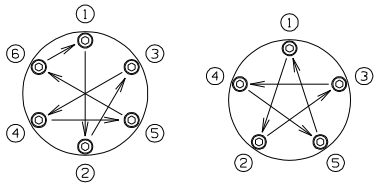
The wrist unit mass is listed below. Pay extra attention when you handle them.

Robot type	Wrist unit mass
SRA100-01, SRA166-01, SRA120EL-01,SRA133L-01,SRA166L-01	50 kg
SRA210-01,SRA240-01,SRA250-01 SRA210L-01,SRA240L-01	77 kg

Tools required (*Customer preparation required.)

Name of each parts	Part No. (Model)
Torque wrench	M12 torque wrench (L type torque wrench)
	M10 torque wrench (L type torque wrench)
	M10 torque wrench
	M8 torque wrench
Locking agent	ThreeBond 1374
Grease	LONGTIME PD2 (Compatible; ALVANIA RA-J)

Be absolutely sure to use the torque wrench to tighten the bolts by the specified torque.
In case of tightening the bolts on circumference, tighten them equally and gradually.

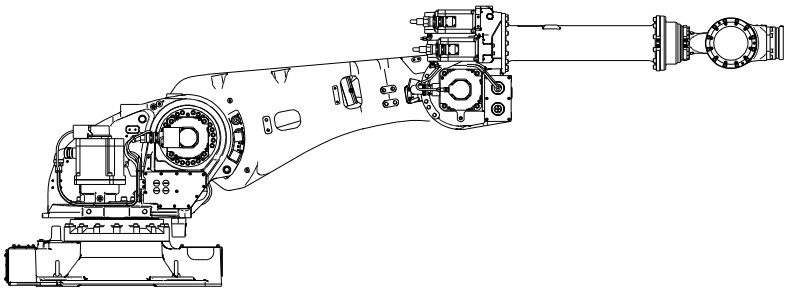


Order of tighten bolts

"Wrist unit", prepared as a spare part, includes not only wrist assembly but also fixing bolts and O-rings. Replace the old bolts and O-rings to the new ones in spite of their damage level.

Wrist unit replacement procedure

STEP	Required work	Check points
1	If possible, move the wrist axes (axis 4, 5 and 6) to the reference position and the fore arm to horizontal angle.	As for the reference position, Refer to "4.1.4 Encoder correction"

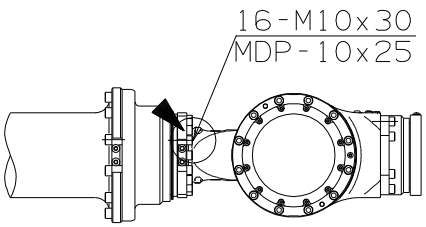
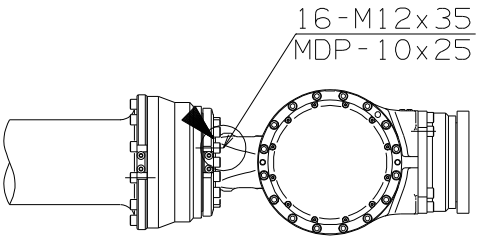
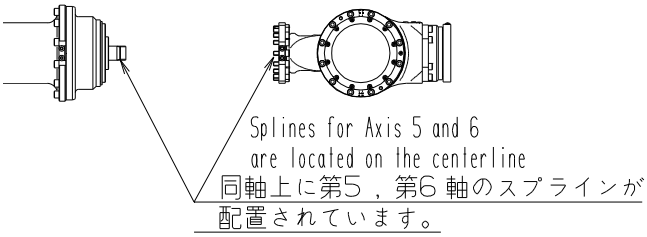
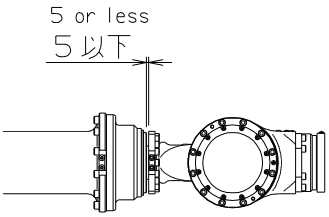


CAUTION

If this work is done while axis 3 (fore arm) was not in horizontal angle, spline and shaft may be damaged.

CAUTION

It is unnecessary to disconnect encoder cable as this is just a mechanical replacement work. Therefore encoder reset procedure is unnecessary.
But mechanical zero position of wrist axes changes by this work, so encoder correction procedure is absolutely necessary. If encoder correction was forgotten, it is impossible to playback the existing programs.

STEP	Work performed	Checkpoints
2	Turn off the controller power.	
3	Disengage the loads (welding gun, hand, or work-piece etc.) from the wrist unit.	As for the wrist flange, see ☞ "1.3 Details of load installation face".
4	Remove the wrist unit fixing bolts and locating pin. And then disengage the wrist unit from the robot. **[SRA100-01] [SRA166-01] [SRA120EL-01] [SRA133L-01] [SRA166L-01]** (Tightening torque: 67 N・m)  **[SRA210-01] [SRA240-01] [SRA250-01] [SRA210L-01] [SRA240L-01]** (Tightening torque: 116 N・m) 	Wrist unit is heavy. Be careful.
5	Apply grease (LONGTIME PD2) on all the splines of the forearm side and the new wrist unit side until the gaps of them are filled with the grease. And set new wrist unit to the forearm.  All the splines will match when the gap between wrist unit and forearm is shorter than 5mm. 	・Replace O-ring at the same time. (☞ Refer to "5 Recommended spare parts and special maintenance tools for maintenance".) ・Do not tighten the bolts forcefully unless the splines match with each other. If you do so, those splines will be broken. ・At this time, using new bolts, and apply 1 or 2 drops of locking agent (ThreeBond 1374) onto the bolts in advance. ・Although ALVANIA RA-J grease is applied on the gears, LONGTIME PD2 can be applied there because it has the same lithium soap base and the same consistency.
6	Turn on the controller power.	
7	Perform encoder correction of replaced motor. ☞ Refer to "4.1.4 Encoder correction"	
8	Remove the zeroing pin. Make sure that there is no problem with the robot operation.	

NOTE

Chapter 5 Recommended spare parts and special tools for maintenance

Recommended spare parts are listed below. To purchase any parts, check the manufacturing No. and date of the robot, and then please contact our Service Department.

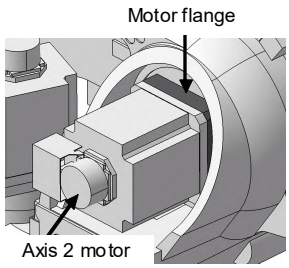
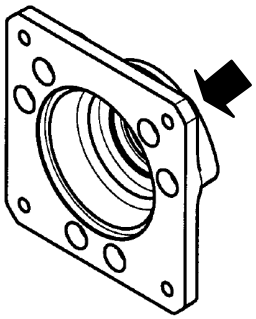
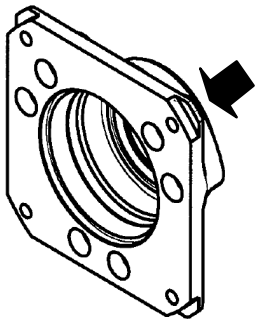
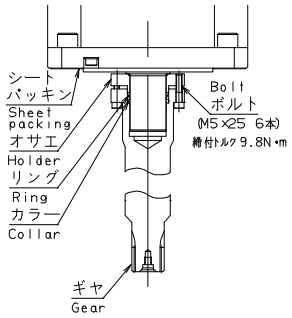
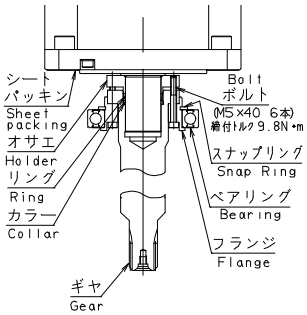
Classification A: Periodical maintenance parts B: Spare parts

