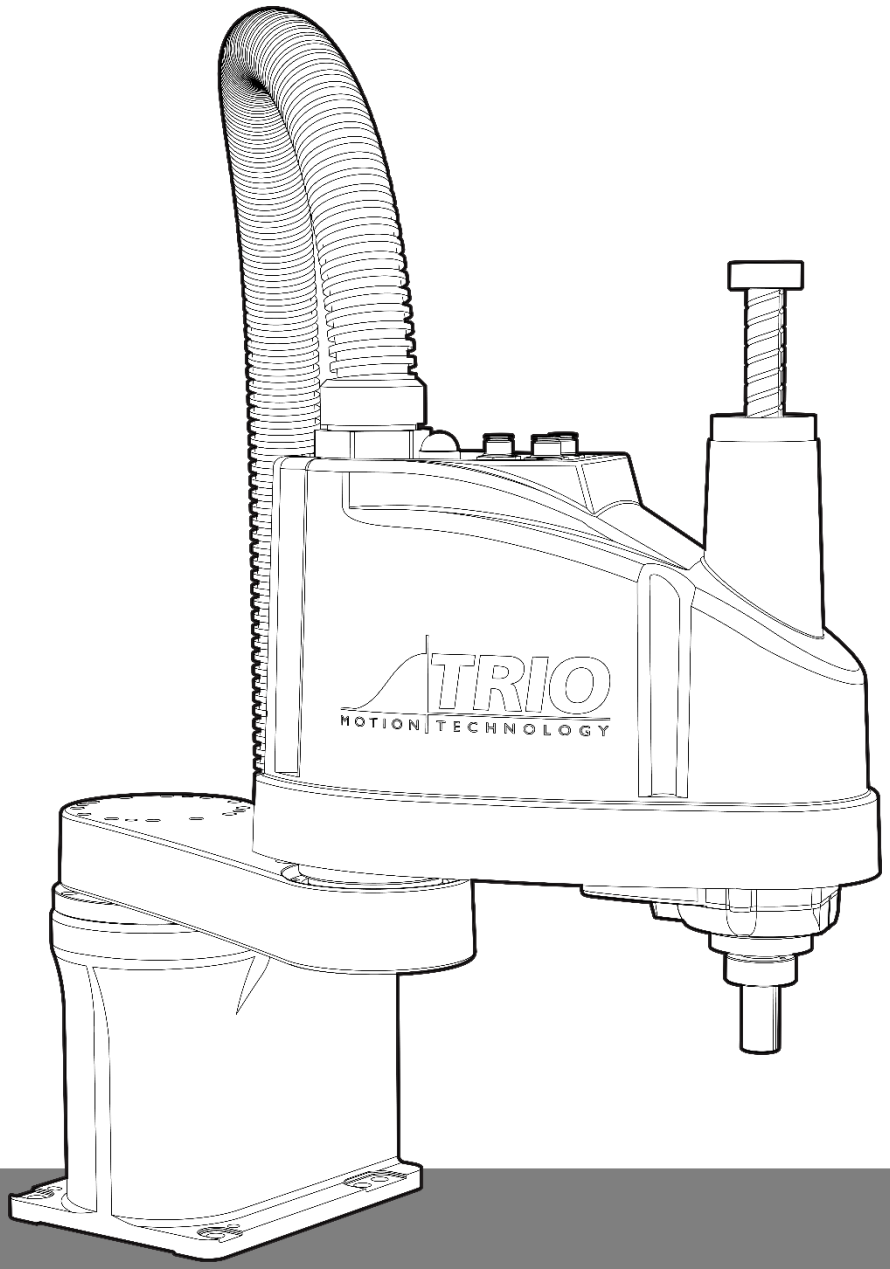
TRIO
MOTION TECHNOLOGY
A MEMBER OF THE ESTUN GROUP



RX

SCARA ROBOT

MECHANICAL UNIT OPERATOR'S MANUAL

Thank you for purchasing TRIO robots.

Before using the robot, be sure to read the SAFETY PRECAUTION and understand the content.

TRIO endeavours to improve the products. All specifications and designs are subject to change without notice.

In this manual, all specifications and information are checked on a regular basis. Nevertheless, discrepancies cannot be precluded, for which reason we are not able to guarantee total conformity. TRIO assumes no responsibility for any direct or indirect losses arising from use of this manual and products described herein.

Always keep this manual handy for easy access.

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Safety

Installation and transportation of robots and robotic equipment shall be performed by qualified personnel and should conform to all national and local standards. Please read this manual and other related manuals before installing the robot system or before connecting cables. Always keep this manual handy for easy access.

Conventions

Important safety considerations are indicated throughout the manual by the following symbols. Be sure to read the descriptions shown with each symbol.

Symbol	Description
 DANGER	Indicates a hazard with a high level of risk that, if not avoided, may result in death or serious injury.
 WARNING	Indicates a hazard with a medium or low level of risk which, if not avoided, could result in minor or moderate injury.
 CAUTION	Indicates a potentially hazardous situation that, if not avoided, could cause equipment damage, loss of data, performance degradation, or unexpected results.
 IMPORTANT	Indicates precautions or restrictions that must be observed. Also indicates alarm displays and other precautions that will not result in machine damage.
 NOTE	Provides additional information to emphasize or supplement important points of the main text.

Design and Installation Safety

Only trained personnel should design and install the robot system. Trained personnel are defined as those who have taken robot system training and maintenance training classes held by the manufacturer, dealer, or local representative company, or those who understand the manuals thoroughly and have the same knowledge and skill level as those who have completed the training courses.

To ensure safety, a safeguard must be installed for the robot system.

Personnel who design and/or construct the robot system with this product must read the Safety chapter to understand the safety requirements before designing and/or constructing the robot system. Designing and/or constructing the robot system without understanding the safety requirements is extremely hazardous, may result in serious bodily injury and/or severe equipment damage to the robot system, and may cause serious safety problems.

The Robot and the Controller must be used within the environmental conditions described in their respective manuals. This product has been designed and manufactured strictly for use in a normal indoor environment. Using the product in an environment that exceeds the specified environmental conditions may not only shorten the life cycle of the product but may also cause serious safety problems.

The robot system must be used within the installation requirements described in the manuals. Using the robot system outside of the installation requirements may not only shorten the life cycle of the product but also cause serious safety problems.

Operation Safety

(1) Please carefully read the safety-related requirements in the Safety chapter before operating the robot system. Operating the robot system without understanding the safety requirements is extremely hazardous and may result in serious bodily injury and/or severe equipment damage to the robot system.

(2) Do not enter the operating area of the Robot while the power to the robot system is turned ON. Entering the operating area with the power ON is extremely hazardous and may cause serious safety problems as the Robot may move even if it seems to be stopped.

(3) Before operating the robot system, make sure that no one is inside the safeguarded area. The robot system can be operated in the mode for teaching even when someone is inside the safeguarded area. The motion of the Robot is always in restricted (low speeds and low power) status to secure the safety of an operator. However, operating the robot system while someone is inside the safeguarded area is extremely hazardous and may result in serious safety problems in case that the Robot moves unexpectedly.

(4) Immediately press Emergency Stop switch (if available) whenever the Robot moves abnormally while the robot system is operated. Continuing the operation while the Robot moves abnormally is extremely hazardous and may result in serious bodily injury and/or severe equipment damage to the robot system.

(5) To shut off power to the robot system, pull out the power plug from the power source. Be sure to connect the AC power cable to a power receptacle. DO NOT connect it directly to a factory power source.

(6) Before performing any replacement procedure, turn OFF the robot control system and then pull out the power plug from the power source. Performing any replacement procedure with the power ON is extremely hazardous and may result in electric shock and/or malfunction of the robot system.

(7) Do not insert or pull out the motor connectors while the power to the robot system is turned ON. Inserting or pulling out the motor connectors with the power ON is extremely hazardous and may result in serious bodily injury as the Robot may move abnormally and may result in electric shock and/or malfunction of the robot system.

(8) Whenever possible, only one person should operate the robot system. If it is necessary to operate the robot system with more than one person, ensure that all people involved communicate with each other as to what they are doing and take all necessary safety precautions.

(9) Joint #1, #2 and #4: repeatedly operating the joint in a motion angle less than 5 degrees may result in shortage bearing oil film and shorten the service life of joint. To avoid shortening the service life of joint, please move the joint over 50 degrees for about 5 to 10 times per day.

(10) Joint #3: if arm’s vertical move distance is shorter than 10mm, please move the joint over half of the maximum motion range for about 50 times per day.

(11) When the robot is operating at a low speed (about 5~20% of rated speed), continuous vibration (or sympathetic vibration) may occur as the direction of arm and end effector load. The following measures may reduce vibration caused by natural vibration frequency of arm.

- Change operating speed
- Change teaching point
- Change the load of end effector

(12) Vibration of the front end of the arm may increase when J3-axis upper side or lower side is moving, according to the weight and inertia of the grippers. This is due to an increased distance between the end and head of the shaft, which leads to a change in inertia. Adjust speed etc. according to item 11 when this vibration causes a negative effect on robot operation.

(13) Do not touch Joint #3 and Joint #4 directly by hand during greasing and teaching. Touching Joint #3 and Joint #4 frequently may cause rust.

(14) Please remove any tape of seal on oil paint surface with care, as this might incur damage to the paint.

(15) Please be advised that robot joints and parts may become hot after operation with high payload or speed that can cause minor skin burn. Only perform maintenance once these parts have cooled down.

Emergency Stop (if available)

There may be several Emergency Stop buttons in a robot system to stop the robot in case of emergencies. The red button, as shown in the left figure, shall be mounted on the teach pendant. Certainly, the emergency buttons can be mounted by your requirement.
Emergency stop button shall be located on the place where is easy to reach, so that the buttons can be pressed down immediately in case of emergencies.

Operators must be fully aware of the danger of electric shock from cables of servo motor, gripper, chuck, and other devices.

The Emergency Stop switch should be used to stop the Robot only in case of emergencies. Avoid pressing the Emergency Stop switch unnecessarily while the Robot is running normally.

Emergency Movement without Drive Power

When the system is placed in emergency mode, push the arm or joint of the Robot by hand as shown below:

Joint #1 Push the arm by hand.

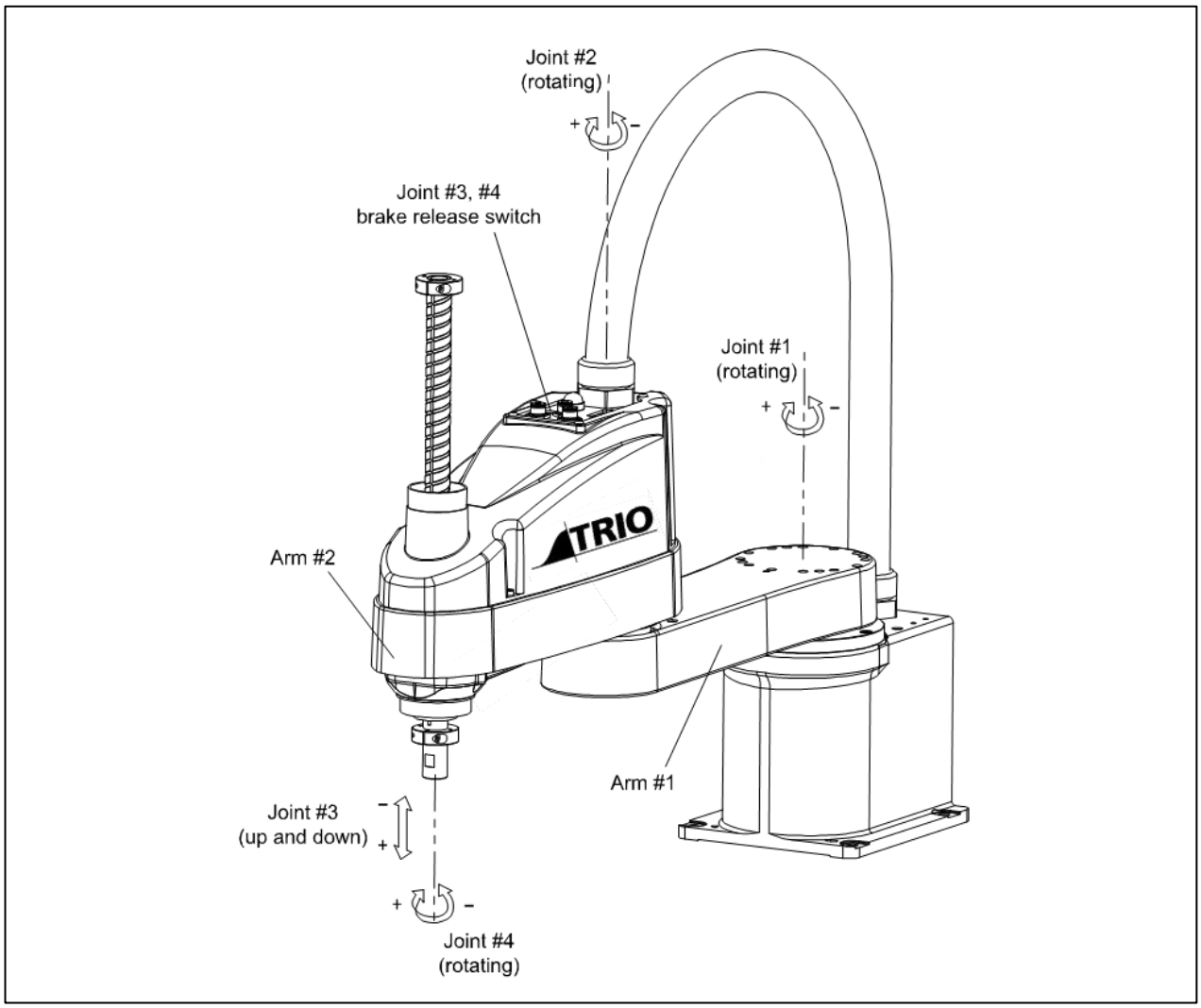
Joint #2 Push the arm by hand.

Joint #3 The joint cannot be moved up/down by hand until the solenoid brake applied to the joint has been released. Move the joint up/down while pressing the brake release switch.

Joint #4 RX3: move the shaft by hand.

RX6: The shaft cannot be rotated by hand until the solenoid brake applied to the shaft has been released. Move the shaft while pressing the brake release switch.

The brake release switch affects both Joints #3 and #4. When the brake release switch is pressed in emergency mode, the brake for both Joints #3 and #4 are released simultaneously. Be careful of the shaft falling and rotating while the brake release switch is pressed because the shaft may be lowered by the weight of an end effector.



Robot Labels

（1）Electric Shock Warning

Fig A Electric shock warning

This label indicates hazardous voltage or electric shock. Do not touch any electronic parts inside.

（2）Personal Injury Warning

Fig B Personal injury warning

Never enter the operation area while the Robot is moving. This is extremely hazardous and may result in serious safety problems.

（3）Hand Pinch Warning

Fig C Hand pinch warning

Never touch the robot when it is moving. This is extremely hazardous and may injury your hand.

（4）Manual Reading Warning

Fig D Manual reading warning

Be sure to read and understand the content of the manual and the labels before installation and operation. Read the content again when operate the robot the next time. Information not included in this manual is not allowed.

Preface

This manual describes the following robots.

Robot Type		Load Capacity
RX3	RX3-400-SR	3kg
RX6	RX6-500-SR	6kg
	RX6-600-SR	
	RX6-700-SR	

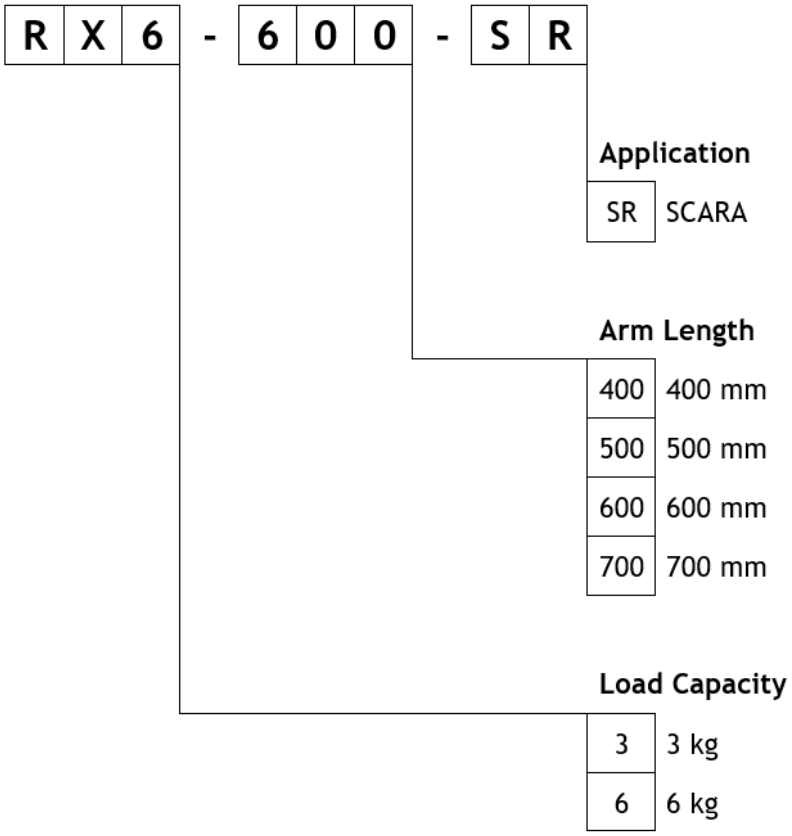
Related manuals

Trio SCARA Assembly and Wiring Manual

Contents

1. Specifications

1.1. Model Number



1.2. Part Names and Outer Dimensions

WARNING

Be careful of the shaft while the brake release switch is being pressed because the shaft may be lowered by the weight of the end effector.

While the LED lamp is on, the current is being applied to the robot. Performing any work with the power ON is extremely hazardous and it may result in electric shock and/or improper function of the robot system.

CAUTION

The brake release switch affects both Joints #3 and #4. When the brake release switch is pressed in emergency mode, the brakes for both Joint #3 and Joint #4 are released simultaneously.

