

YAMAHA SCARA ROBOT

# YK-X/XH Series

User's Manual

YK250X(H)/YK350X(H)/YK400X(H)  
YK500X/YK550X/YK600X  
YK700X/YK800X/YK1000X/YK1200X



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## **Before using the robot** **(Be sure to read the following notes.)**

At this time, our thanks for your purchase of this YAMAHA YK-X series SCARA robot.

### **1. Please be sure to perform the following tasks before using the robot.**

Failing to perform the tasks below will require re-teaching of the robot since the origin position cannot be set to the same previous position. Robot malfunctions (vibration, noise) may also occur.

The origin position of the YK-X series robots is adjusted to the robot arm extended position at the factory prior to shipment, so the reference or standard coordinates are temporarily set.

The customer should set the origin position before any other job. There are 2 types of origin position settings as shown below.

- [1] Setting the robot arm extended position (the origin position adjusted at the factory prior to shipment) as the origin position  
(When setting the origin position with the robot arm extended, you must check that there will not be any interference from any peripheral equipment during the next absolute reset.)
- [2] Setting a position **OTHER** than the robot arm extended position (the origin position adjusted at the factory prior to shipment) as the origin position

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- [1] To set the robot arm extended position (the origin position adjusted at the factory prior to shipment) as the origin position

### **Absolute Reset**

The YK-X series robots only require the absolute reset to be performed once when the robot is introduced.

Once the absolute reset is performed, you do not need to reperform it when the power is turned on next time.

Set the origin position while referring to absolute reset methods in "3. Adjusting the origin" in Chapter 4 of this manual and in "Absolute Reset" of the "YAMAHA Robot Controller User's Manual". Setting of reference coordinates is not required in the above case.

### **CAUTION**

Never enter the robot movement range once the robot servo is turned on as this is extremely hazardous.

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- [2] To set a position **OTHER** than the robot arm extended position (the origin position adjusted at the factory prior to shipment) as the origin position

### **1. Absolute reset**

The YK-X series robots only require the absolute reset to be performed once when the robot is introduced.

Once the absolute reset is performed, you do not need to reperform it when the power is turned on next time.

Set the origin position while referring to absolute reset methods in "3. Adjusting the origin" in Chapter 4 of this manual and in "Absolute Reset" of the "YAMAHA Robot Controller User's Manual".

Set the origin position with the absolute reset.

### **▲ CAUTION**

Never enter the robot movement range once the robot servo is turned on as this is extremely hazardous.

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### **2. Affixing the origin position sticker**

Set in emergency stop when absolute reset is complete, and immediately affix the origin point sticker according to instructions in "6. Affixing Stickers for Origin Positions, Movement Directions and Axis Names" in Chapter 4 of this manual.

### **3. Setting the reference coordinates**

Set the reference coordinates while referring to instructions in "5. Setting the Reference Coordinates" in Chapter 4 of this manual and also to "Setting the Reference Coordinates" in the "YAMAHA Robot Controller User's Manual".

Robot malfunctions (vibration, noise) may occur if the reference coordinates are not set correctly.

Even though there is no problem with the robot, the following error messages are issued when the robot and controller are connected and power first turned on.

(Actual error messages may differ according to how the robot and controller are connected.)

#### **Error messages issued when robot & controller are connected (RCX142)**

17.81 : D?.ABS.battery wire breakage  
17.83 : D?.Backup position data error 1  
17.85 : D?.Backup position data error 2  
17.92 : D?.Resolver disconnected during power off  
17.93 : D?.Position backup counter overflow  
etc.

#### **Error messages issued when robot & controller are connected (RCX240)**

17.81 : D?.ABS.battery wire breakage  
17.83 : D?.Backup position data error 1  
17.85 : D?.Backup position data error 2  
17.92 : D?.Resolver disconnected during power off  
17.93 : D?.Position backup counter overflow  
etc.