Recommended spare parts

Classification	Product name	Part No. (Model)	In use/unit	Recommended/unit	Robot model										Remark
					SRA100-01	SRA166-01	SRA210-01	SRA240-01	SRA250-01	SRA120EL-01	SRA133L-01	SRA166L-01	SRA210L-01	SRA240L-01	
A	GREASE	ALVANIA-RA-J-16KG	-	1	○	○	○	○	○	○	○	○	○	○	ALVANIA RA-J 16KG (*1)
A	GREASE	LONGTIME-PD2-18KG	-	1	○	○	○	○	○	○	○	○	○	○	Tribol GR 100-2 PD(*1),(*6) (Old name:LONGTIME PD2)
A	GREASE	VIGOG-RE0-16KG	-	1	○	○	○	○	○	○	○	○	○	○	VIGO Grease RE0 16KG (*1)
A	GREASE	U4623-16KG	-	1	○	○	○	○	○	○	○	○	○	○	(*2)
A	BATTERY	ER17505V-2C38	4	4	○	○	○	○	○	○	○	○	○	○	(*3)
A	BATTERY UNIT	KP-ZA-011	1	1	○	○	○	○	○	○	○	○	○	○	4pcs of battery (*4)
A	COVER SET	SP-CS-004	1	1	○	○	○	○	○	○	○	○	○	○	Axis 1
A	COVER SET	SP-CS-011	1	1	○	○	○	○	○	○	○	○	○	○	Balancer protection cover
B	AC SERVO MOTOR	MDMU402S2V3	3	1	○	○	○	○	○	○	○	○	○	○	Axis 1,2 and 3
B	AC SERVO MOTOR	MSME202S2V3	3	1	○	○	○	○	○	○	○	○	○	○	Axis 4,5 and 6
B	ENCODER	DVOP3560	6	1	○	○	○	○	○	○	○	○	○	○	All axes
B	COUPLING GEAR SET	KP-ZH-144	1	1		○	○	○	○	○	○	○	○	○	Axis 1
B	COUPLING GEAR SET	KP-ZH-150	1	1	○										
B	COUPLING GEAR SET	KP-ZH-145 or KP-ZH-189	1	1		○					○				Axis 2 (*5)
B	COUPLING GEAR SET	KP-ZH-151 or KP-ZH-188	1	1	○										
B	COUPLING GEAR SET	KP-ZH-154 or KP-ZH-191	1	1					○			○	○	○	
B	COUPLING GEAR SET	KP-ZH-149 or KP-ZH-190	1	1			○	○		○					
									○			○	○	○	Axis 3
B	COUPLING GEAR SET	KP-ZH-146	1	1		○	○	○		○	○				
B	COUPLING GEAR SET	KP-ZH-152	1	1	○							○			
B	COUPLING GEAR SET	KP-ZH-147	1	1	○	○	○	○	○	○	○	○	○	○	Axis 4 and 5
B	COUPLING GEAR SET	KP-ZH-148	2	1	○	○	○	○	○	○	○		○	○	Axis 6
B	WRIST UNIT	SP-W1-044	1	1	○							○			100Kg payload type
B	WRIST UNIT	SP-W1-045	1	1		○				○	○				166Kg payload type
B	WRIST UNIT	SP-W1-046	1	1			○	○	○			○	○	○	210Kg payload type
B	BJ1 UNIT ASSY	SP-BJ1-170	1	1	○	○	○	○	○	○	○		○	○	All wiring integrated type

(*1) If SDS (Safety Data Sheet) of this chemical material is necessary, you need to get from the chemical material supplier.
(*2) If SDS (Safety Data Sheet) of this chemical material is necessary, please contact to NACHI service.
(*3) This battery is compatible with ER17/50H used before 2021 March.
In case of purchasing in China, please order ER18505-2. This is compatible with ER17/50H and ER17505V-2C38.
(*4) In case of purchasing in China, please order KP-ZA-011CN. This is compatible with KP-ZA-011. When replacing all batteries in robot, please order battery unit.
(*5) All of axis 2 coupling gear set and SRA250 axis 3 coupling gear set differ due the shape of motor attachment portion (motor flange). Please do not make mistake the type when ordering it. (Refer to ☞ "How to identify the type of axis 2 coupling gear set")
(*6) In this manual, this grease uses the old name LONGTIME PD2.

■ How to identify the type of axis 2 coupling gear set

<table>
<tr>
<td>Motor flange
 
</td>
<td>Identified by the shape of 4 corners
  </td>
<td>Identified by the shape of 4 corners
  </td>
</tr>
<tr>
<td>Coupling gear set</td>
<td>KP-ZH-151
(for SRA100)
KP-ZH-145
(for SRA166, SRA133L)
KP-ZH-149
(for SRA210, SRA240, SRA166L,SRA210EL)
(and for SRA250 axis 3)
KP-ZH-154
(for SRA250)
 
</td>
<td>KP-ZH-188
(for SRA100)
KP-ZH-189
(for SRA166, SRA133L)
KP-ZH-190
(for SRA210,SRA240,SRA166L,SRA210EL)
(and for SRA250,SRA210L,SRA240L axis 3)
KP-ZH-191
(for SRA250,SRA210L,SRA240L)
 
</td>
</tr>
</table>

■ AC servo motor with coupling gear set

AC servo motor with coupling gear set is provided as spare parts.
This part can reduce the time to replace motor.

AC servo motor with coupling gear set

Classification	Part No. (Model)	assembled coupling gear set	In use/unit	Recommended/unit	Robot model										Remark
					SRA100-01	SRA166-01	SRA210-01	SRA240-01	SRA250-01	SRA120EL-01	SRA133L-01	SRA166L-01	SRA210L-01	SRA240L-01	
B	KP-ZH-198	KP-ZH-144	1	1		○	○	○	○	○	○	○	○	○	Axis 1
B	KP-ZH-206	KP-ZH-150	1	1	○										
B	KP-ZH-200 (*1)	KP-ZH-145 (*1)	1	1		○					○				Axis 2
B	KP-ZH-214 (*2)	KP-ZH-189 (*2)													
B	KP-ZH-208 (*1)	KP-ZH-151 (*1)	1	1	○										
B	KP-ZH-212 (*2)	KP-ZH-188 (*2)													
B	KP-ZH-217 (*1)	KP-ZH-154 (*1)	1	1					○ Axis 2						
B	KP-ZH-218 (*2)	KP-ZH-191 (*2)											○	○	
B	KP-ZH-204 (*1)	KP-ZH-149 (*1)	1	1			○	○	○ Axis 3	○		○			
B	KP-ZH-216 (*2)	KP-ZH-190 (*2)											○ Axis 3	○ Axis 3	
B	KP-ZH-202	KP-ZH-146	1	1		○	○	○		○	○	○			Axis 3
B	KP-ZH-210	KP-ZH-152	1	1	○										
B	KP-ZH-247	KP-ZH-147	2	1	○	○	○	○	○	○	○	○	○	○	Axis 4, Axis 5
B	KP-ZH-249	KP-ZH-148	1	1	○	○	○	○	○	○	○	○	○	○	Axis 6

(*1) For the robot shipped prior to November 2014. ("How to identify the type of axis 2 coupling gear set")
(*2) For the robot shipped December 2014 or later. ("How to identify the type of axis 2 coupling gear set")

■ Seal

Following seals and O rings are necessary for the motor and the wrist replacement procedure. "COUPLING GEAR SET" and "Wrist Unit" include these parts. This list is just the reference when ordering them individually.

Usage	Name	Type	Notes
Sheet packing for axis 1 motor replacement	SEAL	037-0676-001	Applicable to all robot
Sheet packing for axis 2 and 3 motor replacement	SEAL	037-0665-001	
Sheet packing for axis 4,5 and 6 motor replacement	SEAL	037-0664-002	
O ring for 100kg to 166kg payload wrist replacement O ring for SRA210L and SRA240L wrist replacement	O RING	CO0552A	
O ring for 210kg to 240kg payload wrist replacement	O RING	CO0548A	

The fixtures listed below are required tools for maintenance work or for efficient work. To purchase any parts, check the manufacturing No. and date of the robot, and then contact our Service Department.