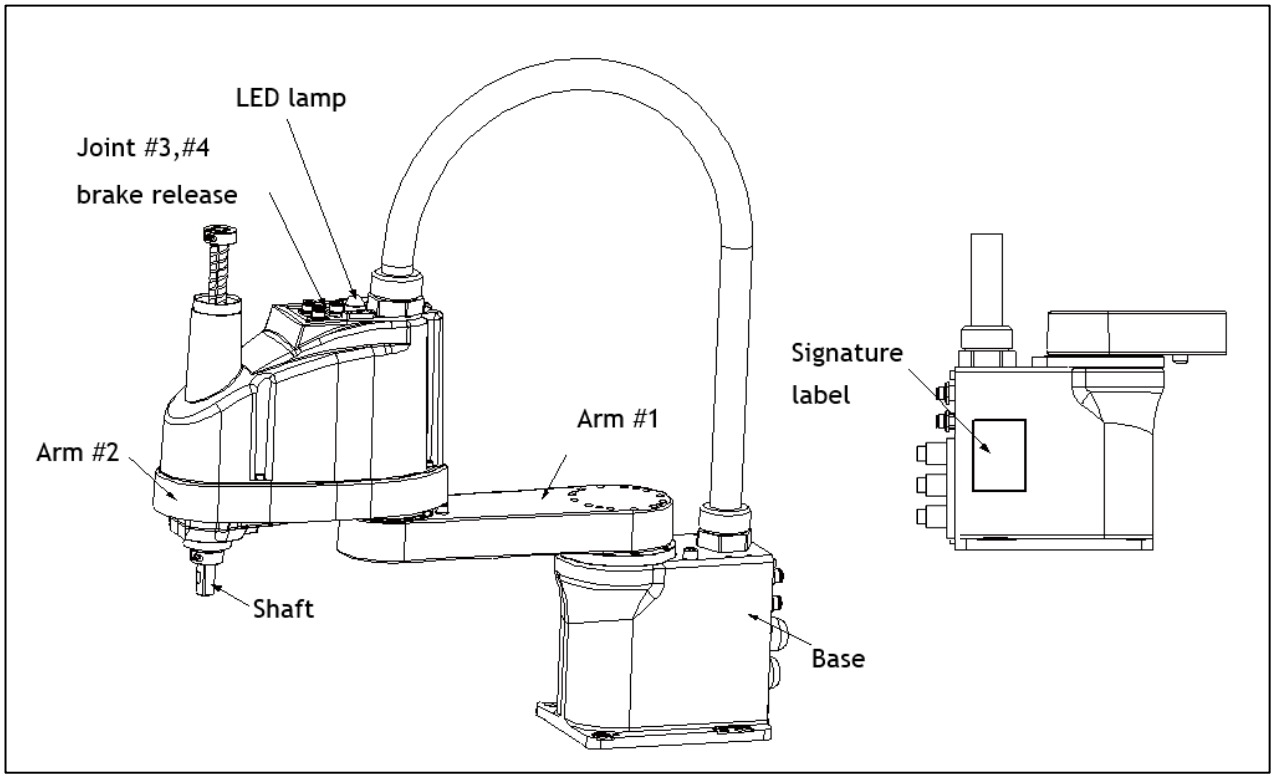


Fig 1.1 Part name (RX3)

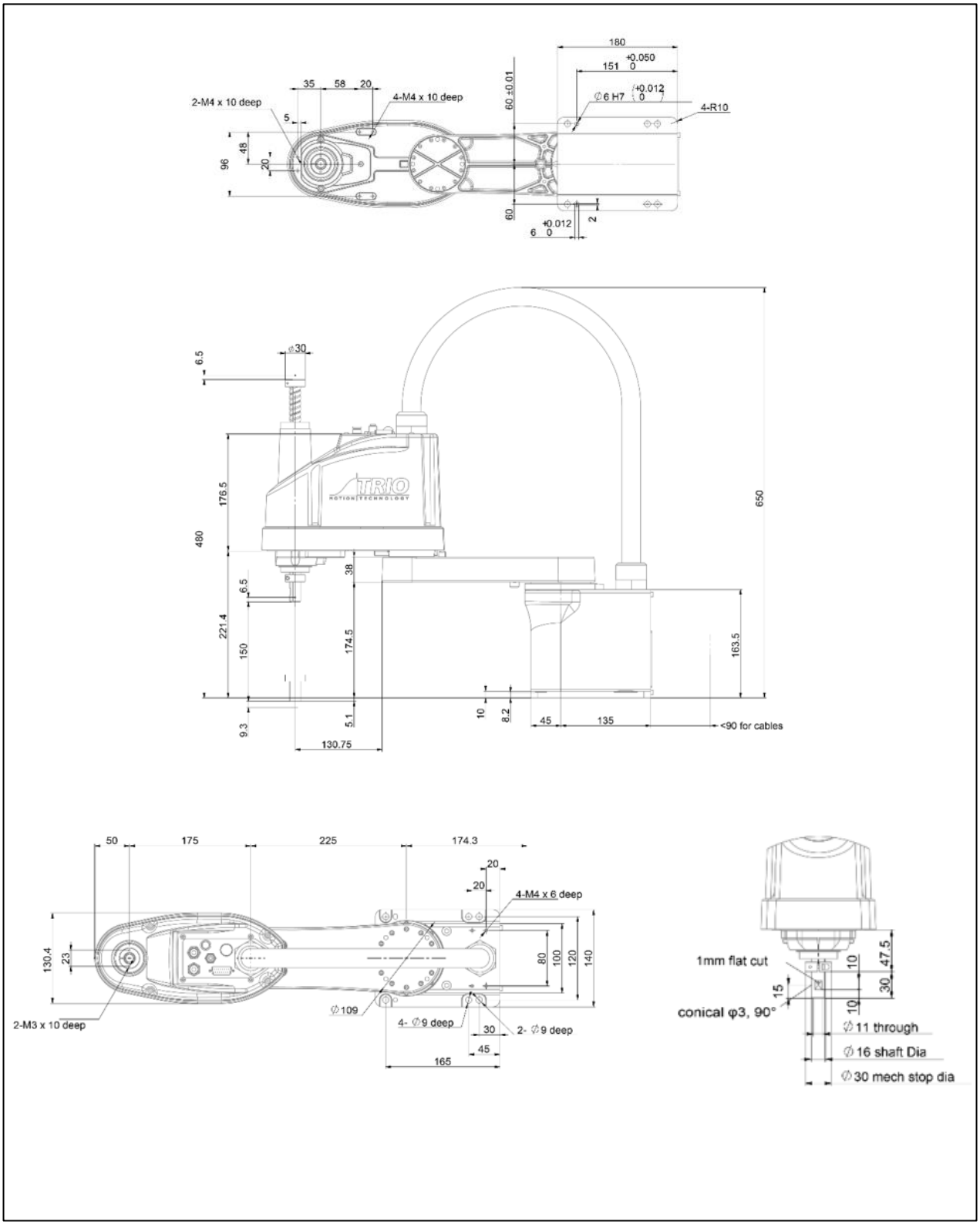


Fig 1.2 Dimension of RX3 robot

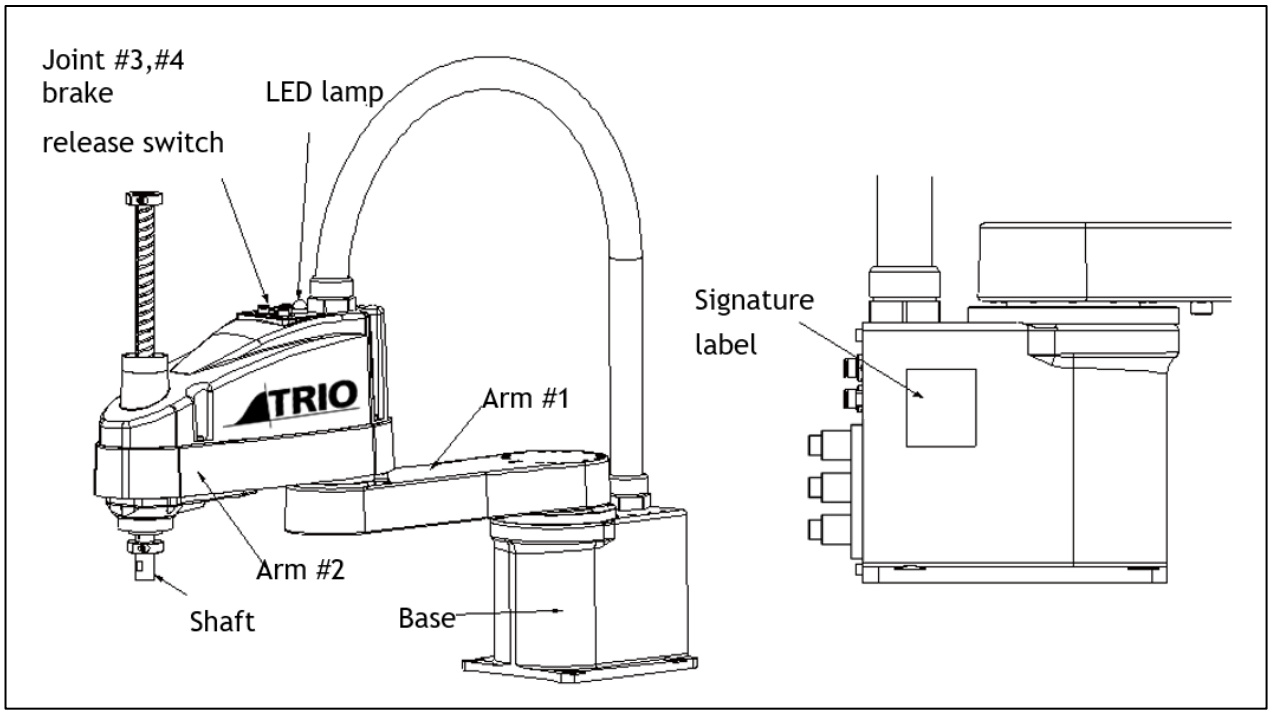
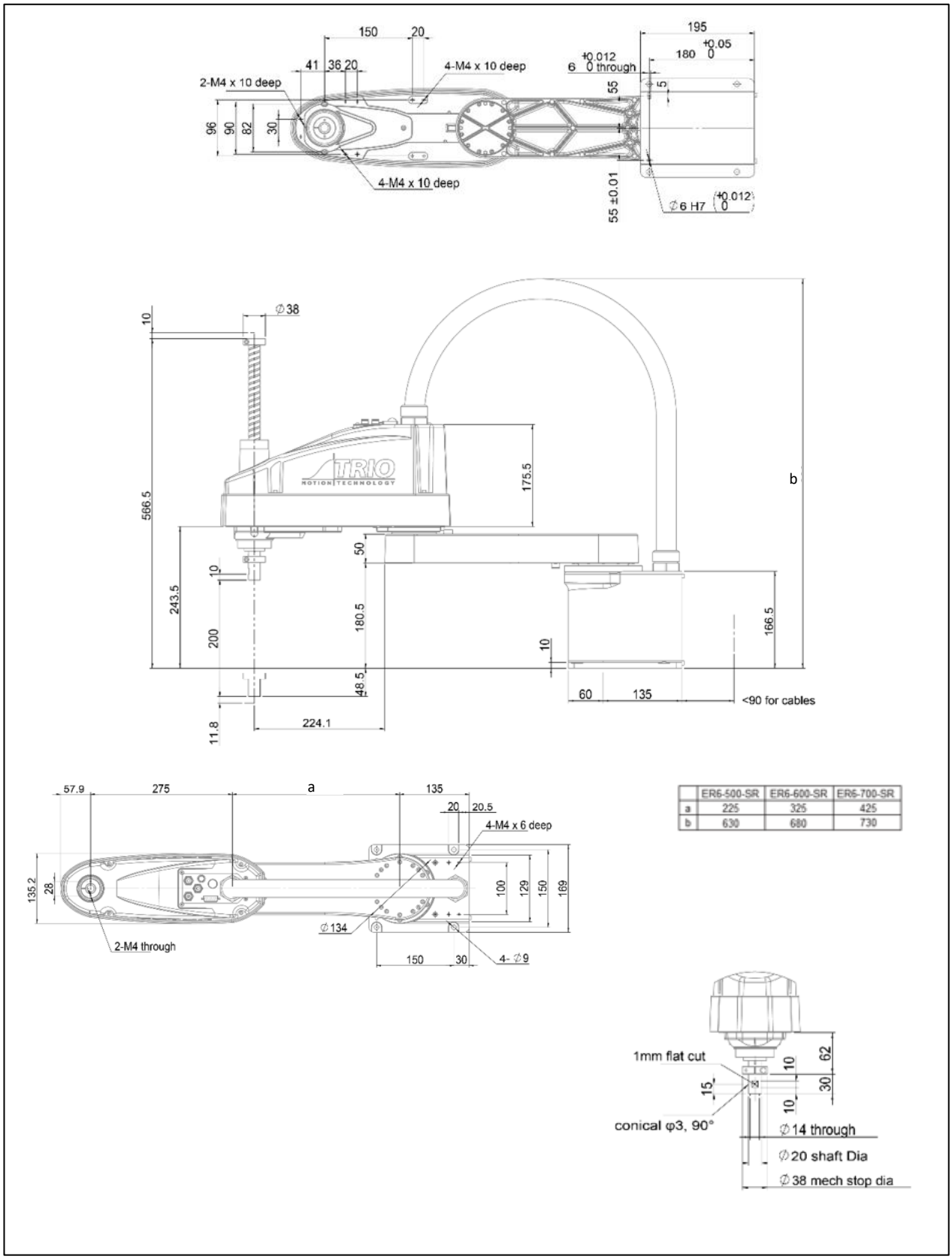


Fig 1.3 Part name (RX6)



	ER6-500-SR	ER6-600-SR	ER6-700-SR
a	225	325	425
b	630	680	730

Fig 1.4 Dimension of RX6 (STANDARD) robot

1.3. Specifications

Item		RX3-XXX-SR	RX6-XXX-SR		
		400	500	600	700
Arm length	Arm#1 & #2 (mm)	400	500	600	700
	Arm#1 (mm)	225	225	325	425
	Arm#2 (mm)	175	275		
Max. operating speed	Joint#1, #2 (mm/s)	5400	6000	6650	5900
	Joint#3 (mm/s)	960	1000		
	Joint#4 (°/s)	2250	1730		
Repeatability	Joint#1, #2 (mm)	±0.025	±0.025		
	Joint#3 (mm)	±0.015	±0.015		
	Joint#4 (°)	±0.01	±0.01		
Payload (Load)	Rated (kg)	1	2		
	Max. (kg)	3	6		
Joint #4 allowable moment of inertia	Rated（kg·m^2）	0.005	0.01		
Hand	Shaft diameter (mm)	16	20		
	Through hole (mm)	11	14		
Mounting hole		120×120	150×150		
		4-M8	4-M8		
Colour of the robot		Traffic white (No: RAL 9016)			
Weight (3m cables included) (kg)		15	18	18	19
Max. power consumption (kW) (at max. load & max. speed)		0.214	0.244	0.248	0.246

Power consumption (kW) (Servo ON at zero position)		0.09	0.12	0.12	0.12
Power consumption (kW) (Servo OFF at zero position)		0.07	0.07	0.09	0.09
Driving method	All joints	AC servo motor			
Motor energy consumption	Joint #1 (W)	200	400		
	Joint #2 (W)	100	200		
	Joint #3 (W)	100	100		
	Joint #4 (W)	100	100		
Joint #3 down force (N)		100	100		
Installed wire for customer use		15 pins: D-sub			
Installed pneumatic tube for customer use		2 pneumatic tubes (ø6 mm): 0.59 Mpa (6 kgf/cm^2: 86 psi)			
		1 pneumatic tube (ø4 mm): 0.59 Mpa (6 kgf/cm^2: 86 psi)			
Environmental requirements	Ambient Temp.	5 to 40 degrees C (with minimum temperature variation)			
	Ambient relative humidity	10 to 80% (no condensation)			
Noise level (*1)		$L_{Aeq=}$70dB（A）			
Applicable Controller		TRIO EtherCat controllers. See TRIO website for details.			

Tab 1.1 Specifications for SCARA robots

(*1) Conditions of Robot during measurement as follows:

Operating conditions: Under rated load, 4-joints simultaneous motion, maximum speed, maximum acceleration, and duty 50%.

Measurement point: In front of the Robot, 1000 mm apart from the motion range, 50 mm above the base-installed surface.

Item	Max. motion range			
	Joint#1 (°)	Joint#2 (°)	Joint#3 (mm)	Joint#4 (°)
RX3-400-SR	±132	±141	150	±360
RX6 series	±132	±150	200	±360

2. Environment and installation

2.1. Environmental Conditions

A suitable environment is necessary for the robot system to function properly and safely. Be sure to install the robot system in an environment that meets the following conditions:

Item	Conditions
Ambient temperature*	5 to 40°C (with minimum temperature variation)
Ambient relative humidity	10 to 80% (no condensation)
First transient burst noise	2 kV or less
Electrostatic noise	6 kV or less
Environment	·Install indoors. ·Keep away from direct sunlight. ·Keep away from dust, oily smoke, salinity, metal powder or other contaminants. ·Keep away from flammable or corrosive solvents and gases. ·Keep away from water. ·Keep away from shocks or vibrations. ·Keep away from sources of electric noise.

*The ambient temperature conditions are for the Robots only.

Robots are not suitable for operation in harsh environments such as painting areas, etc.

2.1.1. Special Environmental Conditions

The robot surface is generally oil resistant. Please consult your distributor if you are concerned about a certain type of oil in your application’s environment.

Rapid change in temperature and humidity might cause condensation inside the Robot.

For food handling, please consult your distributor if you feel any concern regarding the robot being suitable to handle the material.

Corrosive environments, where acid or alkaline is used, is not suitable for the robot. Robot parts are susceptible to rust in a salty environment.

Do not use alcohol or benzene for cleaning the robot. It may damage the robot’s paint.