### **2. If the X, Y or R axis rotation angle is small.**

If the X, Y or R axis rotation angle is smaller than 5° so that it always moves in the same position, an oil film is difficult to be formed on the joint support bearing, possibly leading to damage to the bearing. In this type of operation, add a movement so that the joint moves through 90° or more, about 5 times a day.

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## Introduction

The YAMAHA YK-X series robots are SCARA type industrial robots developed based on years of YAMAHA experience and achievements in the automation field as well as efforts to streamline our in-house manufacturing systems.

The YK-X series robots have a two-joint manipulator consisting of an X-axis arm and a Y-axis arm, and are further equipped with a vertical axis (Z-axis) and a rotating axis (R-axis) at the tip of the manipulator. The YK-X series robots can be used for a wide range of assembly applications such as installation and insertion of various parts, application of sealant, and packing operations.

This instruction manual describes the safety measures, handling, adjustment and maintenance of YK-X series robots for correct, safe and effective use. Be sure to read this manual carefully before installing the robot. Even after you have read this manual, keep it in a safe and convenient place for future reference.

This instruction manual should be used with the robot and considered an integral part of it. When the robot is moved, transferred or sold, send this manual to the new user along with the robot. Be sure to explain to the new user the need to read through this manual.

This manual describes all models of the YK-X series except for the YK120X series.

When you are using clean room models, dust/drip-proof models or ceiling-mount models of the YK-X series robots, refer to their user's manuals. For precautions and operations common to standard models of the YK-X series, please refer to this manual.

If there are any obscure points in handling these robot models or other custom models, be sure to contact YAMAHA sales office or dealer.

For details on specific operation and programming of the robot, refer to the separate "YAMAHA Robot Controller User's Manual".

### NOTES

- The contents of this manual are subject to change without prior notice.
- Information furnished by YAMAHA in this manual is believed to be reliable. However, if you find any part unclear or inaccurate in this manual, please contact YAMAHA sales office or dealer.

YAMAHA MOTOR CO., LTD.  
IM Operations

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# MEMO

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# CHAPTER 1

## Using the Robot Safely

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# MEMO

# 1 Safety Information

Industrial robots are highly programmable, mechanical devices that provide a large degree of freedom when performing various manipulative tasks. To ensure correct and safe use of YAMAHA industrial robots, carefully read this manual and make yourself well acquainted with the contents. FOLLOW THE WARNINGS, CAUTIONS AND INSTRUCTIONS INCLUDED IN THIS MANUAL. Failure to take necessary safety measures or mishandling due to not following the instructions in this manual may result in trouble or damage to the robot and injury to personnel (robot operator or service personnel) including fatal accidents.

Warning information in this manual is shown classified into the following items.

## DANGER

Failure to follow DANGER instructions will result in severe injury or death to the robot operator, a bystander or a person inspecting or repairing the robot.

## WARNING

Failure to follow WARNING instructions could result in severe injury or death to the robot operator, a bystander or a person inspecting or repairing the robot.

## CAUTION

Failure to follow CAUTION instructions may result in injury to the robot operator, a bystander or a person inspecting or repairing the robot, or damage to the robot and/or robot controller.

## NOTE

Explains the key point in the operation in a simple and clear manner.

Refer to the user's manual by any of the following methods to operate or adjust the robot safely and correctly.

1. Operate or adjust the robot while referring to the printed version of the user's manual (available for an additional fee).
2. Operate or adjust the robot while viewing the CD-ROM version of the user's manual on your computer screen.
3. Operate or adjust the robot while referring to a printout of the necessary pages from the CD-ROM version of the user's manual.

It is not possible to list all safety items in detail within the limited space of this manual. So it is essential that the user have a full knowledge of basic safety rules and also that the operator makes correct judgments on safety procedures during operation.

For specific safety information and standards, refer to the applicable local regulations and comply with the instructions. This manual and warning labels supplied with or attached to the robot are written in English. Unless the robot operators or service personnel understand English, do not permit them to handle the robot.