Special tools for maintenance (option)

Product Name	Part No. (Model)	Robot model										Remark
		SRA100-01	SRA166-01	SRA210-01	SRA240-01	SRA250-01	SRA120EL-01	SRA133L-01	SRA166L-01	SRA210L-01	SRA240L-01	
ACCESSORY	OP-T2-053	○	○				○	○	○			Zeroing pin & block (Common with ST100/70L)
ACCESSORY	OP-T2-054			○	○	○				○	○	Zeroing pin & block (Common with ST-F series)
MAINTENANCE TOOL	KP-ZD-005	○	○	○	○	○	○	○	○	○	○	Axis 2 Arm locking fixture
MAINTENANCE TOOL	KP-ZJ-011	○	○	○	○		○	○	○			Axis 3 Arm locking fixture
MAINTENANCE TOOL	KP-ZJ-045					○				○	○	Axis 3 Arm locking fixture
MAINTENANCE TOOL	KP-ZJ-012	○	○	○	○	○	○	○	○	○	○	Gas balancer unit Replacement fixture
MAINTENANCE TOOL	KP-ZJ-013	○	○	○	○	○	○	○	○	○	○	Gas balancer unit Analog pressure gauge
MAINTENANCE TOOL	KP-ZJ-014	○	○	○	○	○	○	○	○	○	○	Gas balancer unit Digital pressure gauge
MAINTENANCE TOOL	KP-ZJ-015 (*1)	○	○	○	○	○	○	○	○	○	○	Gas balancer unit Charging equipment (W22,picth14,Female)
MAINTENANCE TOOL	KP-ZJ-016 (*1)	○	○	○	○	○	○	○	○	○	○	Gas balancer unit Charging equipment (W23,picth14,Male)
MAINTENANCE TOOL	KP-ZJ-019	○	○	○	○	○	○	○	○	○	○	Gas balancer unit Joint of Female->Male (W22)
MAINTENANCE TOOL	KP-ZJ-017	○	○	○	○	○	○	○	○	○	○	Axis 1 Motor replacement fixture
Bypass cable	BCUNIT20-30	○	○	○	○	○	○	○	○	○	○	Bypass cable unit

(*1) Charging equipment shipped prior to February 2020 and shipped February 2020 or later has different shape of gas cylinder connecting portion. Seal is attached to the gas cylinder connecting portion on the charging equipment shipped on February 2020 or later. This seal is consumable. For details, refer to "3.4 Inspection of balancer unit and filling gas".

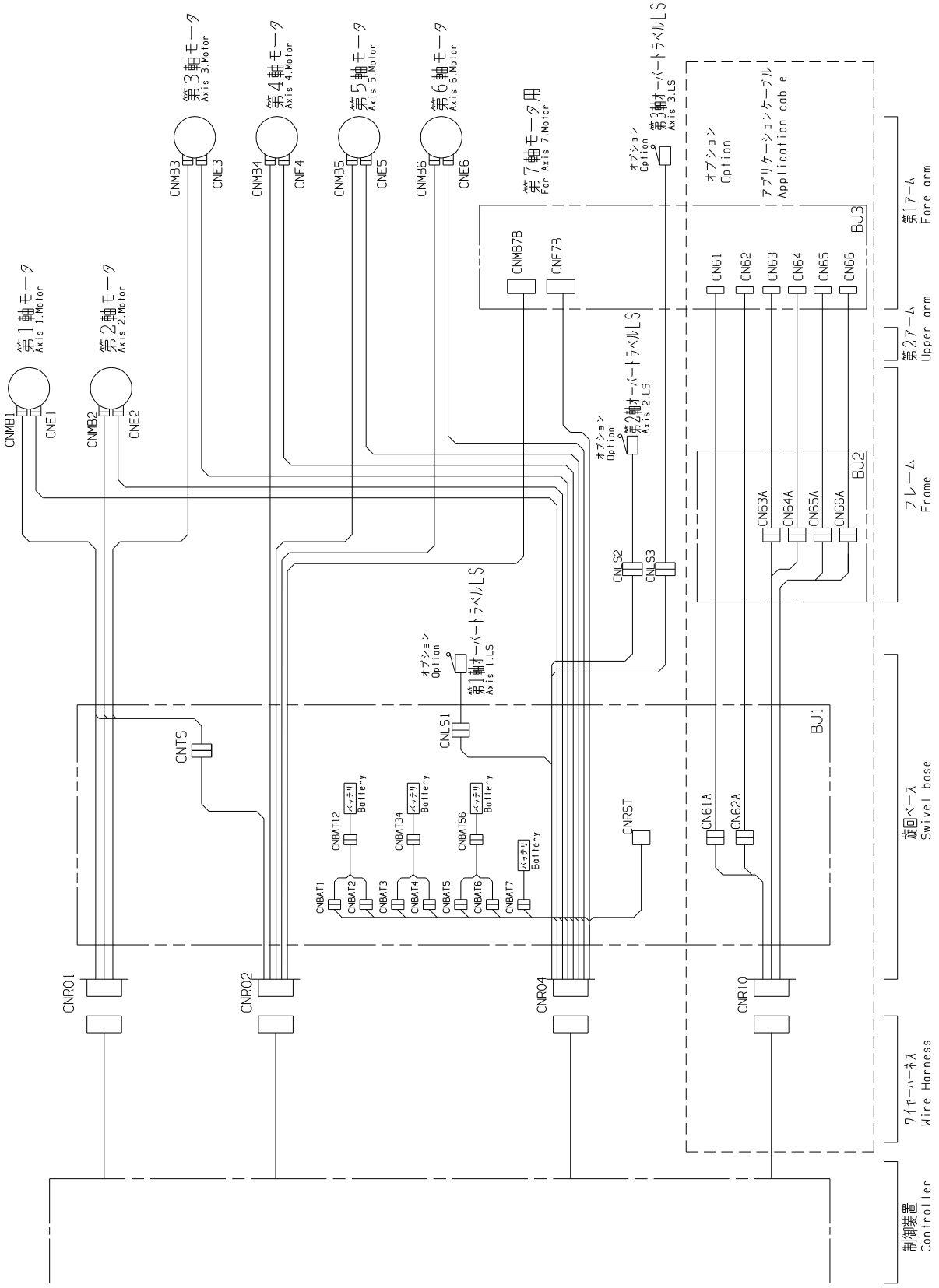
Contents of OP-T2-*** (Zeroing pin & zeroing block) (option)

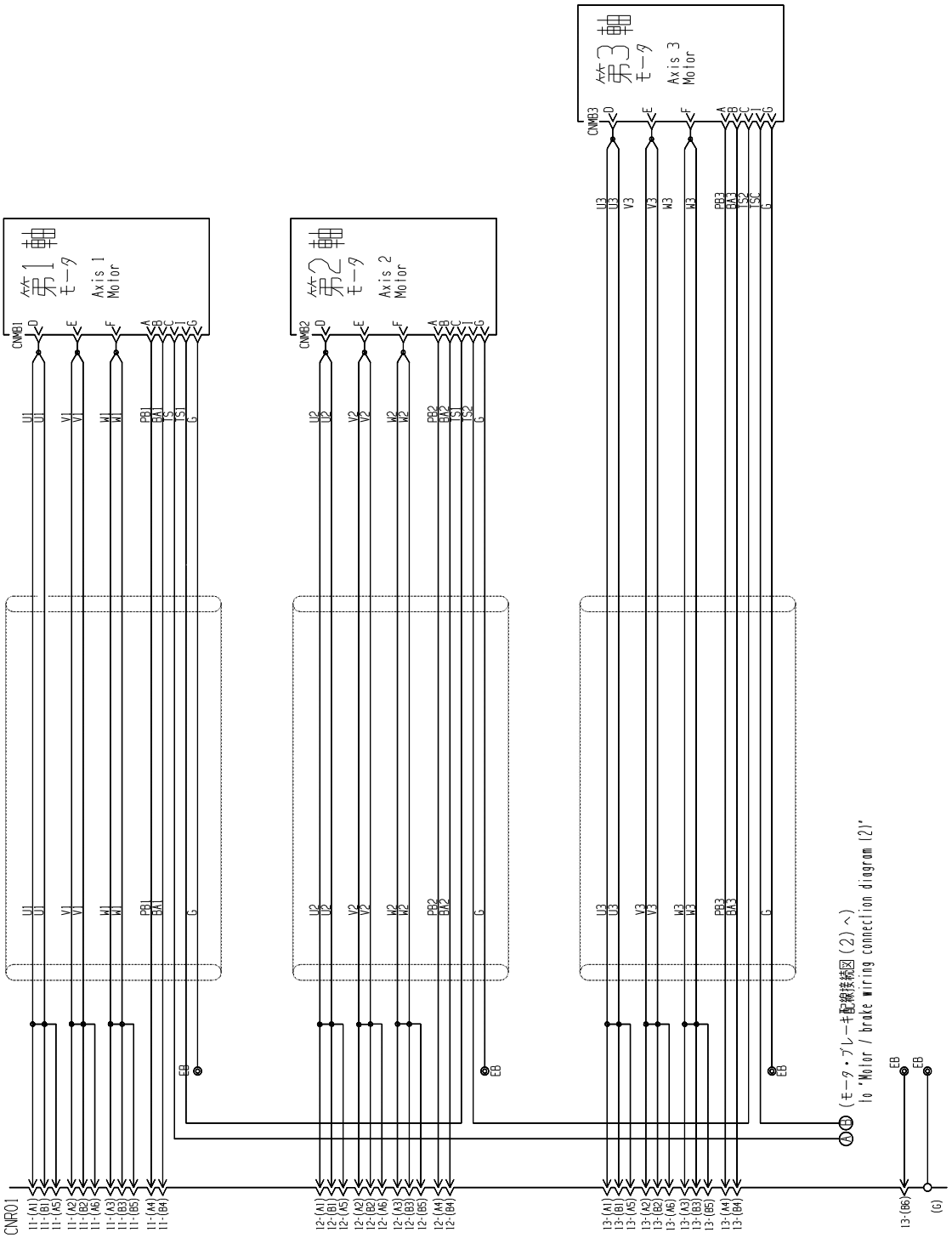
Applied Robot model	Name	Marking	Appearance, etc
All model	Axis 1,4,5,6 Zeroing pin		
All model	Axis 2,3 Zeroing pin		
All model	Axis 4 fixed side Zeroing block	ST J4	
	Axis 4 moving side Zeroing block	ST J4	
	Axis 5 moving side Zeroing block	ST/SB J5	
	Axis 6 fixed side Zeroing block	SF133 J6	
SRA100,166,120EL, 133L, 166L	Axis 6 moving side Zeroing block	SF133 J6	
SRA210, 240, 250,210L,240L	Axis 6 moving side Zeroing block	SF200F J6	
All model	Axis 4 fixed side fixing bolt		Hex. socket head cap screw 2-M8X60
	Axis 4 moving side fixing bolt		Hex. socket head cap screw 2-M8X100
	Axis 5 moving side fixing bolt		Hex. socket head cap screw 2-M8X40
All model	Axis 6 fixed side fixing bolt		Hex. socket head cap screw 2-M8X45
SRA100,166,120EL, 133L, 166L	Axis 6 moving side fixing bolt		Hex. socket head cap screw 2-M8X55
SRA210, 240, 250,210L,240L	Axis 6 moving side fixing bolt		Hex. socket head cap screw 2-M8X35