2.2. Base Table

A base table for anchoring the Robot is not supplied. Please make or obtain the base table for your Robot. The shape and size of the base table differs depending on the use of the robot system. For your reference, we list some Robot table requirements here.

The torque and reaction force produced by the movement of the Robot are as follows:

Type	RX3	RX6
Max. Reaction torque on the horizontal plate	250 N·m	322 N·m
Max. Horizontal reaction force	1000 N	1600 N
Max. Vertical reaction force	900 N	1300 N

The threaded holes required for mounting the Robot base is M8 (RX3 and RX6). Use mounting bolts with specifications conforming to ISO898-1 property class: 10.9 or 12.9.

The plate for the Robot mounting face should be 20 mm thick or more and made of steel to reduce vibration. The surface roughness of the steel plate should be 25 μm or less.

The table must be secured on the floor or wall to prevent it from moving.

The Robot must be installed horizontally.

When using a leveller to adjust the height of the base table, use a screw with M16 diameter or more.

To ensure safety, a safeguard must be installed for the robot system.

Cable break may occur when the robot is operating on the rail or lifting platform, due to factory-set configuration with a fixed installation standard for cables between devices. If cable break occurs, contact TRIO for custom solutions for flexible cable with drag chain.

2.3. Mounting Dimension

The maximum space described in section 1.2 shows that the radius of the end effector is 60 mm or less. If the radius of the end effector exceeds 60 mm, define the radius as the distance to the outer edge of maximum space.

If a camera or solenoid valve extends outside of the arm, set the maximum range including the space that they may reach.

Be sure to allow for the following extra spaces in addition to the space required for mounting the Robot, Controller, and peripheral equipment.

- Space for teaching
- Space for maintenance and inspection (Ensure a space open covers and plates for maintenance)
- Space for cables

The minimum bend radius of the power cable is 90 mm. When installing the cable, be sure to maintain sufficient distance from obstacles. In addition, leave enough space for other cables so that they are not bent forcibly.

Ensure distance to the safeguard from the maximum motion range is more than 100 mm.

The maximum space described in figures shows that the motion range of the robot. Take the motion range as reference when you want to find a proper position for mounting robot. Avoid interference with robot and its motion range when mounting peripheral equipment.

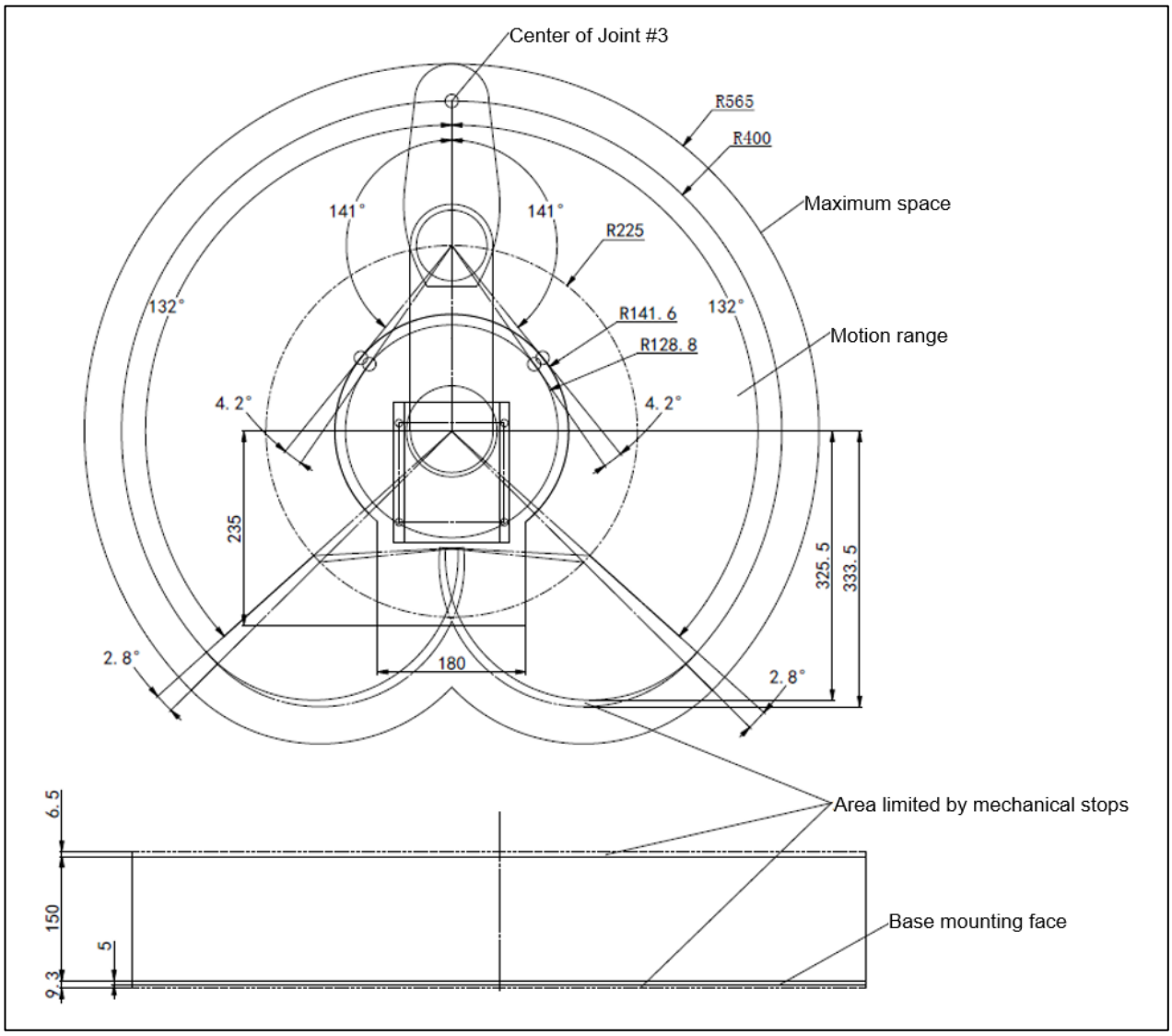


Fig 2.2 Motion range (RX3-400-SR)

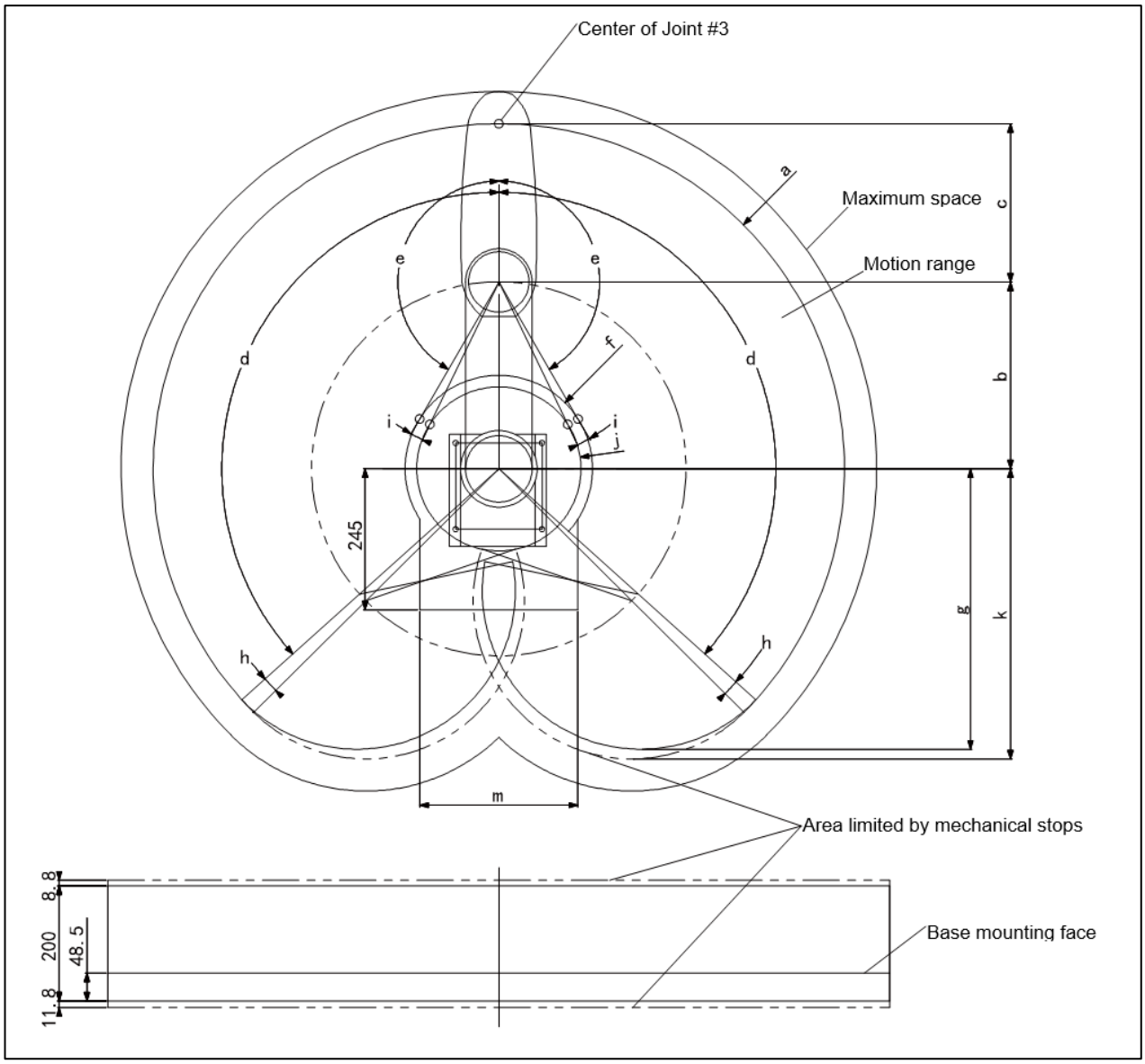


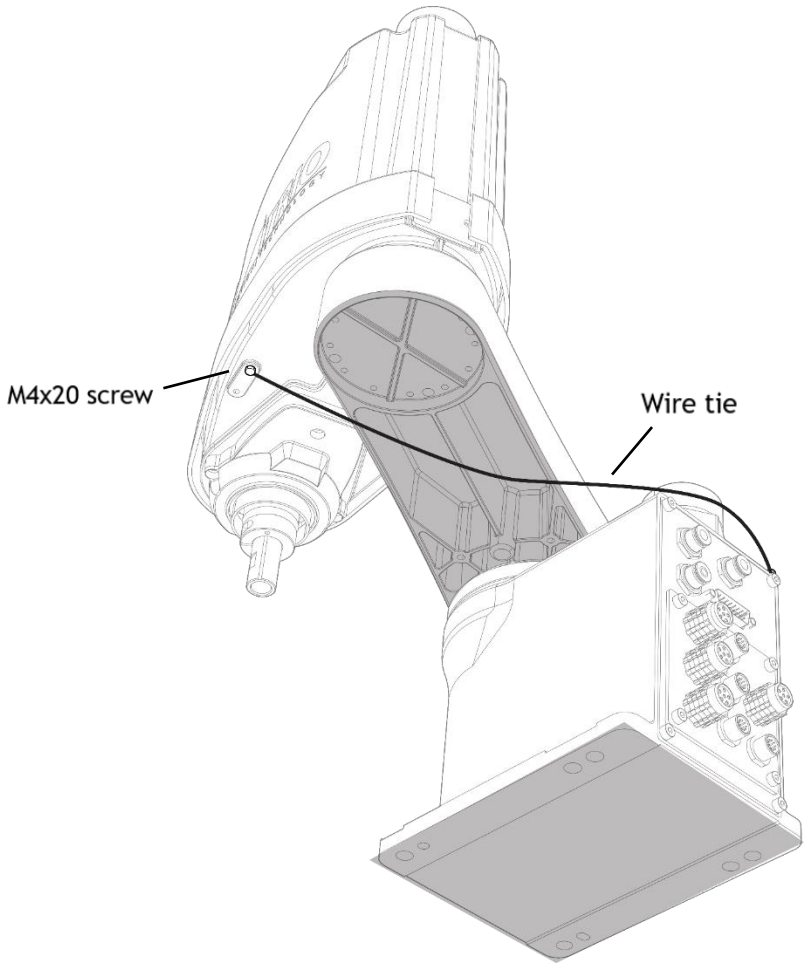
Fig 2.3 Motion range (RX6 Standard model)

Item	RX3-XXX-SR	RX6-XXX-SR		
	400	500	600	700
Length of Arm #1& Arm #2 (mm)	400	500	600	700
Length of Arm #1 (mm)		225	325	425
Length of Arm #2 (mm)		275	275	275
Motion range of Joint #1 (°)		±132	±132	±132
Motion range of Joint #2 (°)		±150	±150	±150
Motion range (mm)		138.1	162.6	232
Motion range of backside (mm)		425.6	492.5	559.4
Mechanical stop position angle of Joint #1 (°)		2.8	2.8	2.8
Mechanical stop position angle of Joint #2 (°)		4.2	4.2	4.2
Mechanical stop position range (mm)		121.8	142.5	214
Mechanical stop position range of backside (mm)		433.5	504	574.5
Motion range (mm)		240	220	220
Maximum space (mm)		560	660	760

2.4. Unpacking and Transportation

Only authorized personnel should perform sling work and operate a crane and a forklift. When these operations are performed by unauthorized personnel, it is extremely hazardous and may result in serious bodily injury and/or severe equipment damage to the robot system.

Using a cart or similar equipment, transport the Robot in the same manner as it was delivered.



After removing the bolts securing the Robot to the delivery equipment, the Robot can fall. Be careful not to get hands or fingers caught.

The arm is secured with a wire tie. Leave the wire tie secured until you finish the installation so as not to get hands or fingers caught. To carry the Robot, have two or more people to work on it and secure the Robot to the delivery equipment or hold the bottom of Arm #1 and bottom of the base (as shown in the figure) by hand.

Stabilize the Robot with your hands when hoisting it.

Fig 2.4 Transport the robot (RX3 & RX6)

When transporting the Robot for a long distance, secure it to the delivery equipment directly so that the Robot never falls.

If necessary, pack the Robot in the same style as it was delivered.

The Robot weights are as follows.

Parts	Weight (kg)	
Robot	RX3-400-SR	15
	RX6-500-SR	18
	RX6-600-SR	18
	RX6-700-SR	19
Cabinet	n/a	

NOTE

Some lightweight parts are not listed on the above table.

2.5. Installation Procedure

CAUTION

The robot system must be installed to avoid interference with buildings, structures, utilities, other machines, and equipment that may create a trapping hazard or pinch points.

Vibration (or sympathetic vibration) may occur during operation as the rigidity of worktable. If it does, please improve the rigidity of the worktable, or change the settings of speed, acceleration, and deceleration.

Install the Tabletop Mounting Robot with two or more people. Be careful not to get hands, fingers, or feet caught and/or have equipment damaged by a fall of the Robot.

(1) Secure the base to the base table with four bolts.

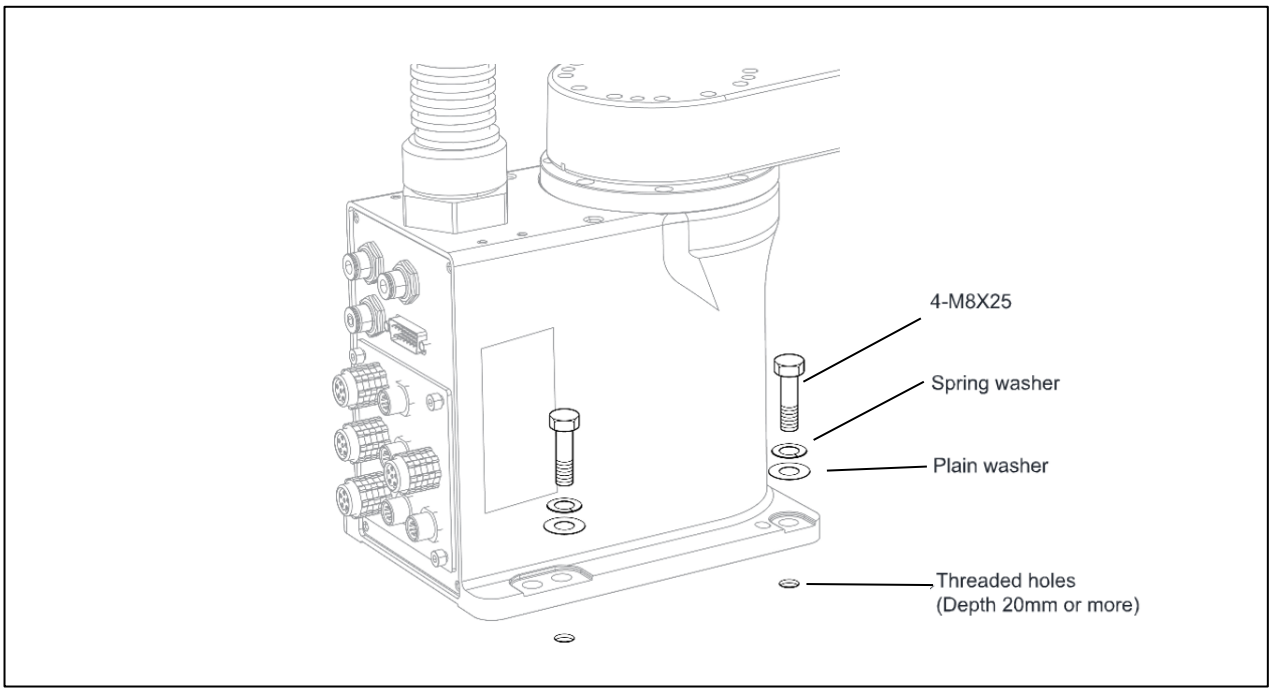


Fig 2.5 Secure the base table (RX3 & RX6)

CAUTION

Use bolts with specifications conforming to ISO898-1 Property Class: 10.9 or 12.9. The tightening torque is 32.0 N·m (326kgf·cm).