- \* Cautions regarding the official language of EU countries

For equipment that will be installed in EU countries, the language used for the user's manuals, CE declarations, and operation screen characters is English only. Warning labels only have pictograms or else include warning messages in English. In the latter case, Japanese messages might be added.

## 2 Essential Caution Items

Particularly important cautions for handling or operating the robot are described below. In addition, safety information about installation, operation, inspection and maintenance is provided in each chapter. Be sure to comply with these instructions to ensure safe use of the robot.

### (1) Observe the following cautions during automatic operation.

Warning labels 1 (Fig. 1-1) are affixed to the robot. See Fig. 2-2 to Fig. 2-6 for the locations of warning labels.

- Install a safeguard enclosure (protective enclosure) to keep any person from entering within the movement range of the robot and suffering injury due to being struck by moving parts.
- Install a safety interlock that triggers emergency stop when the door or panel is opened.
- Install safeguards so that no one can enter inside except from doors or panels equipped with safety interlocks.
- The warning labels shown in Fig. 1-1 are supplied with the robot and should be affixed to a conspicuous spot on doors or panels equipped with safety interlocks.



Serious injury or death will result from impact with moving robot.

- Keep outside of guard during operation.
- Lock out power before approaching robot.

### (2) Use caution to prevent hands or fingers from being pinched or crushed.

Warning labels 2 (Fig. 1-2) are affixed to the robot. See Fig. 2-2 to Fig. 2-6 for the locations of warning labels.

Be careful not to let hands or fingers be pinched or crushed by the moving parts of the robot during transportation or teaching.

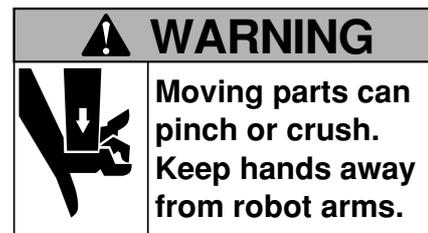


Moving parts can pinch or crush hands.

Keep hands away from robot arms.



■Fig. 1-1 Warning label 1



■Fig. 1-2 Warning label 2

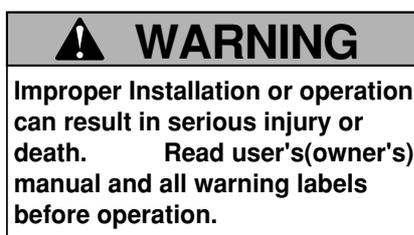
**(3) Follow the instructions on warning labels and in this manual.**

Warning label 3 (Fig. 1-3) is affixed to the robot. See Fig. 2-2 to Fig. 2-6 for the locations of warning labels.

- Be sure to read the warning label and this manual carefully and make you thoroughly understand the contents before attempting installation and operation of the robot.
- Before starting the robot operation, even after you have read through this manual, read again the corresponding procedures and cautions in this manual as well as descriptions in this chapter (Chapter 1, "Using the Robot Safely").
- Never install, adjust, inspect or service the robot in any manner that does not comply with the instructions in this manual.

**⚠ WARNING**

Improper installation or operation can result in serious injury or death. Read user's manual and all warning labels before installation or operation.



■Fig. 1-3 Warning label 3

**(4) Do not use the robot in environments containing inflammable gas, etc.****⚠ WARNING**

- This robot was not designed for operation in environments where inflammable or explosive substances are present.
- Do not use the robot in environments containing inflammable gas, dust or liquids. Explosions or fire could otherwise result.

**(5) Do not use the robot in locations possibly subject to electromagnetic interference, etc.****⚠ WARNING**

Avoid using the robot in locations subject to electromagnetic interference, electrostatic discharge or radio frequency interference. Malfunction may otherwise occur.

**(6) Use caution when releasing the Z-axis (vertical axis) brake.**

**⚠ WARNING**

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The Z-axis will slide down when the Z-axis brake is released, causing a hazardous situation.