Tightening torque for M8 bolt: 33.3 N•m

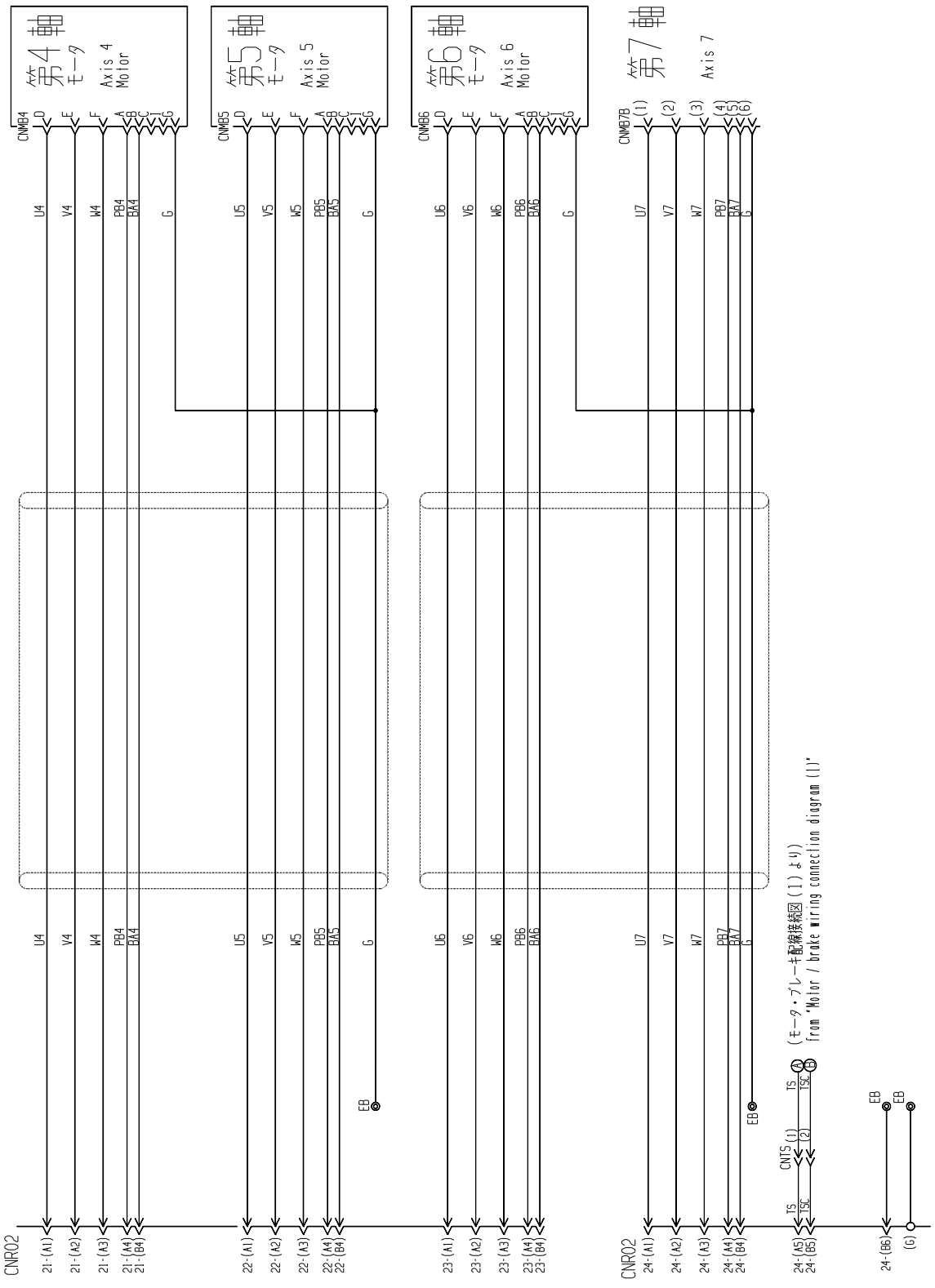
Parts like pins and blocks can not be purchased individually.