Use bolts with specifications conforming to ISO898-1 Property Class: 10.9 or 12.9. The tightening torque is 73.5 N·m (750kgf·cm).

(2) Using nippers, cut off the wire tie binding the shaft and arm retaining bracket on the base.

(3) Remove the bolts securing the wire ties removed in step (2). Remove the retaining bracket on the arm.

Make sure to remove the wire tie protecting the mechanical stops.

2.6. Connecting the Cables

WARNING

To shut off power to the robot system, pull out the power plug from the power source. Be sure to connect the AC power cable to a power receptacle. DO NOT connect it directly to a factory power source.

Before performing any replacement procedure, turn OFF the Controller and related equipment, and then pull out the power plug from the power source. Performing any replacement procedure with the power ON is extremely hazardous and may result in electric shock and/or malfunction of the robot system.

Be sure to connect the cables properly. Do not allow unnecessary strain on the cables. (Do not put heavy objects on the cables. Do not bend or pull the cables forcibly.) The unnecessary strain on the cables may result in damage to the cables, disconnection, and/or contact failure. Damaged cables, disconnection, or contact failure is extremely hazardous and may result in electric shock and/or improper function of the robot system.

Grounding the robot is done by connecting with the controller. Ensure that the controller is grounded and the cables are correctly connected. If the ground wire is improperly connected to ground, it may result in the fire or electric shock.

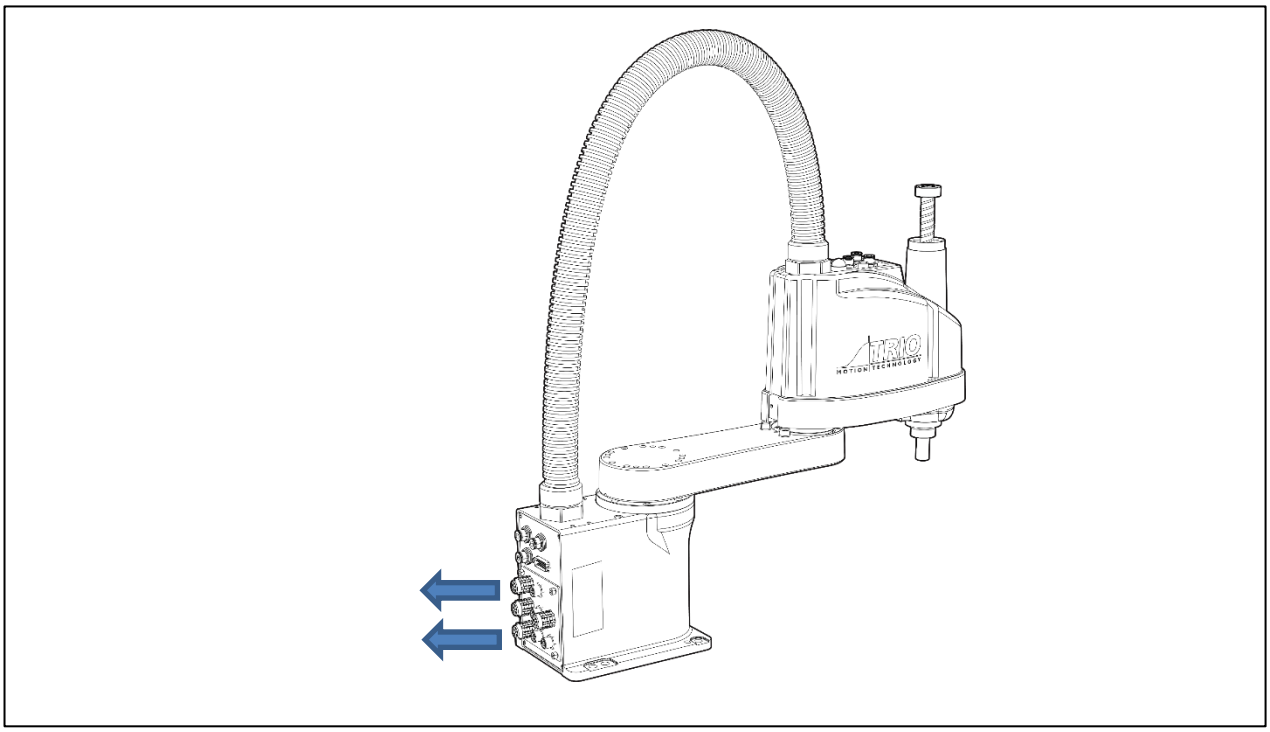


Fig 2.6 Connecting the cable

2.7. User Wires and Pneumatic Tubes

Only authorized or certified personnel should be allowed to perform wiring. Wiring by unauthorized or uncertified personnel may result in bodily injury and/or malfunction of the robot system.

User electrical wires and pneumatic tubes are contained in the cable unit.

2.7.1. Electrical Wires

Rated Voltage	Allowable Current	Wires	Nominal Sectional Area	Note
AC/DC 30V	1A	15	0.211mm^2	Twisted pair

Do not apply the current more than 1A to the robot.

Pins with the same number, indicated on the connectors on both ends of the cables, are connected. Connectors are standard accessories of the robot; you need not to prepare.

Pin	Manufacturer	Description
15-pin	HARTING	D-SUB male plug [09670155604]
		D-SUB female plug [09670154704]
		D-SUB casting [09670150344]
9-pin	HARTING	D-SUB male plug [09670095604]
		D-SUB female plug [09670094704]
		D-SUB casting [09670090344]

2.7.2. Pneumatic Tubes

Max. Usable Pneumatic Pressure	Pneumatic tubes	Outer Diameter × Inner Diameter
0.59 MPa (6 kgf/cm^2 ： 86 psi)	2	ø6 mm × ø4 mm
	1	ø4 mm × ø2.5 mm

Fittings for ø6 mm and ø4 mm (outer diameter) pneumatic tubes are supplied on both ends of the pneumatic tubes.

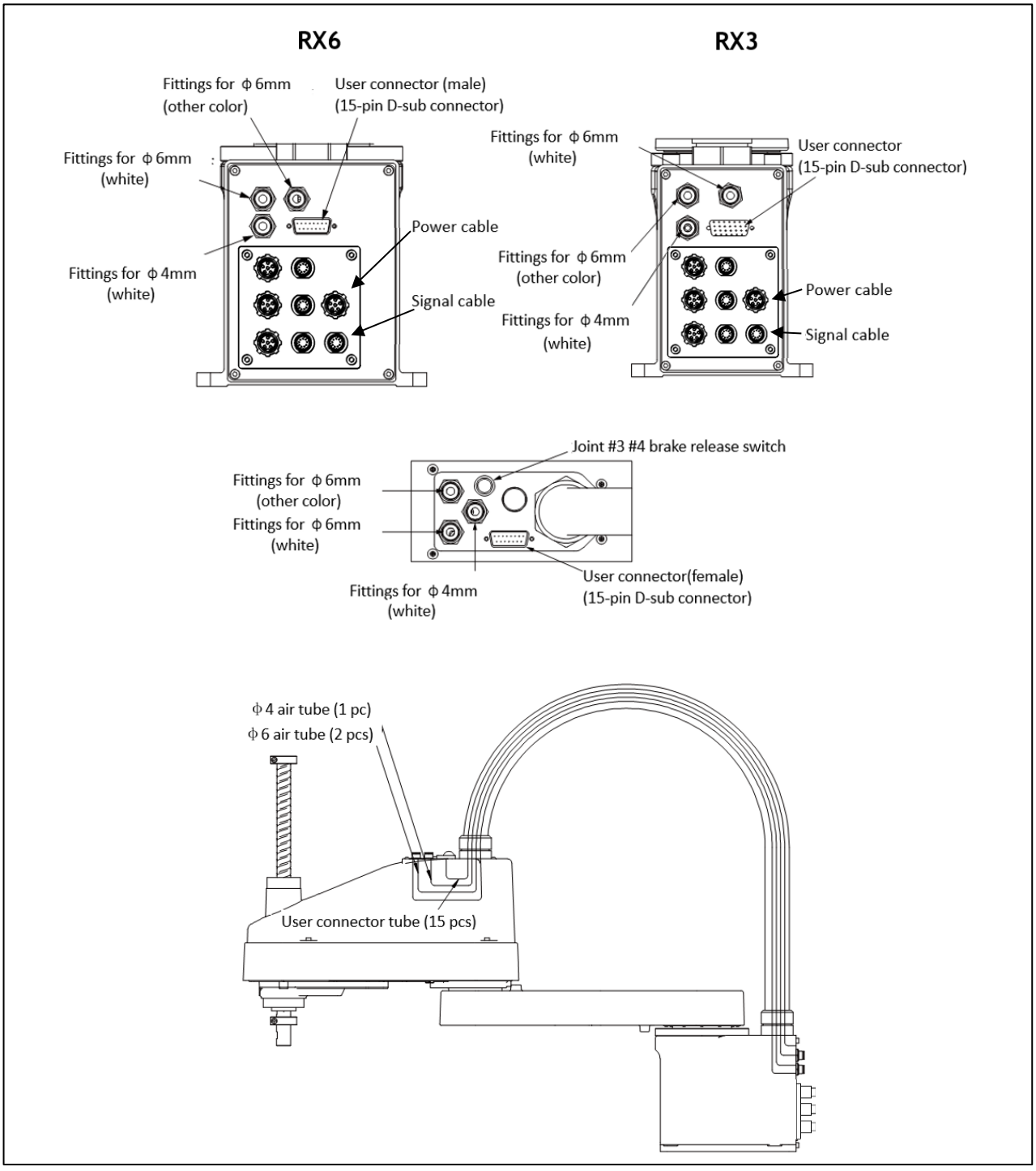


Fig 2.7 Fittings for tubes (RX3 & RX6)

2.8. Relocation and Storage

2.8.1. Precautions for Relocation and Storage

When transporting the Robot for a long distance, secure it to the delivery equipment so that the Robot cannot fall. If necessary, pack the Robot in the same way as it was delivered.

If necessary, pack the Robot in the same way as it was delivered.

When the Robot is used for a robot system again after long-term storage, perform a test run to verify that it works properly, and then operate it thoroughly.

Transport and store the Robot in the range of -25℃ to +55℃. Humidity within 10% to 90% is recommended.

When condensation occurs on the Robot during transport or storage, turn ON the power only after the condensation dries.

Do not shock or shake the Robot during transport.

Only authorized personnel should perform sling work and operate a crane and a forklift. When these operations are performed by unauthorized personnel, it is extremely hazardous and may result in serious bodily injury and/or severe equipment damage to the robot system.

Before relocating the Robot, fold the arm and secure it tightly with a wire tie to prevent hands or fingers from being caught in the Robot.

When removing the anchor bolts, support the Robot to prevent falling. Removing the anchor bolts without support may result in a fall of the Robot, and then get hands, fingers, or feet caught.

To carry the Robot, have two or more people to work on it and secure the Robot to the delivery equipment or hold the bottom of Arm #1, the bottom of the main cable fitting, and the bottom of the base by hand. When holding the bottom of the base by hand, be very careful not to get hands or fingers caught.

Stabilize the Robot with your hands when hoisting it. Unstable hoisting is extremely hazardous and may result in fall of the Robot.

2.8.2. Relocation

(1) Turn OFF the power on all devices and unplug the cables.

(2) Cover the arm with a sheet so that the arm will not be damaged. Tie the lower end of the shaft and arm, and the base and arm together with the wire tie. Be careful not to tie them too tight. Otherwise, the shaft may bend.

(3) Hold the bottom of Arm #1 by hand to unscrew the anchor bolts. Then, remove the Robot from the base table.

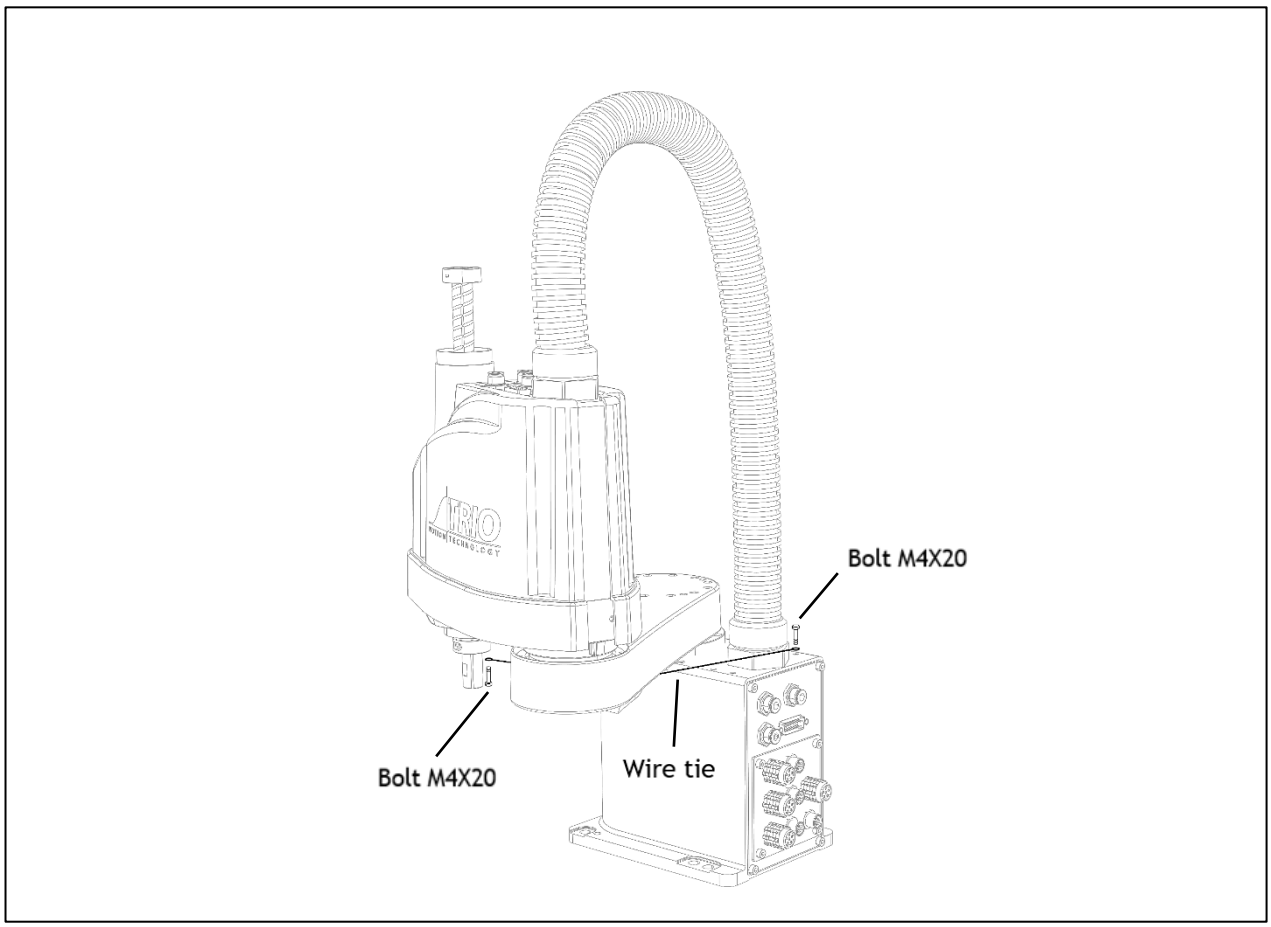


Fig 2.8 Secure the arms

CAUTION

To prevent rust during long period of transporting and/or storing, please pay attention to the maintenance of Joint #3 and Joint #4.

3. Setting Off End Effectors

3.1. Attaching an End Effector

Users are responsible for making their own end effector(s). Before attaching an end effector, observe these guidelines.

If you use an end effector equipped with a gripper or chuck, connect wires and/or pneumatic tubes properly so that the gripper does not release the work piece when the power to the robot system is turned OFF. Improper connection of the wires and/or pneumatic tubes may damage the robot system and/or work piece as the work piece is released when the Emergency Stop switch is pressed. I/O outputs are configured at the factory so that they are automatically shut off (0) by power disconnection, the Emergency Stop switch, or the safety features of the robot system.

3.1.1. Shaft

Attach an end effector to the lower end of the shaft. For the shaft dimensions, and the overall dimensions of the Robot, refer to chapter *1. Specifications*.

Use a split muff coupling with an M4 bolt or larger to attach the end effector to the shaft.

3.1.2. Brake release switch

Joint #3 cannot be moved up/down by hand because the solenoid brake is applied to the joint while power to the robot system is turned OFF. This prevents the shaft from hitting peripheral equipment in the case that the shaft is lowered by the weight of the end effector when the power is disconnected during operation, or when the motor is turned OFF even though the power is turned ON.

To move Joint #3 up/down while attaching an end effector, turn ON the Controller and press the brake release switch.

This button switch is a momentary type; the brake is released only while the button switch is being pressed.

The respective brakes for Joints #3 and #4 are released simultaneously.

Be careful of the shaft while the brake release switch is being pressed because the shaft may be lowered by the weight of the end effector.

Be careful of the shaft falling and rotating while the brake release switch is pressed because the shaft may be lowered by the weight of an end effector.

3.1.3. Layouts

When you operate the robot with an end effector, the end effector may interfere with the Robot because of the outer diameter of the end effector, the size of the work piece, or the position of the arms. When designing your system layout, pay attention to the interference area of the end effector.

3.2. Attaching Cameras and Valves

The bottom of the Arm #2 has threaded holes as shown in the figure below. Use these holes for attaching cameras, valves, and other equipment.