- Press the emergency stop button and prop up the Z-axis with a support stand before releasing the brake.
  - Use caution not to let your body get caught between the Z-axis and installation base when releasing the brake to perform direct teach.
- 

**(7) Provide safety measures for end effector (gripper, etc.).**

**⚠ WARNING**

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- End effectors must be designed and manufactured so that they cause no hazards (for example, loosening of workpiece) even if power (electricity, air pressure, etc.) is shut off or power fluctuations occur.
  - If there is a possible danger that the object gripped by the end effector may fly off or drop, then provide appropriate safety protection taking into account the object size, weight, temperature and chemical properties.
- 

**(8) Be cautious of possible Z-axis movement when the controller is turned off or emergency stop is triggered. (2-axis robots with air-driven Z-axis)**

**⚠ WARNING**

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The Z-axis moves up when the power to the controller or PLC is turned off, the program is reset, emergency stop is triggered, or air is supplied to the solenoid valve for the Z-axis air cylinder.

- Do not let hands or fingers get caught and squeezed by moving parts of the Z-axis.
  - Keep the usual robot position in mind so that the Z-axis will not interfere with obstacles during raising of the Z-axis, except in case of emergency stop.
- 

**(9) Use the following caution items when the Z-axis is interfering with peripheral equipment. (2-axis robots with air driven Z-axis)**

**⚠ WARNING**

---

When the Z-axis comes to a stop due to obstructions from peripheral equipment, the Z-axis may move suddenly when the obstruction is removed, causing injury such as pinched or crushed hands.

- Turn off the controller and reduce the air pressure before attempting to remove the obstruction.
  - Before reducing the air pressure, place a support stand under the Z-axis because it will drop under its own weight.
-

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**(10) Use caution on Z-axis movement when air supply is stopped. (2-axis robots with air-driven Z-axis)****⚠ WARNING**

The Z-axis may suddenly drop when the air pressure to the Z-axis air cylinder solenoid valve is reduced, creating a hazardous situation.

Turn off the controller and place a prop or support under the Z-axis before cutting off the air supply.

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**(11) Use the following caution items when disassembling or replacing the pneumatic equipment.****⚠ WARNING**

Air or parts may fly outwards if pneumatic equipment is disassembled or parts replaced while air is still supplied.

- Do service work after first turning off the controller and reducing the air pressure.
  - Before reducing the air pressure, place a support stand under the Z-axis (2-axis robots with air driven Z-axis) since it will drop under its own weight.
- 

**(12) Use the following caution items when removing the Z-axis motor.****⚠ WARNING**

The Z-axis will drop when the Z-axis motor is removed, possibly resulting in injury.

- Turn off the controller and set a support stand under the Z-axis before removing the motor.
  - Use caution not to allow hands or body to be squeezed or crushed by moving parts on the Z-axis or between the Z-axis and the installation base.
- 

**(13) Use the following caution during inspection of controller.****⚠ WARNING**

- When you need to touch the terminals or connectors on the outside of the controller during inspection, always first turn off the controller power switch and also the power source in order to prevent possible electrical shock.
  - Never touch any internal parts of the controller.
- 

For precautions on handling the controller, refer to the "YAMAHA Robot Controller User's Manual".

**(14) Consult us for corrective action when the robot is damaged or malfunction occurs.**

**⚠ WARNING**

If any part of the robot is damaged or any malfunction occurs, continuous operation may be very dangerous. Please consult YAMAHA dealer for corrective action.

Damage or Trouble	Possible Danger
Damage to machine harness or robot cable	Electrical shock, malfunction of robot
Damage to exterior of robot	Flying outwards of damaged parts during robot operation
Abnormal operation of robot (positioning error, excessive vibration, etc.)	Malfunction of robot
Z-axis brake trouble	Dropping of load

**(15) Use caution not to touch the X-axis motor cooling fan (YK550X) and controller cooling fan.**

**⚠ WARNING**

- Bodily injury may occur from coming into contact with the cooling fan while it is rotating.
- When removing the fan cover for inspection, first turn off the controller and make sure the fan has stopped.