Chapter 6 Wiring Diagrams

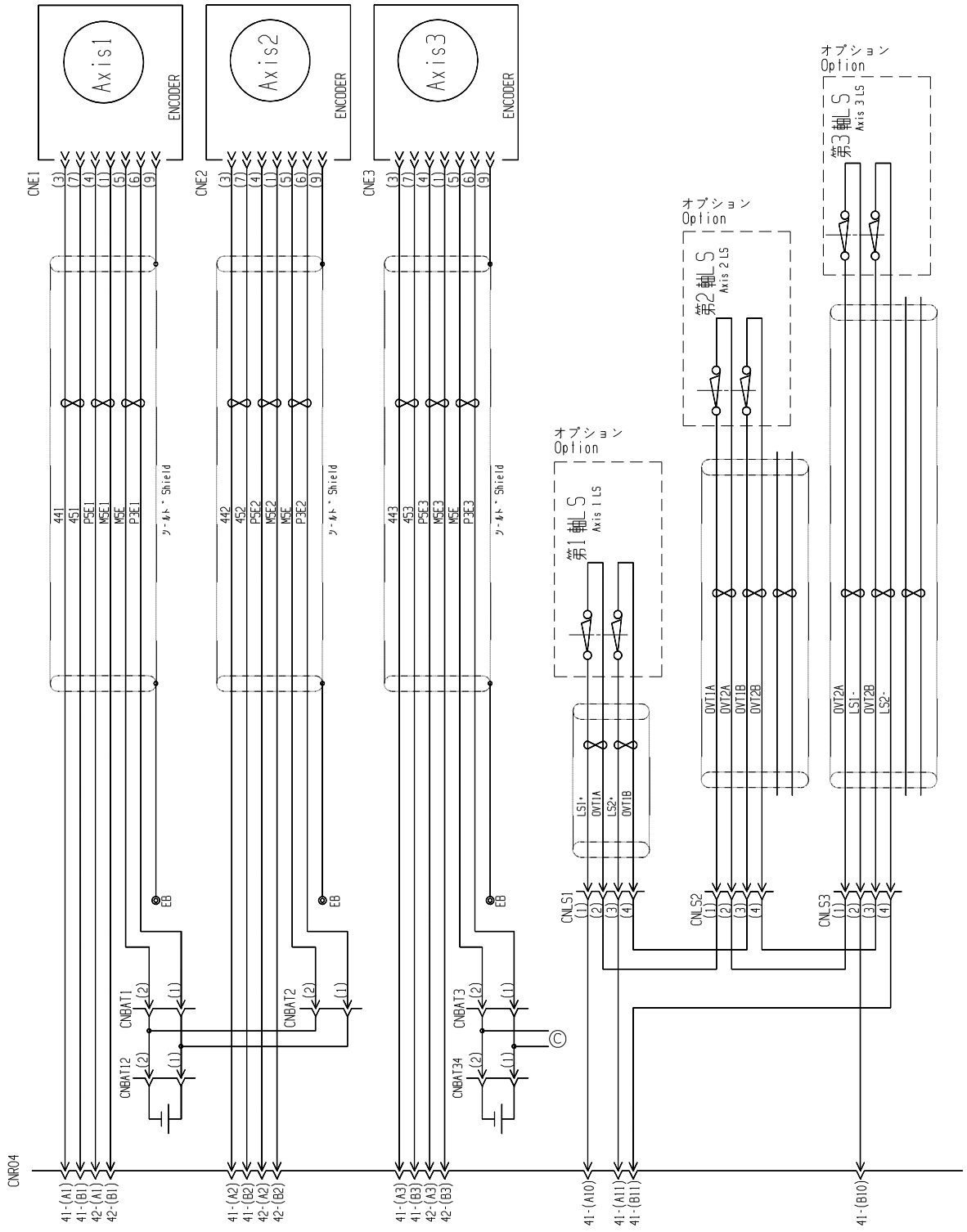




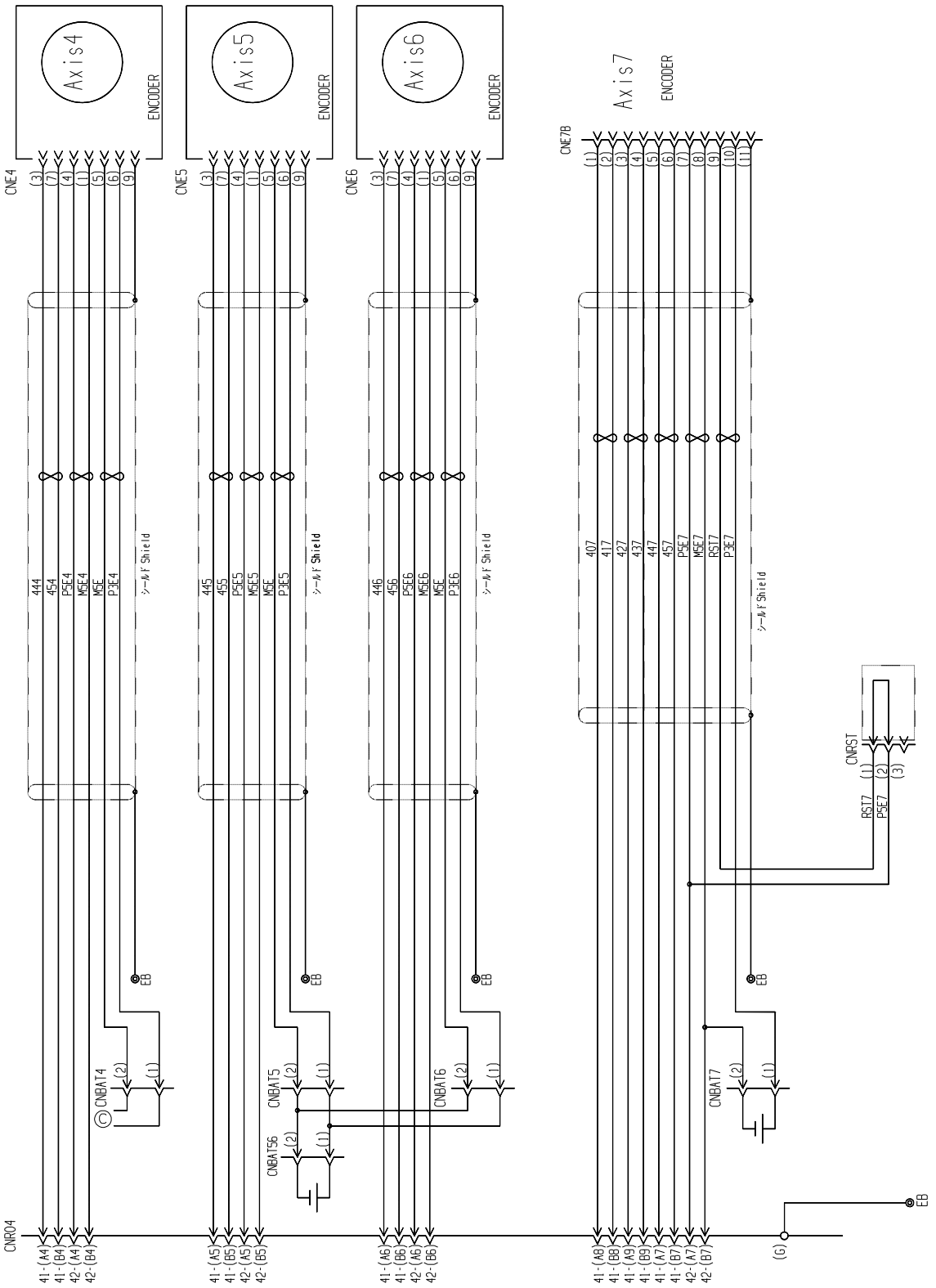
Motor/brake wiring connection diagram (1)



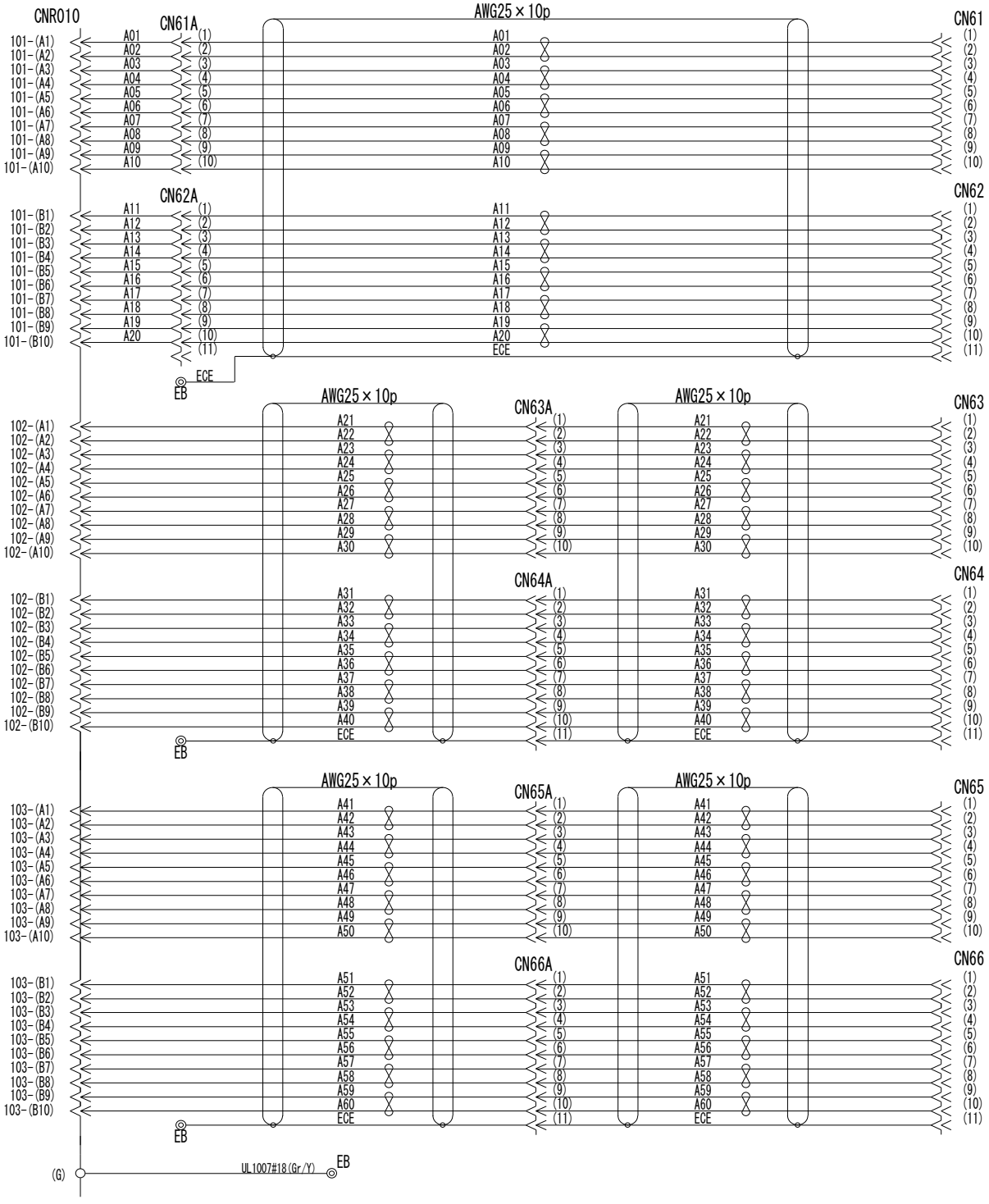
Motor/brake wiring connection diagram (2)