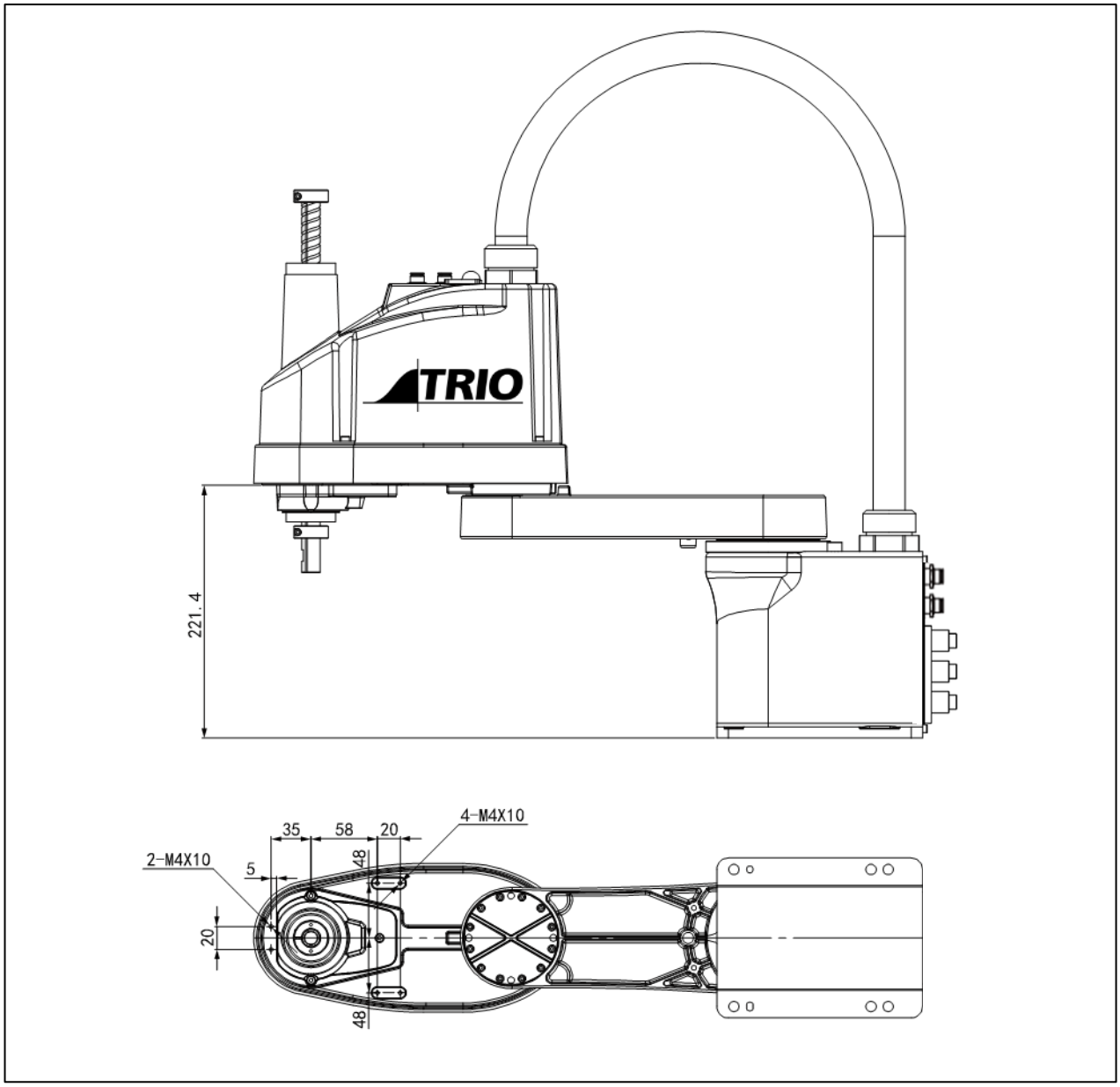


Fig 3.1 Dimensions for attaching cameras and valves (RX3)

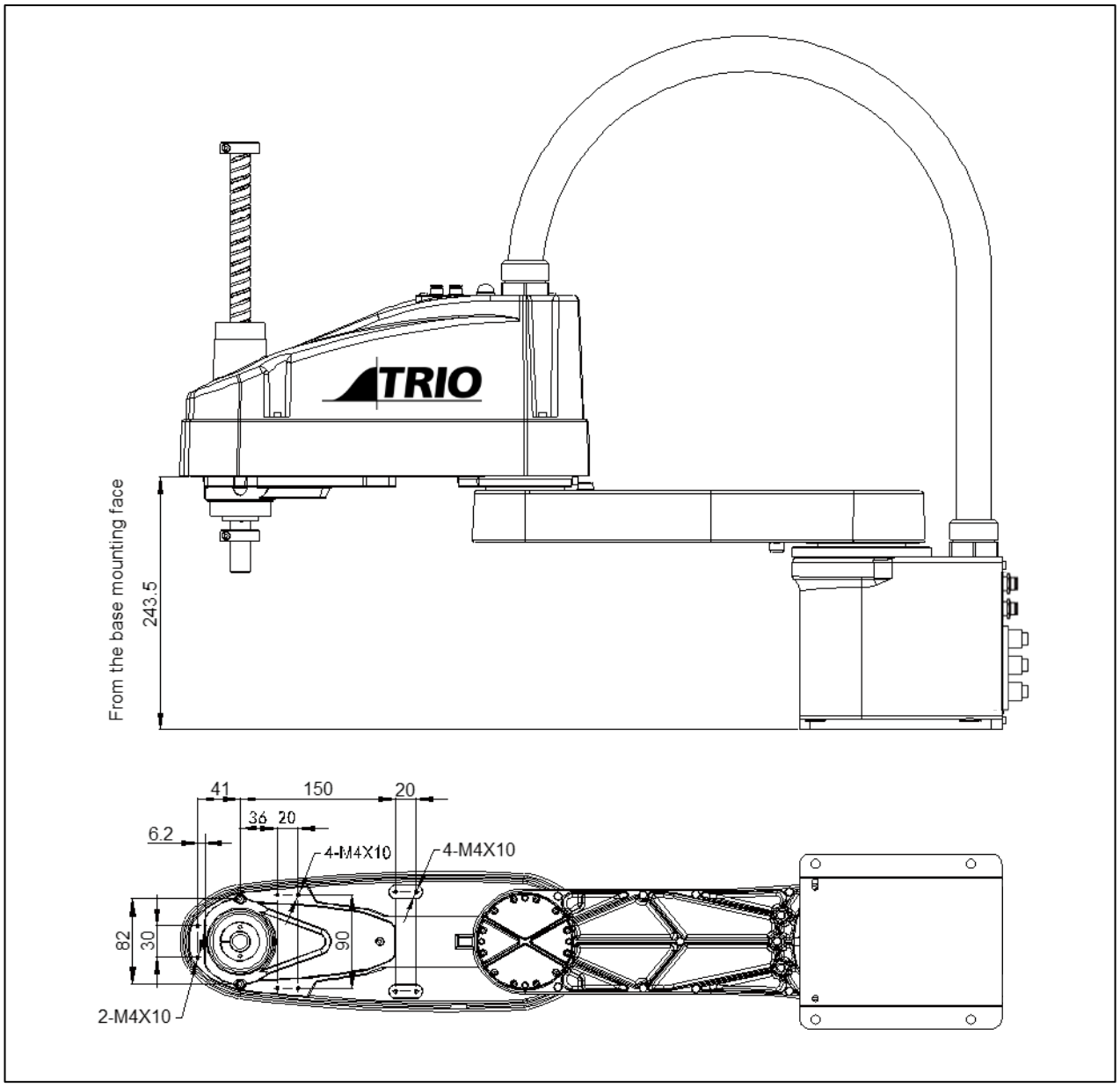


Fig 3.2 Dimensions for attaching cameras and valves (RX6)

3.2.1. Equivalent weight

When you attach a camera or valve to the arm, calculate the weight as the equivalent of the shaft. Then add this to the load. Equivalent weight formula is shown below.

When you attach the equipment near Arm #2: $W_M = M(L_1)^2/(L_1 + L_2)^2$

When you attach the equipment to the end of Arm #2: $W_M = M(L_M)^2/(L_2)^2$

W_M : equivalent weight

M : weight of camera etc.

L_1 : length of Arm #1

L_2 : length of Arm #2

L_M : distance from rotation centre of Joint #2 to centre of gravity

Example:

A “1kg” camera is attached to the end of the arm (550mm away from the rotation centre of Joint #2) with a load weight of “1kg”.

$M = 1$

$L_2 = 450$

$L_{\mathrm{M}} = 550$

$W_M = 1 \times 550^2/450^2 = 1.494 \rightarrow 1.5$ (Rounded up)

$W + W_M = 1 + 1.5 = 2.5$

Enter “2.5” for weight parameter.

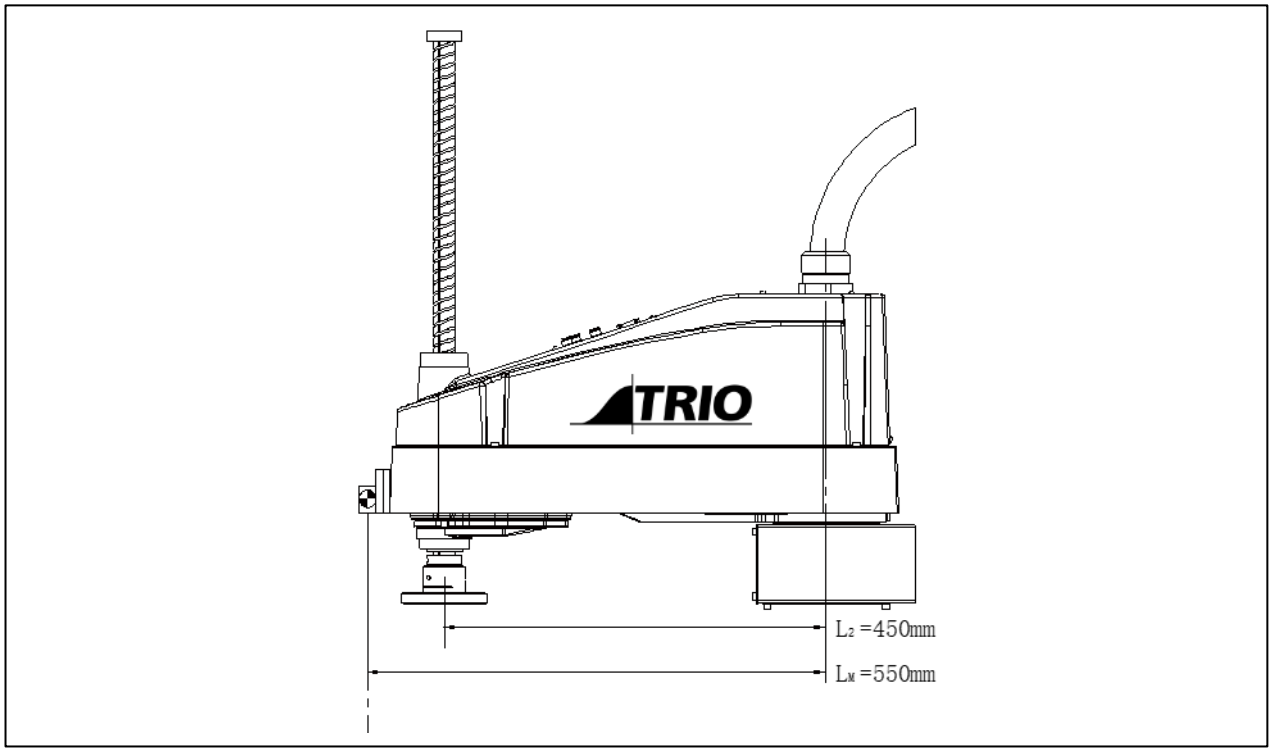


Fig 3.3 Equivalent weight calculation

4. Motion Range

4.1. Motion Range Setting by Mechanical Stops

Mechanical stops physically limit the absolute area that the Robot can move.

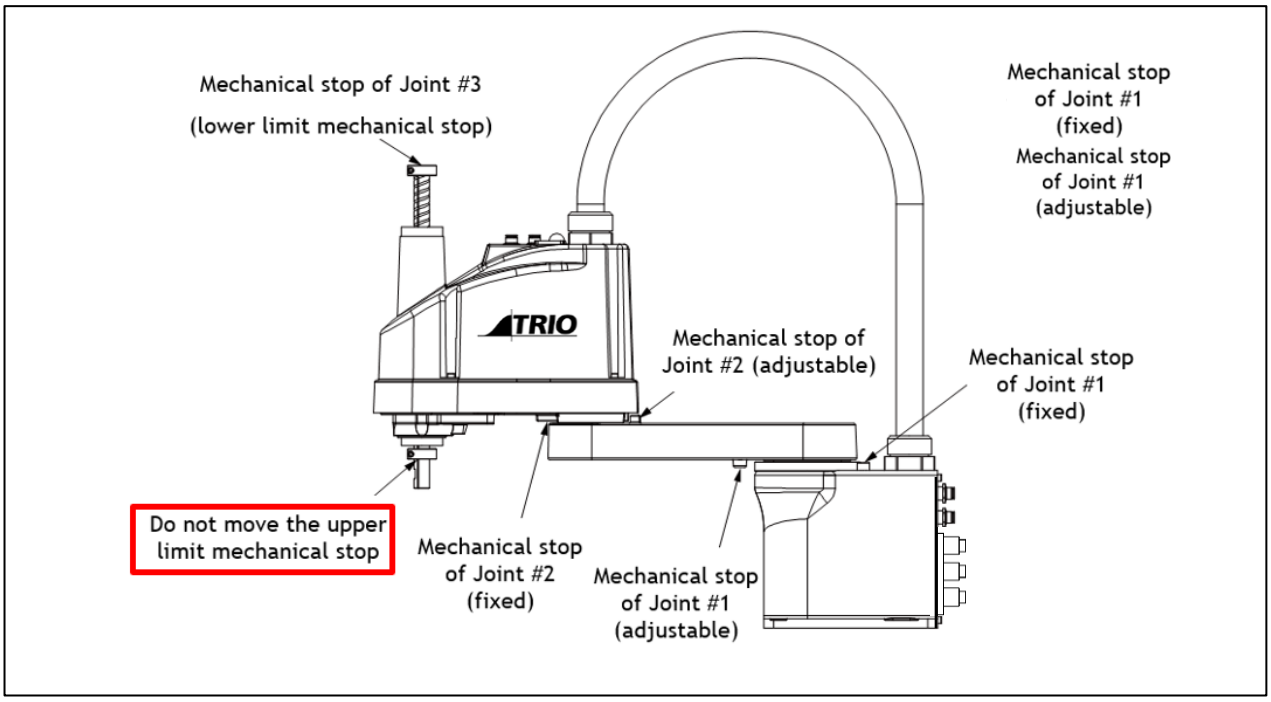


Fig 4.1 Mechanical stops (RX3)

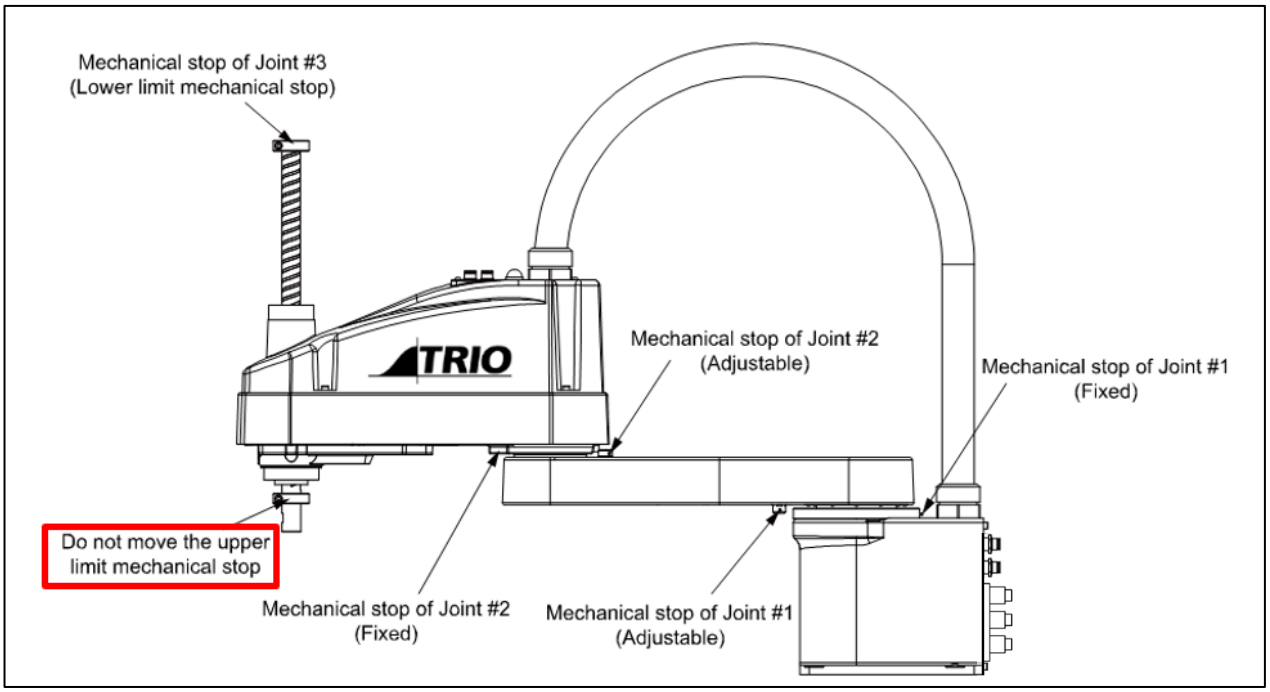


Fig 4.2 Mechanical stops (RX6)

Do not move the upper limit mechanical stop. Moving the upper limit mechanical stop may lead to collision with robot and may result in malfunction of the robot system.

4.1.1. Setting the Mechanical Stops of Joints #1 and #2

Both Joints #1 and #2 have threaded holes in the positions corresponding to the angle for the mechanical stop settings. Install the bolts in the holes corresponding to the angle that you want to set. The angle for Joint #3 can be set in any value within the maximum range.

Install the bolts for the mechanical stop to the following position.

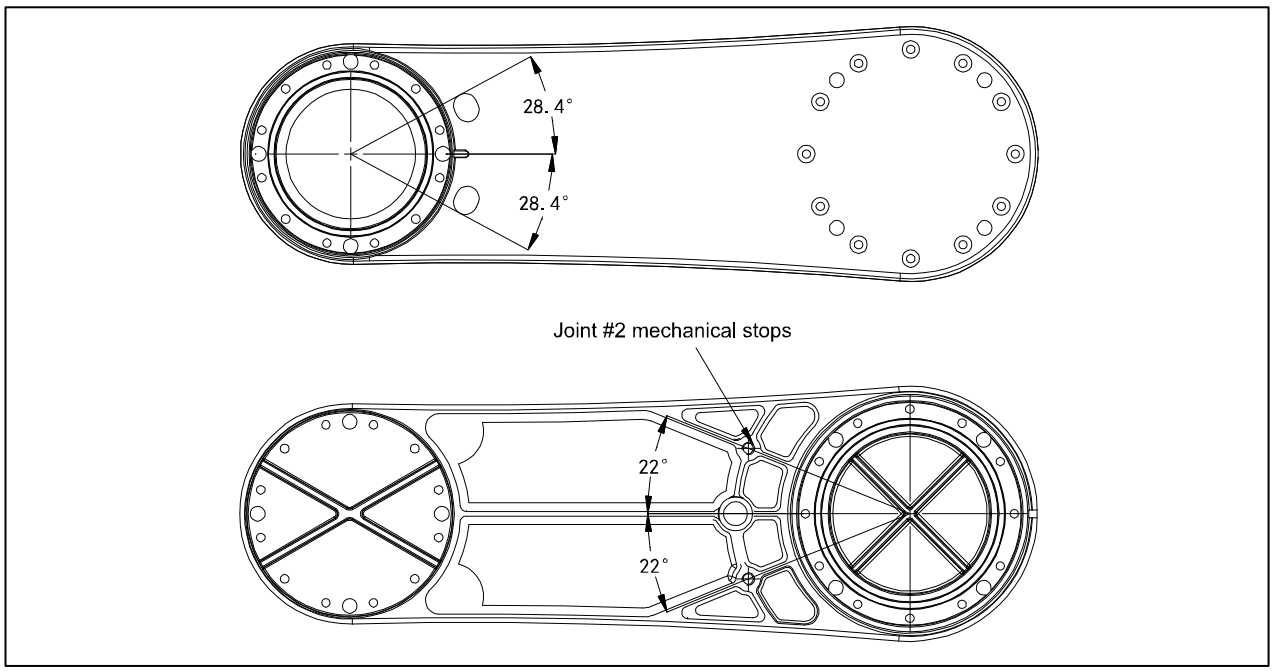


Fig 4.3 Mechanical stops (RX3)

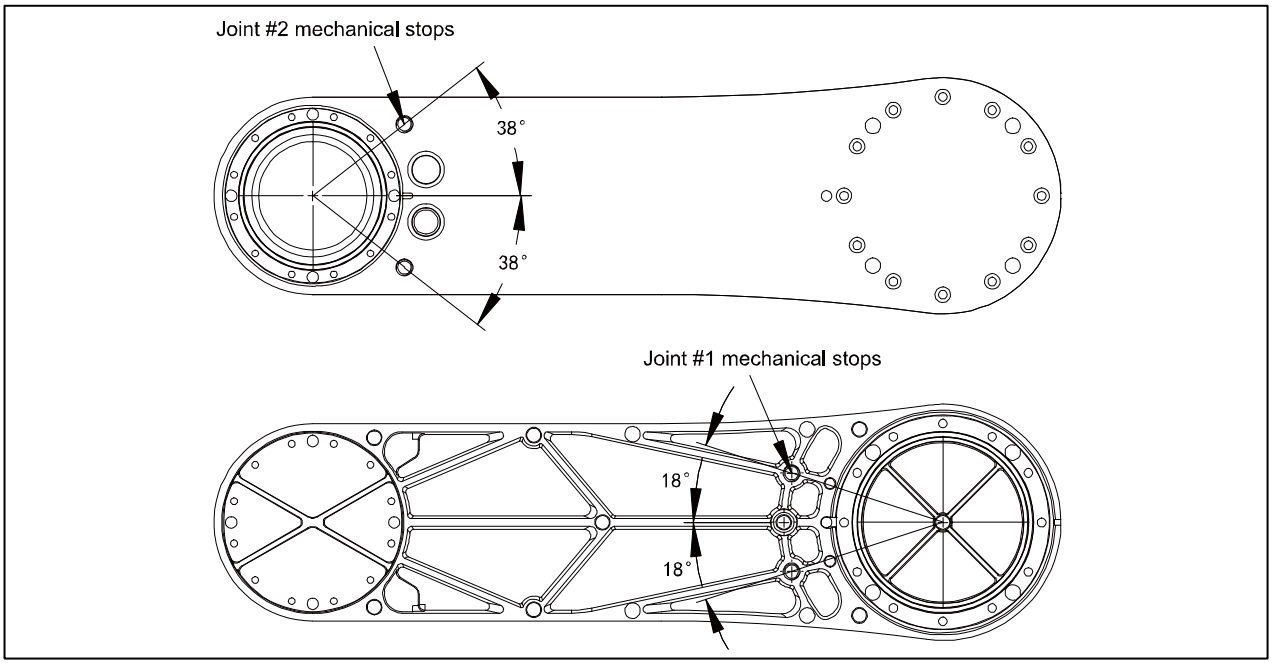


Fig 4.4 Mechanical stops (RX6)

Type	Angle for the J1 axis mechanical stop	Angle for the J2 axis mechanical stop
RX3	±110°	±125°
RX6	±115°	±125°

5. Maintenance

This chapter describes maintenance inspections and procedures. Performing maintenance inspections and procedures properly is essential for preventing trouble and ensuring safety. Be sure to perform the maintenance inspections in accordance with the schedule.

Never perform any maintenance unless shut down the system.

5.1. Schedule for Maintenance Inspection

Inspection points are divided into five stages: daily, monthly, quarterly, biannual, and annual. The inspection points are added every stage. If the Robot is operated for 250 hours or longer per month, the inspection points must be added every 250 hours, 750 hours, 1500 hours, and 3000 hours operation.

（h=hour）	Inspection Point					
	Daily inspection	Monthly inspection	Quarterly inspection	Biannual inspection	Annual inspection	Maintenance
1 month（250h）	Inspect every day	✓				
2 months（500h）		✓				
3 months（750h）		✓	✓			
4 months（1000h）		✓				
5 months（1250h）		✓				
6 months（1500h）		✓	✓	✓		
7 months（1750h）		✓				
8 months（2000h）		✓				
9 months（2250h）		✓	✓			
10 months（2500h）		✓				
11 months（2750h）		✓				
12 months（3000h）		✓	✓	✓	✓	
13 months（3250h）		✓				
□	□	□	□	□	□	□
20000h						✓

5.1.1. Inspection While Power is OFF (Robot is not operating)

Inspection Point	Inspection Place	Daily	Monthly	Quarterly	Biannual	Annual
Check looseness or backlash of bolts/screws. Tighten them if necessary.	End effector mounting bolts	✓	✓	✓	✓	✓
	Robot mounting bolts	✓	✓	✓	✓	✓
	Each arm locking bolts	✓	✓	✓	✓	✓
	Bolts/screws around shaft					✓
	Bolts/screws securing motors, reduction gear units, etc.					✓
Check looseness of connectors. If the connectors are loosening, push it securely or tighten.	External connectors on Robot (on the connector plates etc.)	✓	✓	✓	✓	✓
	Robot cable unit		✓	✓	✓	✓
Visually check for external defects. Clean up if necessary.	External appearance of Robot	✓	✓	✓	✓	✓
	External cables		✓	✓	✓	✓
Check for bends or improper location. Repair or place it properly if necessary	Safeguard etc.	✓	✓	✓	✓	✓
Check tension of timing belts. Tighten it if necessary.	Inside of Arm #2				✓	✓
Grease conditions	Refer to *Greasing*.					
Battery	-	Replace every 1 years				

5.1.2. Inspection While the Power is ON (Robot is operating)

Inspection Point	Inspection Place	Daily	Monthly	Quarterly	Biannual	Annual
Check motion range	Each joint					✓
Move the cables back and forth lightly to check whether the cables are disconnected.	External cables (including cable unit of the Robot)				✓	✓
Push each arm in MOTOR ON status to check whether backlash exists.	Each arm					✓
Check whether unusual sound or vibration occurs.	Whole	✓	✓	✓	✓	✓
Measure the accuracy repeatedly by a gauge.	Whole					✓
Turn ON and OFF the brake release switch and check the sound of the electromagnetic brake. If there is no sound, replace the brake.	Brake	✓	✓	✓	✓	✓

5.2. Greasing

The ball screw spline and reduction gear units need greasing regularly. Only use the grease specified in the following table.

Keep enough grease in the Robot. Operating the Robot with insufficient grease will damage sliding parts and/or result in insufficient function of the Robot.

Tab 5.1 Periodic Greasing

Joint	Greasing part	Greasing Interval	Grease
#1	Reduction gear units	Replace the grease every 10000 hours or 2 years, whichever occur earlier.	Contact TRIO sales representatives.
#2	Reduction gear units		
#3	Ball screw spline shaft	Replace the grease every 6 months or 100 kilometres, whichever occur earlier. (Change the interval if it is necessary.)	AFB-LF+400

If the robot needs greasing, please contact us.

5.2.1. Greasing Procedures

Please cover the furniture and peripheral equipment, etc., in case that grease/oil falls.

(1) Turn the controller power ON.

(2) Move the arm to the position that Joint #3 is to its full motion distance.

(3) Press the brake release switch. Meanwhile, move the shaft to the upper limit.

(4) Turn off the controller.

(5) Clean up the remaining grease on the shaft and add new grease. Use tools such as a clean brush to paint the new grease until it covers the slot on the upper end of the shaft. Then clean up the remaining grease.

(6) Turn the controller power ON.

(7) Press the brake release switch. Meanwhile, move the shaft to the lower limit。

(8) Clean up the remaining grease on the shaft and add new grease. Use tools such as a clean brush to paint the new grease until it covers the slot on the lower end of the shaft. Then clean up the remaining grease

(9) Press the brake release switch. Meanwhile, move the shaft up and down several times to apply the grease evenly. Then clean up the remaining grease.

Turn off the controller power and remove the cover on the upper side of the arm when cleaning up the grease on the shaft.

Incorrect operation of greasing may increase the possibility of rust on the ball screw spline.

5.3. Tightening Hexagon Socket Head Cap Bolts

Hexagon socket head cap bolts are used in places where mechanical strength is required. (A hexagon socket head cap bolt will be called a “bolt” in this manual.)

These bolts are fastened with the tightening torques shown in the following table. When it is necessary to refasten these bolts in some procedures in this manual (except special cases as noted), use a torque wrench so that the bolts are fastened with the appropriate tightening torques as shown below.

Bolt	Tightening Torque
M3	2.0 N·m
M4	4.0 N·m
M5	9.01±0.49 N·m
M6	15.6±0.78 N·m
M8	37.2±1.86 N·m
M10	73.5±3.43 N·m
M12	129±6.37 N·m

Refer below for reducer tightening bolt.

Bolt	Tightening Torque
M3	2.35 N.m
M4	5.4 N.m
M5	10.8 N.m
M6	18.36 N.m

Refer below for the set screw.

Set screw	Tightening Torque
M3	0.9 N·m（9kgf·cm）
M4	2.5 N·m（26 kgf·cm）
M5	3.9 N·m（40 kgf·cm）

The bolts aligned on a circumference should be fastened in a crisscross pattern as shown in the figure below. Do not fasten all bolts securely at one time. Divide the number of times that the bolts are fastened into two or three and fasten the bolts securely with a hexagonal wrench. Then, use a torque wrench so that the bolts are fastened with tightening torques shown in the table above.

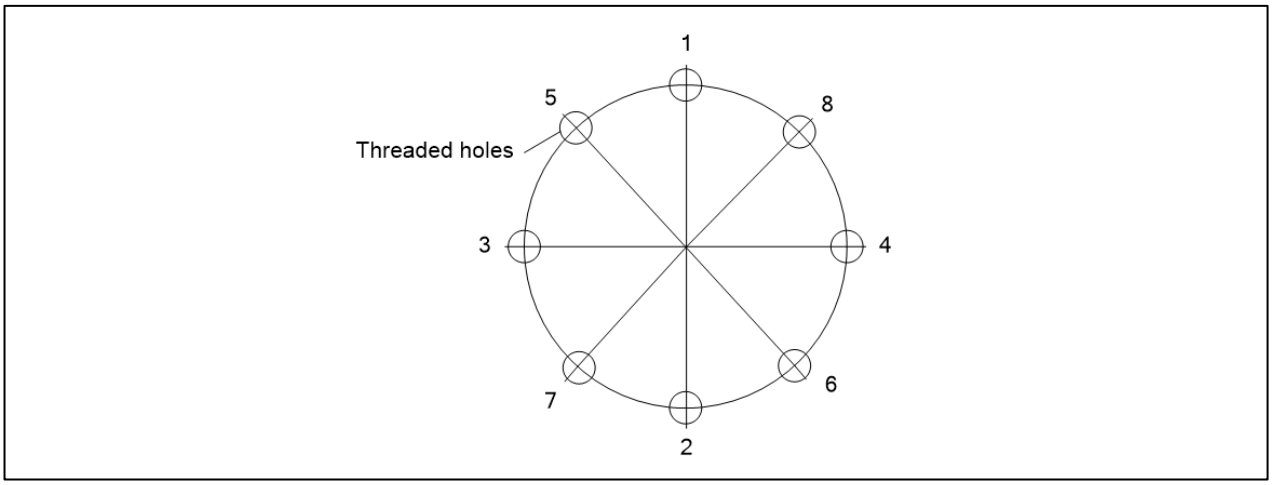


Fig 5.1 Tightening the bolts

5.4. Maintenance of the Belt

	Item	Model	Notes
Tool	Acoustic tension meter	gates U507	For details about measurement, refer to specification of the acoustic tension meter.

5.4.1. Belt specifications

Model	Belt	Mess (g/mm*m)	Width (mm)	Span (mm)	Internal stress (N)	Tense (kgf)
RX3 series	Belt of Joint #3	2.5	10	127	34.3	7±0.5
	Short belt of Joint #4	1.3	10	45	31	6±0.5
	Long belt of Joint #4	1.3	16	85	51	10±0.5
RX6 series	Belt of Joint #3	2.4	10	211	34.4	7±0.5
	Short belt of Joint #4	1.3	10	46	32.3	6±0.5
	Long belt of Joint #4	1.3	15	168	49.5	10±0.5

Tab 5.4 Belt specifications

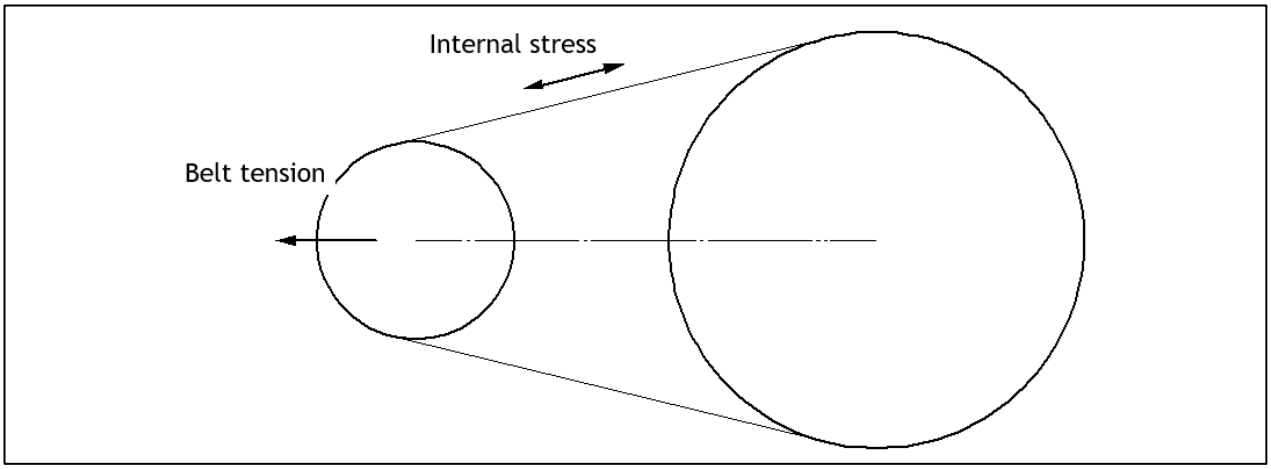
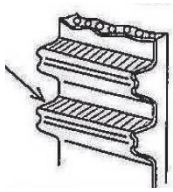


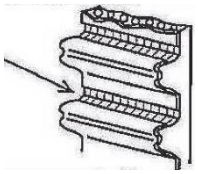
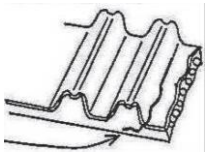
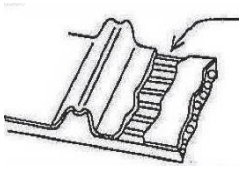
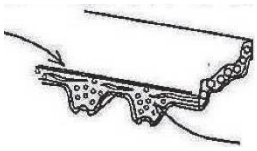
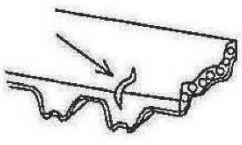
Fig 5.2 Force on belt

5.4.2. Failure mode of timing belt

Periodical maintenance of the timing belt should be performed.

Abnormal item	Appearance	
Abnormal wear on the gear tooth (initial)	The tooth cloth fiber fluffs, the rubber peels down, the color tends to white, the vein of the cloth tends to indistinct.	

Check the appearance. When abnormal situation occurs, replace the abnormal part.

Abnormal item	Appearance	
Abnormal wear on the gear tooth	Wear of the tooth cloth. Exposure of the rubber. (width of tooth profile reduces)	
Crack on the gear dedendum	Crack	
Dedendum fall off	Exposure of core wire	
Abnormal wear	Edge tends to round, abnormal wear (exposure of core wire) Note: it is normal when the side face section shows an knife-cutting shape.	
Crack on the side face of the timing belt		

Replace the timing belt when belt failure occurs. After replacing the timing belt, re-tight the belt tension and re-calibrate the zero position.