Encoder connection diagram (1)

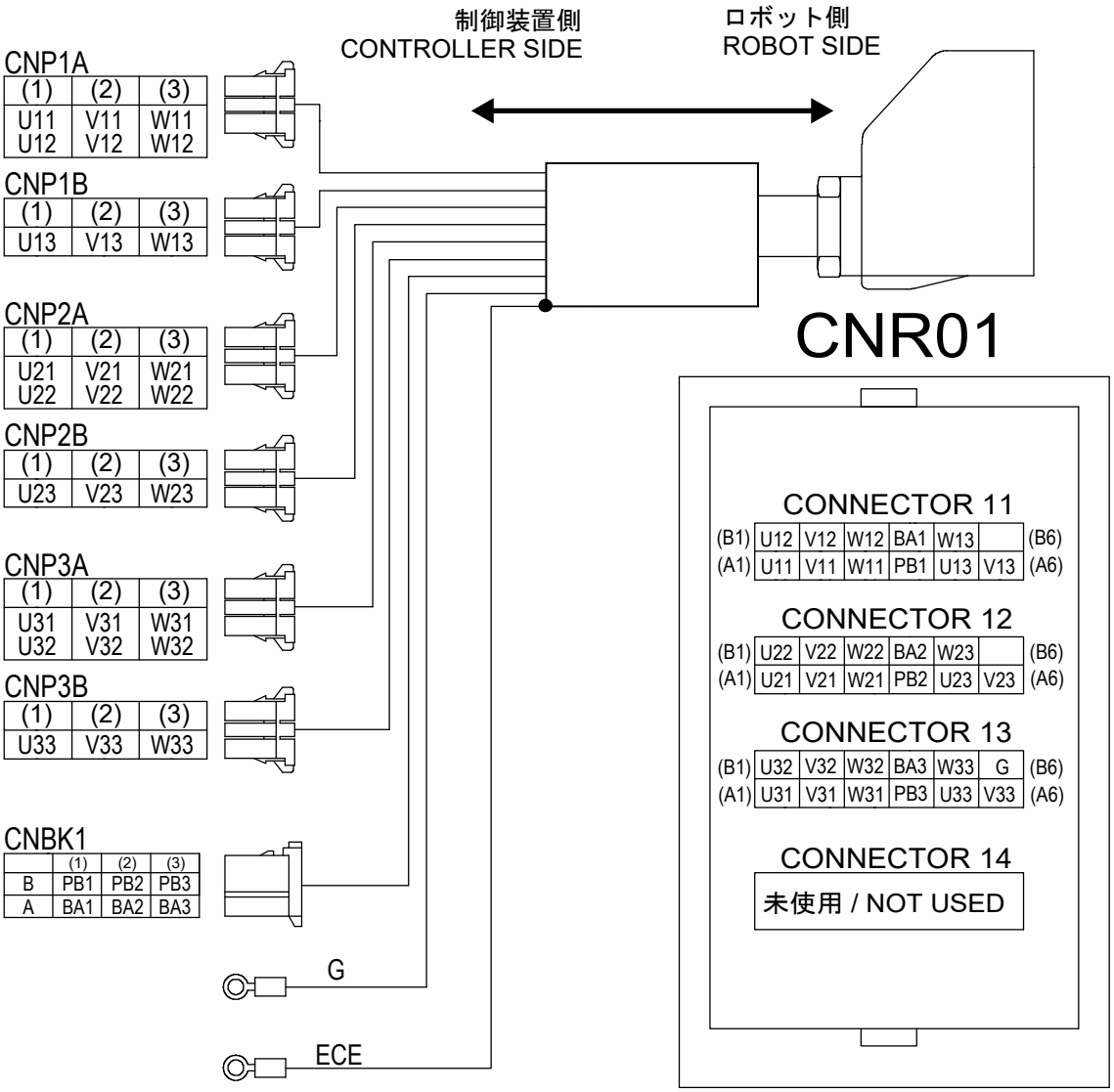


Encoder wiring connection diagram (2)

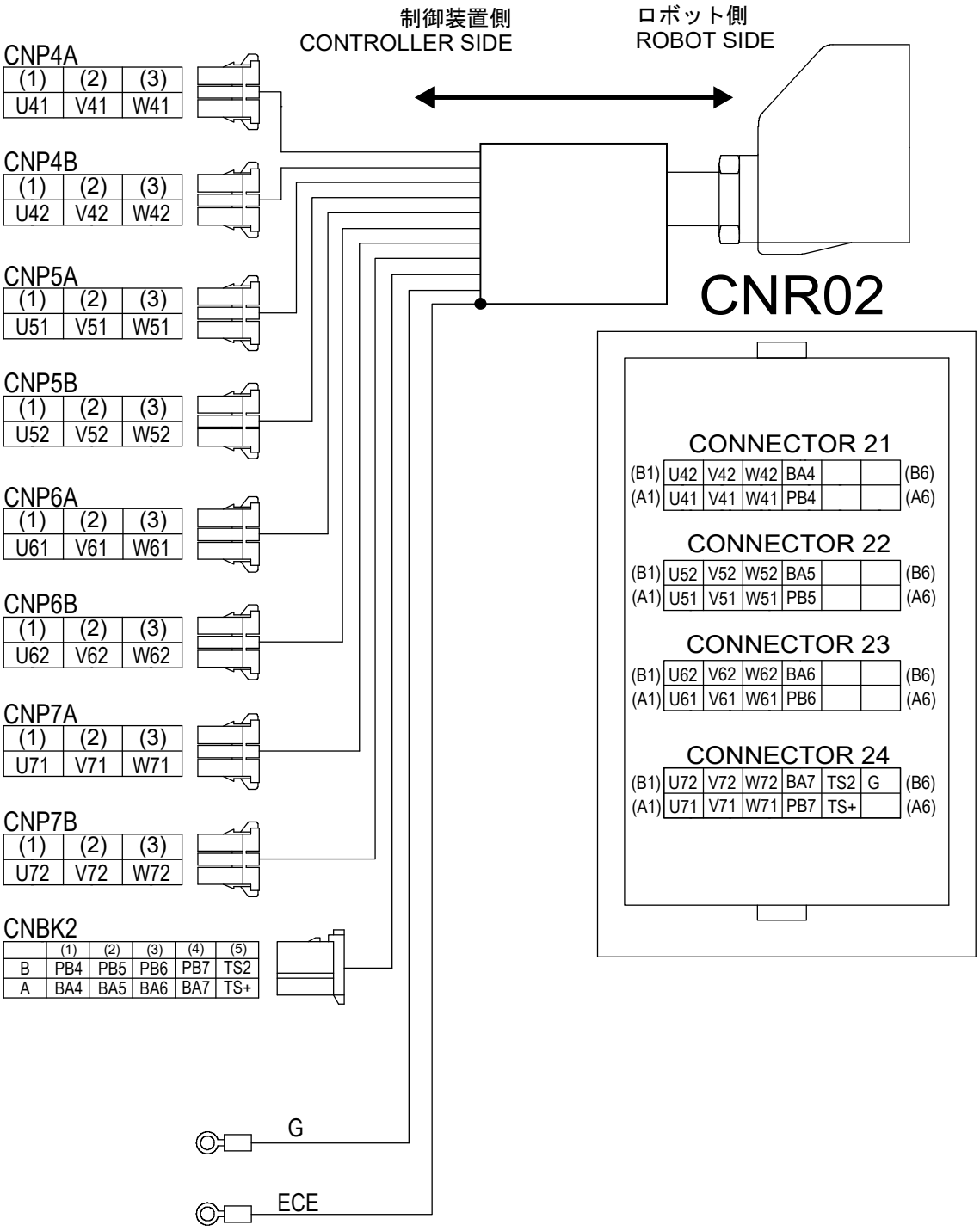


Application wirings may vary according to the specification.
ｱﾌﾟﾘｹｰｼｮﾝ配線は仕様により異なります