6. Calibration and battery

6.1. Introduction

Calibration associates the angle of each robot axis with the pulse count value supplied from the absolute Pulse coder connected to the corresponding axis motor. To be specific, calibration is an operation for obtaining the pulse count value, corresponding to the home position.

Factory calibration data is supplied in a separate document when purchasing the robot. These data are unique as per robot serial number.

Calibration is factory-performed. It is unnecessary to perform calibration in daily operation. However, calibration becomes necessary after:

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

The data, including home position and the pulse encoder, are stored in memory powered by the batteries. The data may get lost when the batteries run out. It is necessary to replace the batteries of control device and robot periodically.

6.2. Finding calibration position

Calibrating is performed at the factory with no loads on the robot system, based on the robot parameters and the special tools and software. This calibration method is the most precise one. Every robot is provided with its calibration values.

The data of home position may be lost due to electrical or software problems. The stored zero position can be regarded as the reference when you perform calibration by teaching method.

The process consists of place robot in specific position by hand, allowing encoders to be at +-0.5 turn. At that position, the system can calculate the offset position if manufacture calibration values are set into the configuration software.

Procedure to calibrate the home position of J1, J2, J3 and J4 axis for RX3/RX6 Robot consists of 3 main steps:

1. Battery replacement
2. Calibration values reset
3. SCARA definition

6.2.1. Battery Replacement Steps

1. Turn power off for all axis drives.

2. Move J1, J2, J3 and J4 and align the mark on the different arms to the position as shown in the figures below.

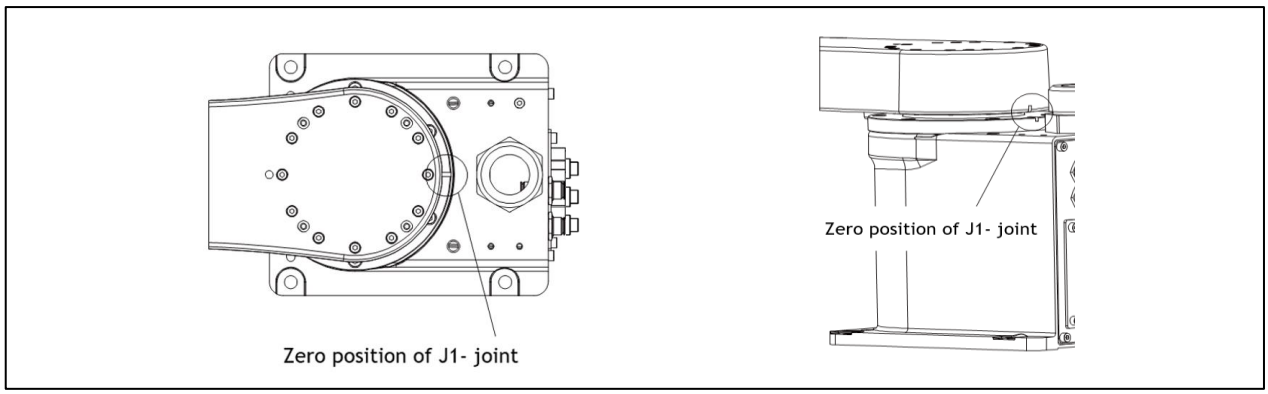


Fig 6.1 Home position of Joint #1 (RX3&RX6)

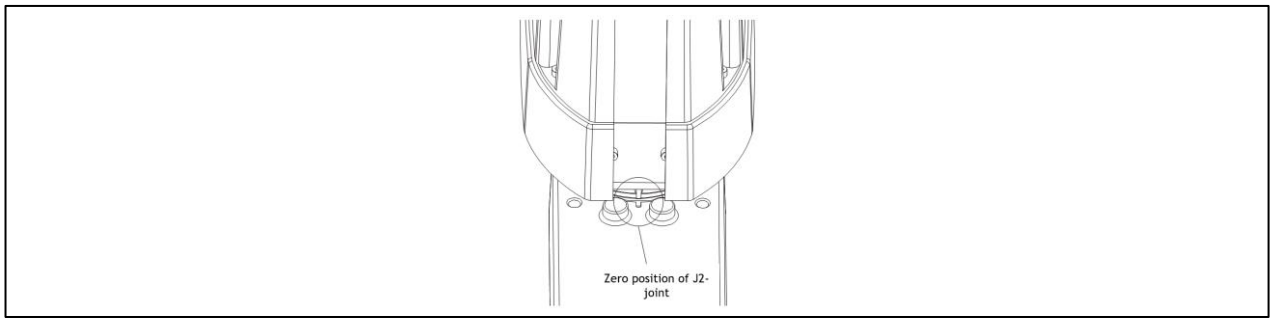


Fig 6.2 Home position of Joint #2 (RX3 & RX6)

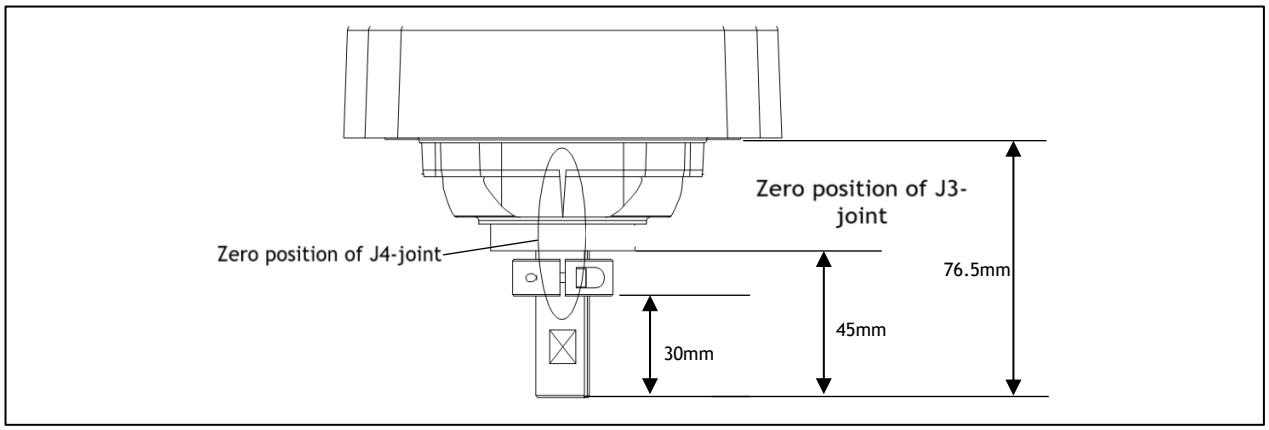


Fig 6.3 Home position of Joint #3 and #4 (RX3)

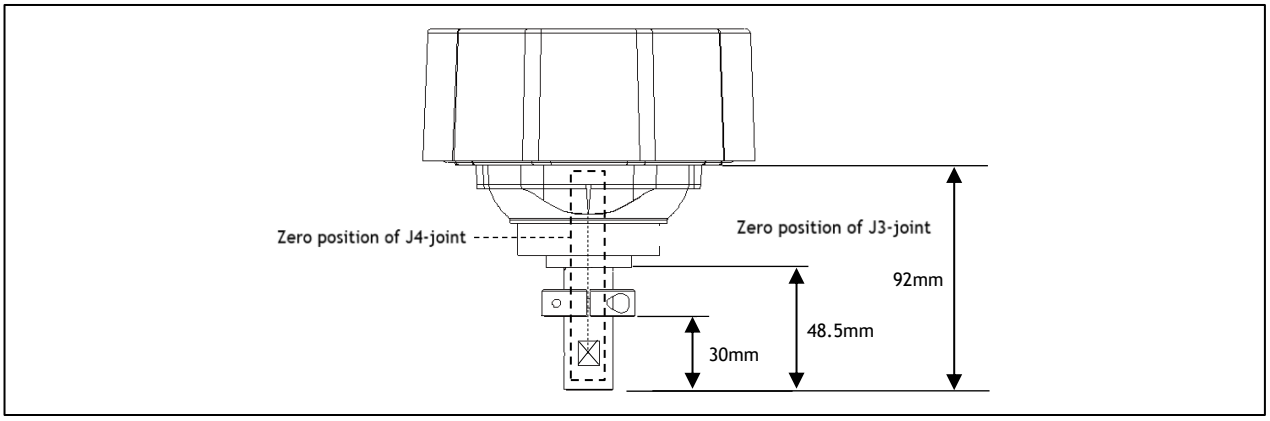


Fig 6.4 Home position of Joint #3 and #4 (RX6)

3. Remove the backplate of the battery compartment in the robot base

4. Replace batteries of J1, J2, J3 and J4 or unplug and then plug them again so absolute encoders multi turn is set to 0.

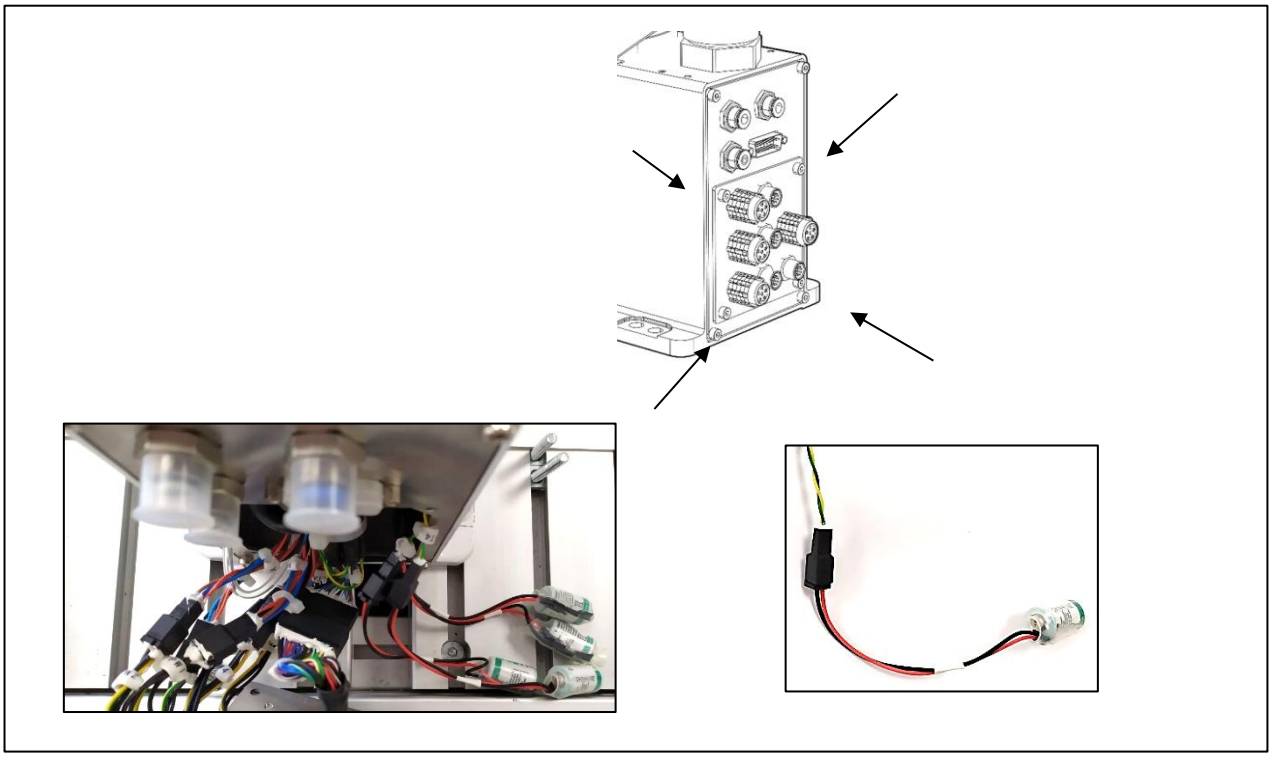


Fig 6.5 Back plate where batteries are stored (RX3&RX6)

NOTE **It is possible that some errors must be cleared after batteries are replaced.**

5. Put the backplate of the battery compartment back on

6. Turn the controller box unit back ON. Battery replacement steps are done.

6.2.2. Calibration Values Reset

1. Start Motion Perfect and create a new project in Motion Perfect

2. Make sure the Ethercat network is in operational state and all axes are all in working state (no errors). You can do this via Intelligent Drive window in Motion Perfect. Master State of the Ethercat network and each axis should look like below in Intelligent Drive. If not, perform next step to clear all errors.

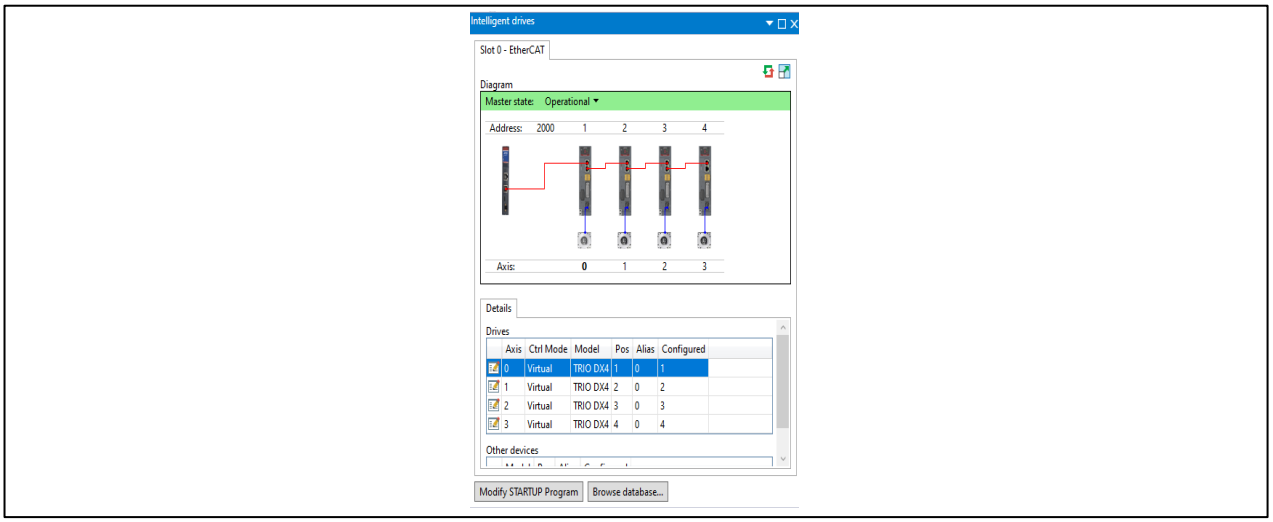


Fig 6.6 Motion Perfect Intelligent Drives window

3. Go to individual axis by clicking the axis icon in Intelligent Drives window and clear any errors of each axis by ‘Clear All Errors’, ‘Clear Multi-turns Errors’, and ‘Clear Active’ in sequence as shown below.

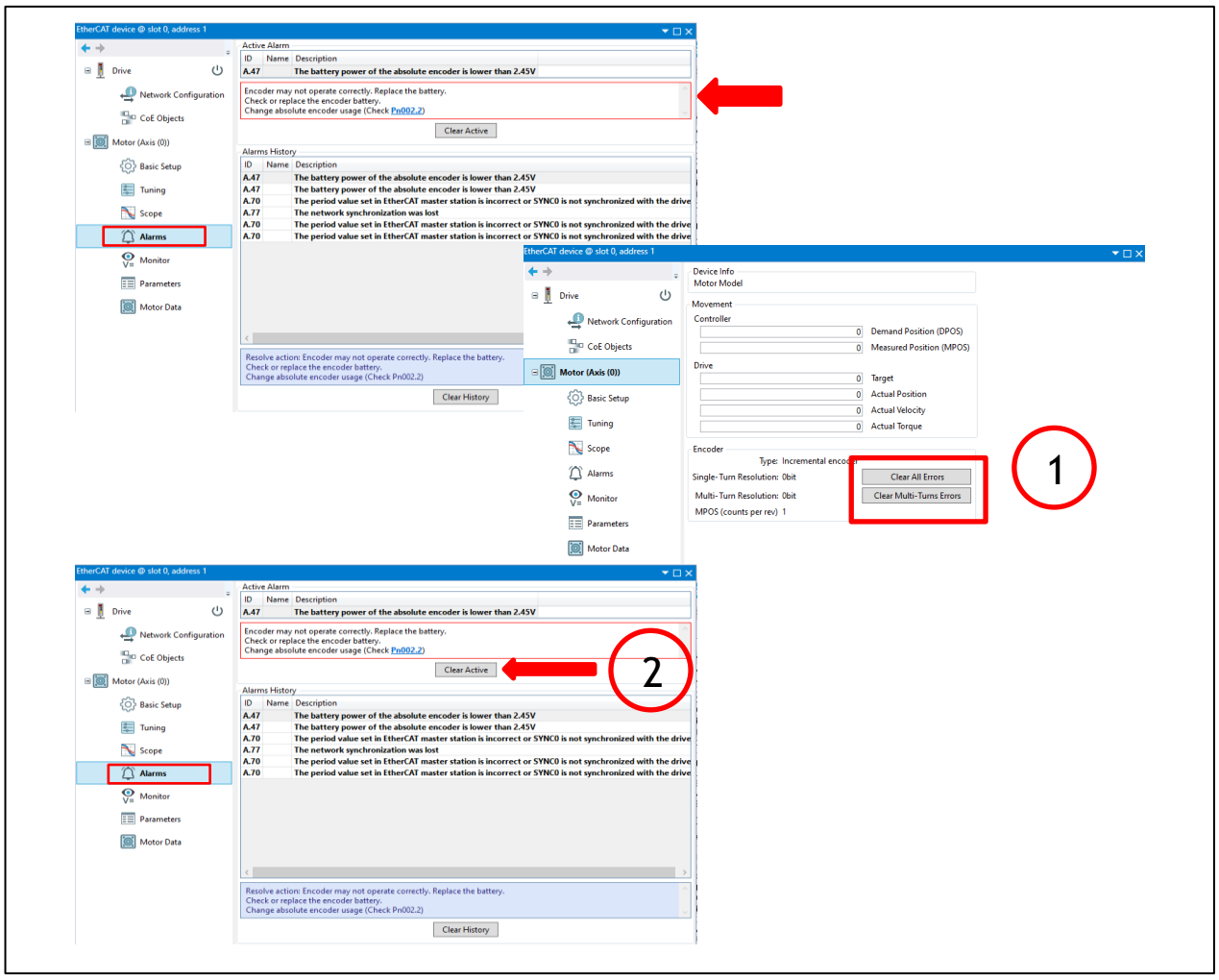


Fig 6.7 Motion Perfect Intelligent Drives window

4. Make sure the controller status is without errors as shown below

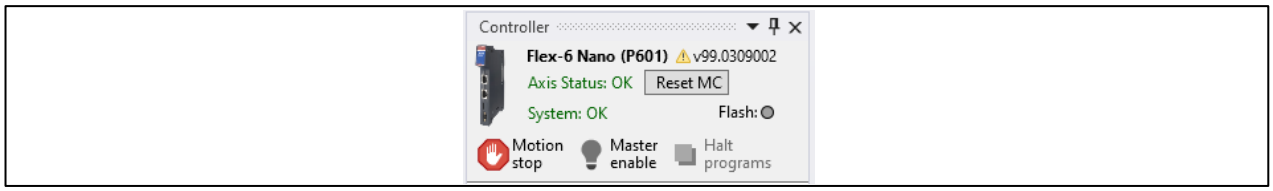
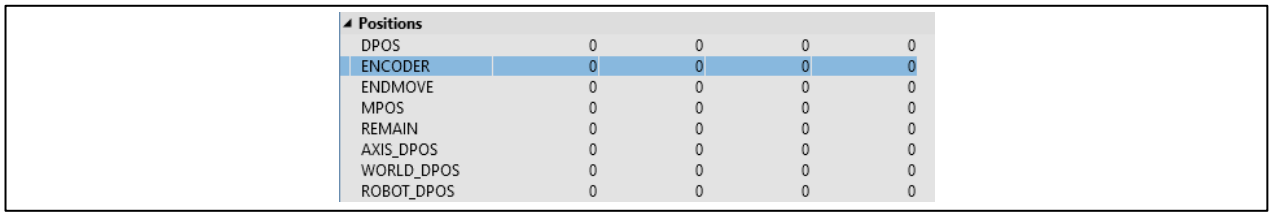


Fig 6.8 Controller status in Motion Perfect

5. Notice that axis parameter ENCODER for each axis should now be around 0 due to battery power loss.



Positions				
DPOS	0	0	0	0
ENCODER	0	0	0	0
ENDMOVE	0	0	0	0
MPOS	0	0	0	0
REMAIN	0	0	0	0
AXIS_DPOS	0	0	0	0
WORLD_DPOS	0	0	0	0
ROBOT_DPOS	0	0	0	0

Fig 6.9 Encoder values in Axis Parameters window

6. Restart the cabinet

7. Via Motion Perfect, make sure the Ethercat network is operational. If not, restart Ethercat network via Controller pane in Motion Perfect.

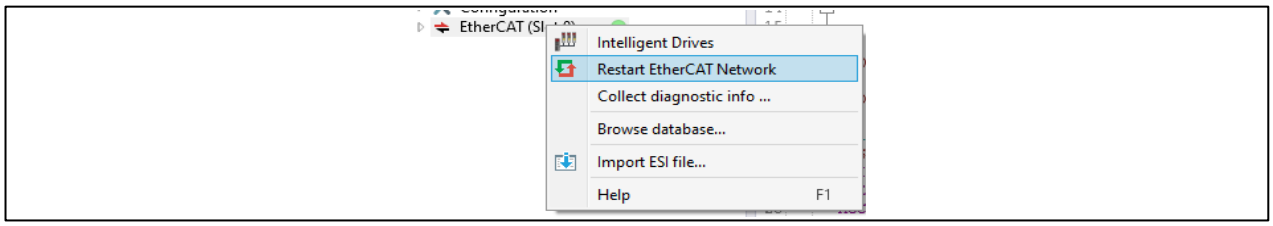
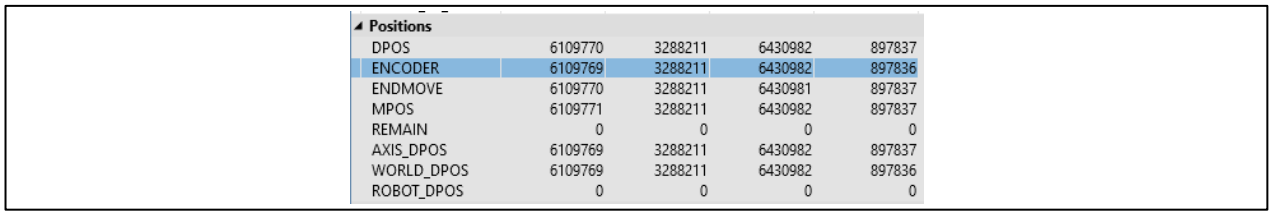


Fig 6.10 Restart EtherCAT network

8. Axis parameter ENCODER (previously of about 0) for each axis should now reflect the proximity of the value in Calibration Data document.



Positions				
DPOS	6109770	3288211	6430982	897837
ENCODER	6109769	3288211	6430982	897836
ENDMOVE	6109770	3288211	6430981	897837
MPOS	6109771	3288211	6430982	897837
REMAIN	0	0	0	0
AXIS_DPOS	6109769	3288211	6430982	897837
WORLD_DPOS	6109769	3288211	6430982	897836
ROBOT_DPOS	0	0	0	0

Fig 6.11 Encoder values in Axis Parameters window

6.2.3. SCARA Definition

1. Run ROBOT_DEFINITIONS file.
2. Switch Master Enable ON and test jog each axis of the robot.

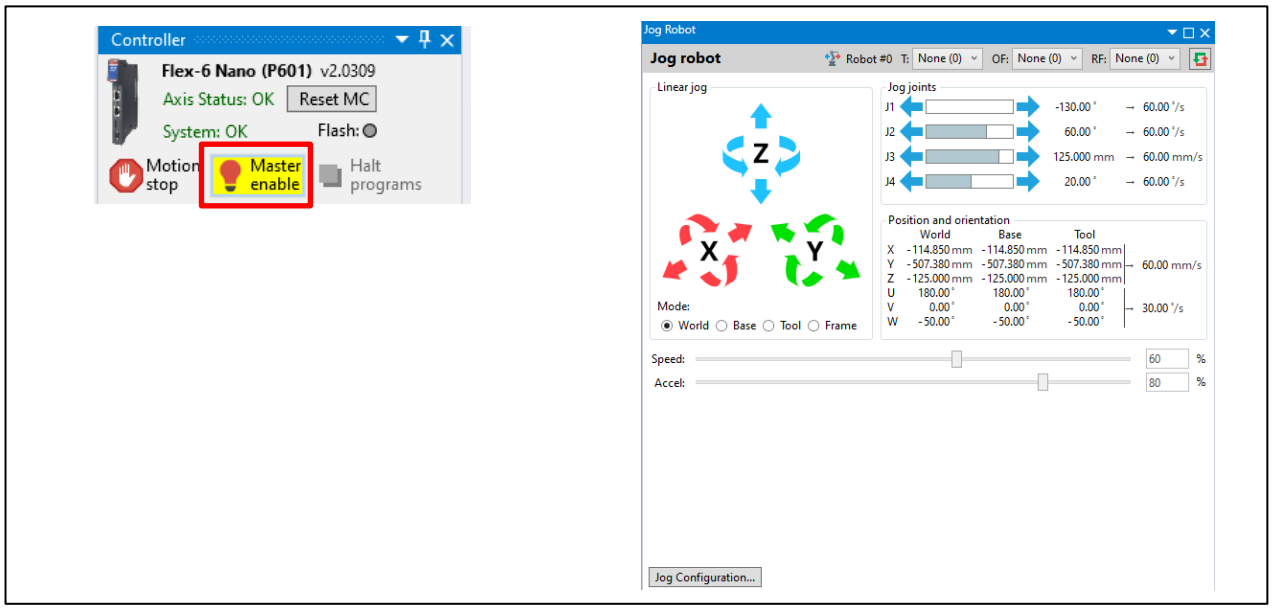
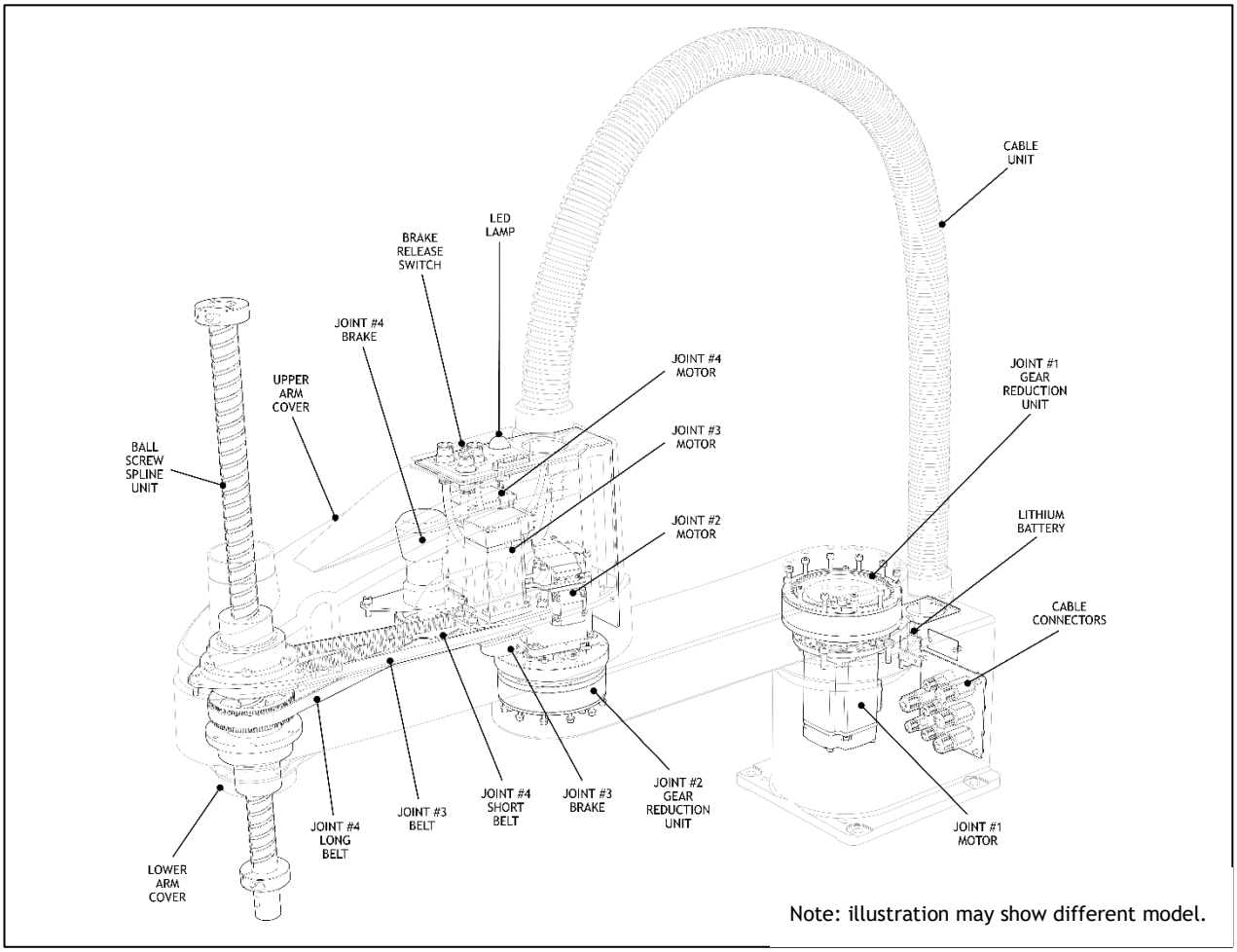


Fig 6.12 Motion Perfect Robot Jog window

Appendix

Appendix A RX3 Maintenance Parts List



Note: illustration may show different model.

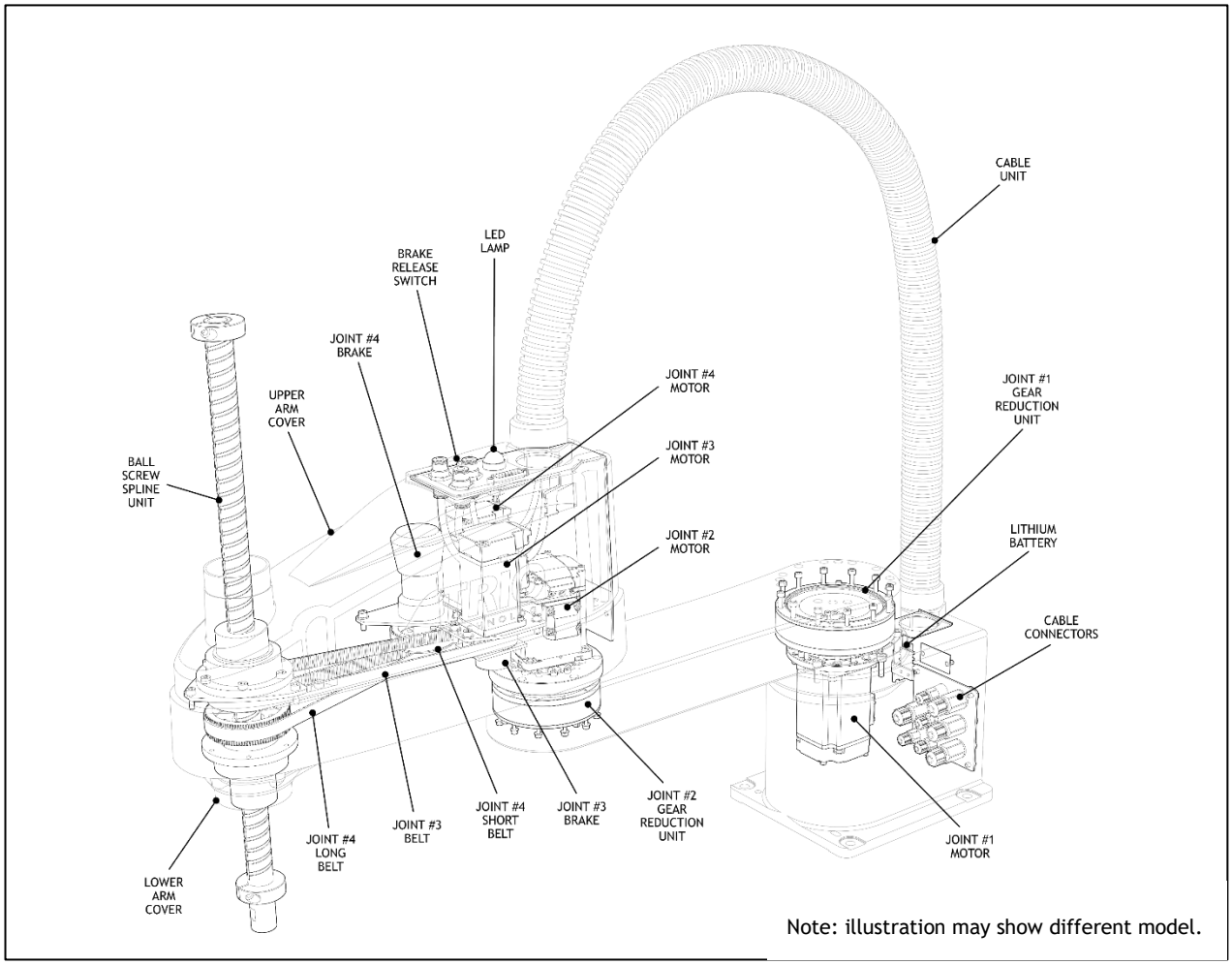
RX3 Robot Parts Name

Part name		Code	Note	Maintenance
AC Servo Motor	Joint #1	12700000053		●
	Joint #2	12700000049		●
	Joint #3/#4	12700000048		
Timing belt	Joint #3	G5401000067		●
	Joint #4	G5401000068	Long Timing Belt	●
		G5401000069	Short Timing Belt	●

Battery		51205A00001		
Grease	Ball Screw Spline	A2144000012	AFB-LF+400	
	Reduction Gear Unit		Contact franchiser or TRIO for purchasing grease.	

RX3 Robot Parts List

Appendix B RX6 Maintenance Parts List



RX6 Robot Parts Name

Part name		Code	Note	Maintenance
AC Servo Motor	Joint #1	12700000057		●
	Joint #2	12700000053		●
	Joint #3/#4	12700000048		●
Timing belt	Joint #3	G5401000046		●
	Joint #4	G5401000047	Long Timing Belt	●
		G5401000048	Short Timing Belt	●
Battery		51205A00001		

Grease	Ball Screw Spline	A2144000012	AFB-LF+400	
	Reduction Gear Unit		Contact franchiser or TRIO for purchasing grease.	

RX6 Robot Parts List

Revision History

Date	Version	Revised Contents
Jan 2021	V1.0	First Draft (BD)
May 2021	V1.1	ER3 & ER6 checks – RX3 & RX6 (RT)
Jun 2021	V1.2	More information on Calibration and Battery section (chap. 6) (RT)
Jul 2021	V1.3	Danger, Warning and Caution box colour indicators (RT)
Aug 2021	V1.4	Corrected RX3 and RX4 calibration position measurements (RT)
Nov 2021	V1.5	- Use of canvas in drawings for consistent display in different format (RT) - Footprint update (RT) - Related Manuals section update (RT) - Calibration values reset update (6.2.2) (RT) - SCARA definition update (6.2.3) (RT)
Jan 2022	V1.6	- Added information on RX3 calibration point (6.2.1 fig 6.3) (RT)
Feb 2022	V1.7	- General editing and formatting (RT) - General proofreading (RT)
Mar 2022	V1.8	- New backplate on figures (RT)

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