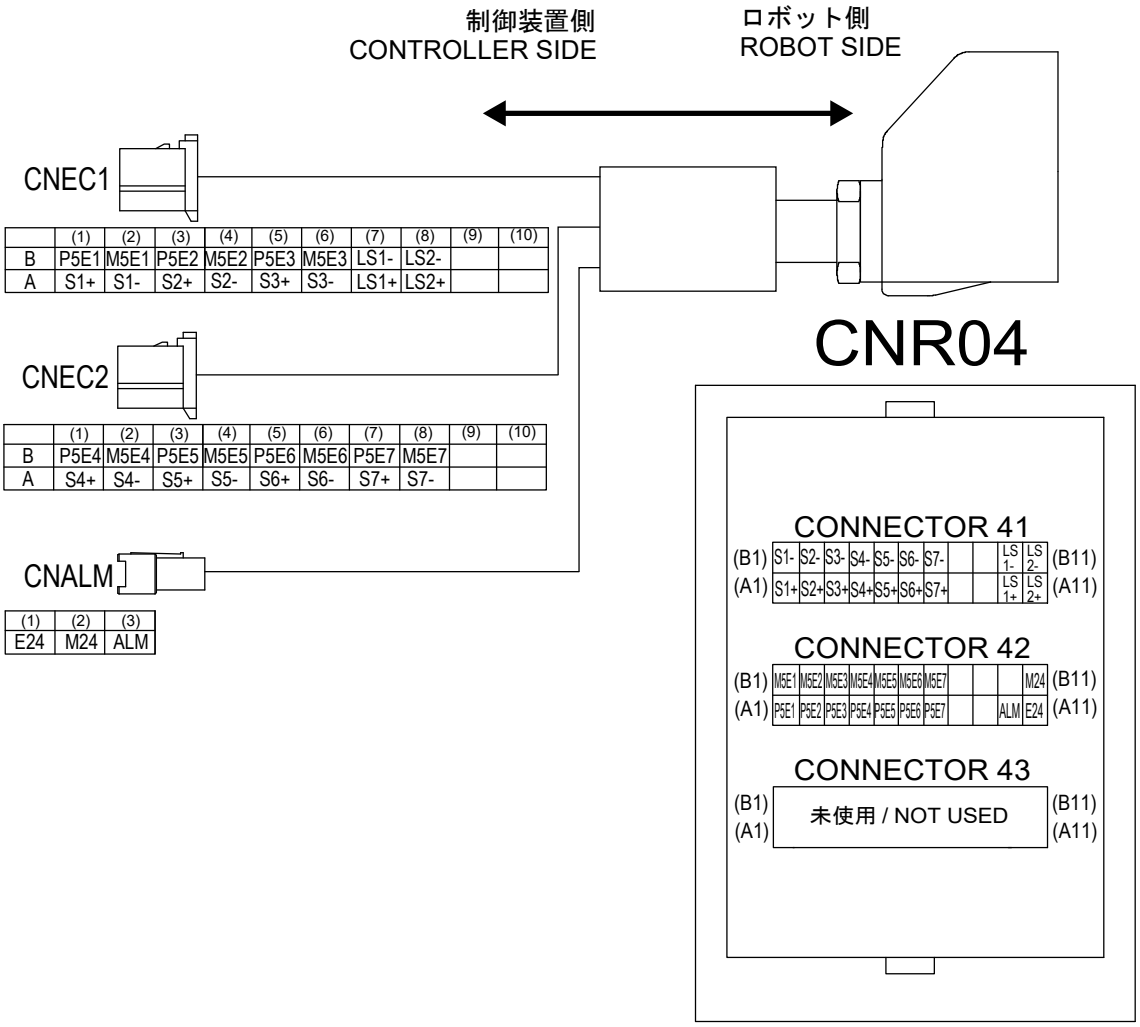
Application wiring connection diagram(*option)



FD11 controller Wire harness connection (1)

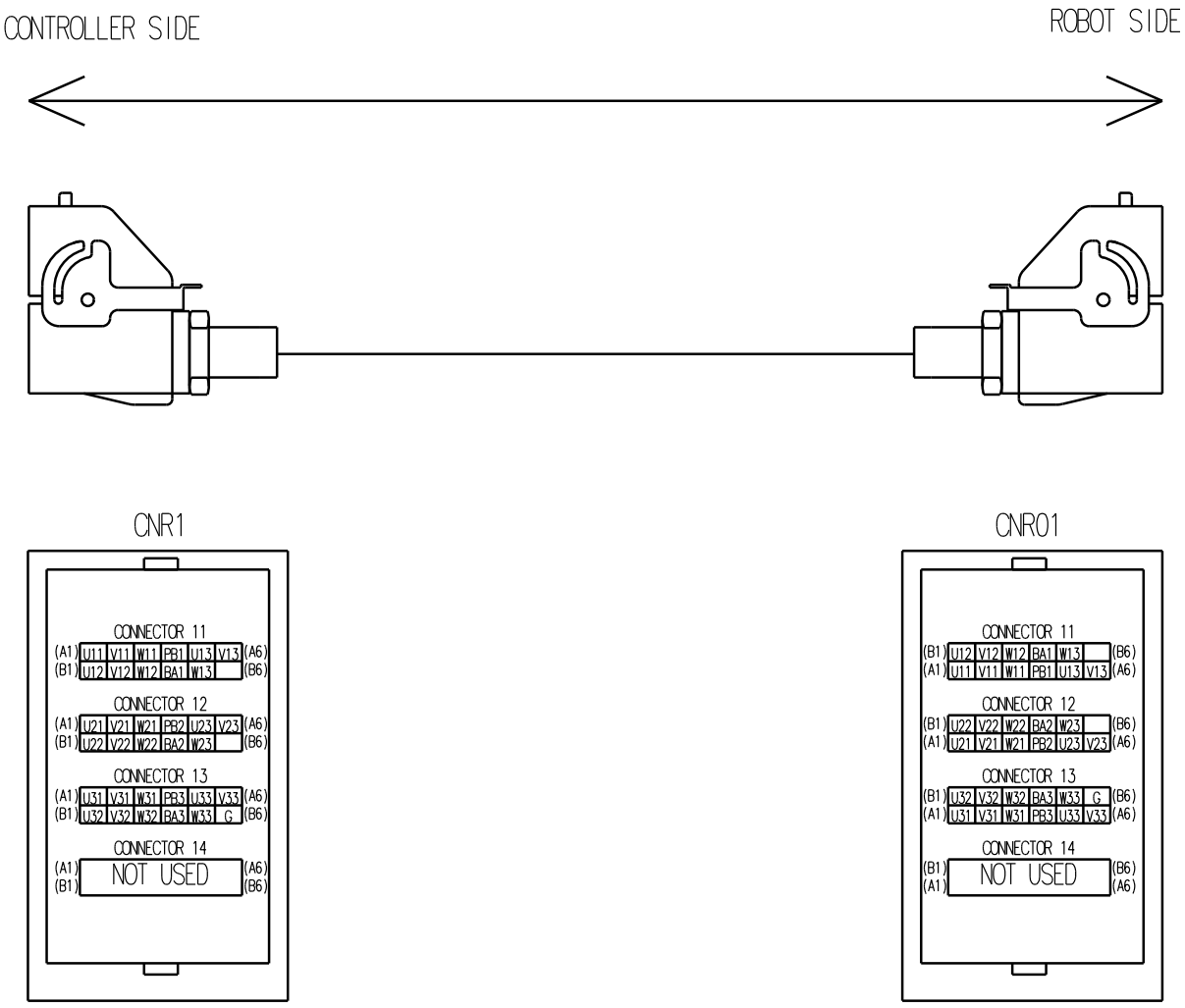


FD11 controller Wire harness connection (2)

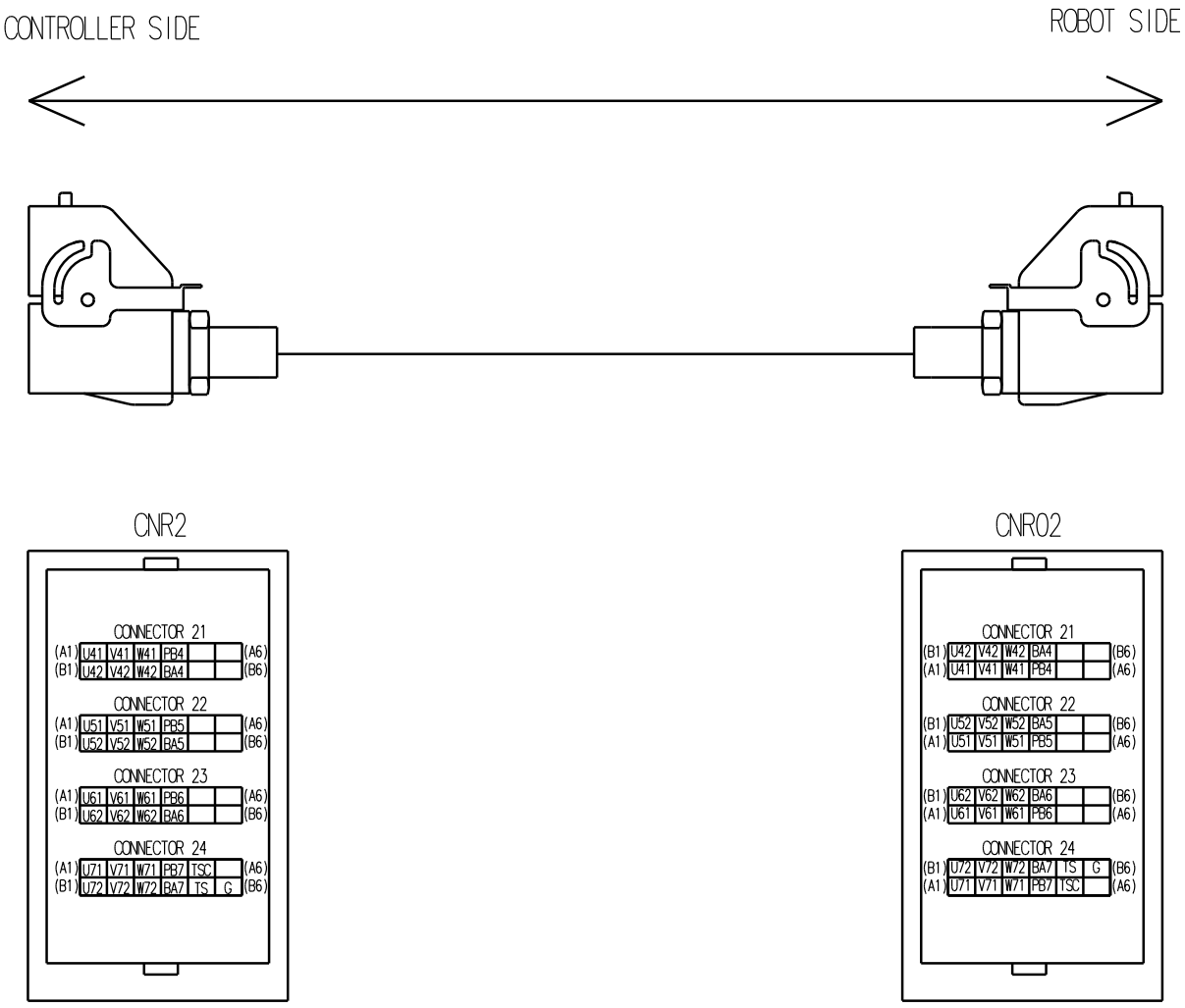


FD11 controller Wire harness connection (3)

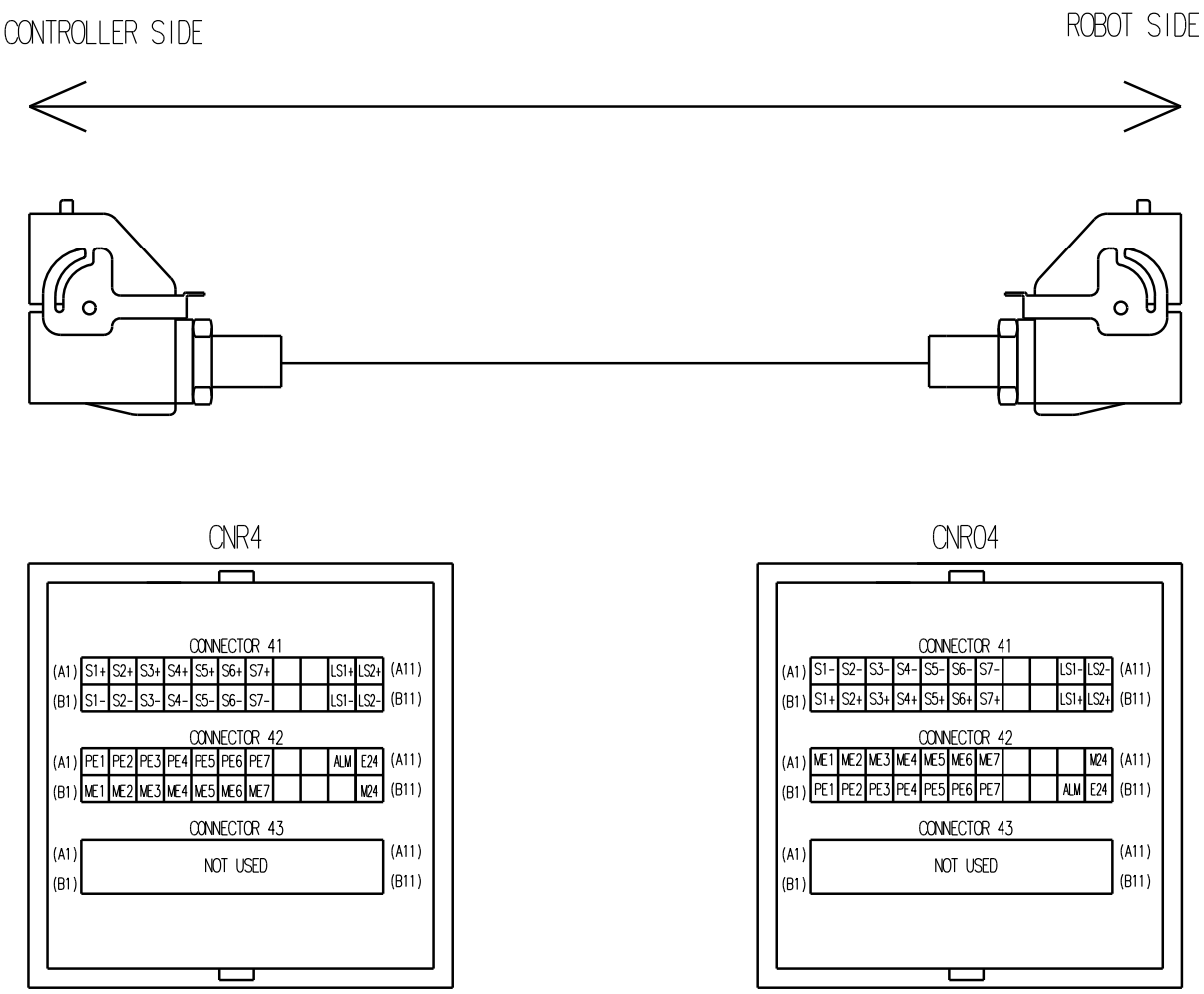
Connector “CNALM” is not used for this robot.



FD11/FD18/FD20 controller Wire harness connection (1)



FD11/FD18/FD20 controller Wire harness connection (2)



FD11/FD18/FD20 controller Wire harness connection (3)

NACHI NACHI-FUJIKOSHI CORP.	***www.nachi-fujikoshi.co.jp***	
NACHI-FUJIKOSHI (CHINA) CO., LTD.	***www.nachi.com.cn***	
NACHI ROBOTIC SYSTEMS, INC. (NRS)	***www.nachirobotics.com***	
NACHI EUROPE GmbH	***www.nachi.de***	

- Concerning the Contact list, please refer to ***"Contact list (TFDJP-254)"***.
-
- In case that an end user uses this product for military purpose or production of weapon, this product may be liable for the subject of export restriction stipulated in the Foreign Exchange and Foreign Trade Control Law. Please go through careful investigation and necessary formalities for export.
- This is an original instruction.