**(16) Use caution not to touch the high temperature motor or speed reduction gear casing.**

**⚠ WARNING**

The motor and speed reduction gear casing are extremely hot after automatic operation, so burns may occur if these are touched.  
Before touching these parts during inspections or servicing, turn off the controller, wait for a while and check that the temperature has cooled.

**(17) Do not remove, alter or stain the warning labels.**

**⚠ WARNING**

If warning labels are removed or difficult to see, necessary cautions may not be taken, resulting in an accident.

- Do not remove, alter or stain the warning labels on the robot.
- Do not allow the warning labels to be hidden by the device installed to the robot by the user.
- Provide proper lighting so that the symbols and instructions on the warning labels can be clearly seen even from the outside of safeguards.

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**(18) Protective bonding****⚠ WARNING**

Be sure to ground the robot and controller to prevent electrical shock.

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**(19) Do not allow any object to enter the X-axis motor cooling fan.  
(YK550X; See Fig. 2-6.)****⚠ WARNING**

If an object such as a small workpiece which the end effector failed to pick up, penetrates into the cooling fan for the X-axis motor, it may rebound and fly away from the fan, possibly causing bodily injury or damage to the fan.

- Provide a proper protective wall which prevents workpieces or other objects from entering the fan.
  - When providing a protective wall, allow a space of at least 100mm between the fan vent and the wall to ensure air flow and cooling effects.
- 

**(20) Be sure to make correct parameter settings.****⚠ CAUTION**

The robot must be operated with correct tolerable moment of inertia and acceleration coefficients according to the manipulator tip mass and moment of inertia. If this is not observed, premature end to the life of the drive units, damage to the robot parts or residual vibration during positioning may result.

---

**(21) Do not use the robot for tasks requiring motor thrust.****⚠ CAUTION**

Avoid using the YK-X series robots for tasks which make use of motor thrust (press-fitting, burr removal, etc.). These tasks may cause malfunctions of the robot.

---

**(22) If the X, Y or R axis rotation angle is small****⚠ CAUTION**

If the X, Y or R axis rotation angle is smaller than 5° so that it always moves in the same position, an oil film is difficult to be formed on the joint support bearing, possibly leading to damage to the bearing. In this type of operation, add a movement so that the joint moves through 90° or more, about 5 times a day.

---

**(23) Follow the specified procedures when installing, adjusting or inspecting the robot.**

**⚠ WARNING**

Always follow the specified procedures when installing, adjusting or inspecting the robot. Never attempt any procedure not described in this manual.

---

**(24) Do not attempt any repair, parts replacement and modification.**

**⚠ WARNING**

Do not attempt any repair, parts replacement and modification unless described in this manual.

These works require technical knowledge and skill, and may also involve work hazards.

---

**(25) Precautions when disposing of the robot**

When disposing of the robot, handle it as industrial waste.

**(26) Location for installing the controller and the programming box**

The robot controller and programming box should be installed at a location that is outside the robot movement range yet where it is easy to operate and view the robot performing tasks.

**(27) Protect electrical wiring and hydraulic/pneumatic hoses as needed.**

Install a cover or similar item to protect the electrical wiring and hydraulic/pneumatic hoses from possible damage.

**(28) Install an operation status light.**

Install an operation status light (signal light tower, etc.) at an easy-to-see position so the operator will know whether the robot is merely stopped or is in emergency-error stop.

**(29) Clean work tools, etc.**

Work tools such as welding guns and paint nozzles which are mounted in the robot arm will preferably be cleaned automatically.

**(30) Provide adequate lighting.**

Make sure to provide enough lighting to ensure safety during work.

**(31) Draw up "work instructions" and makes sure the operator learns them well.**

Decide on "work instructions" for the following items in cases where personnel must work within the robot movement range to perform teaching, maintenance or inspection. Make sure the workers know these "work instructions" well.

- (1) Robot operating procedures needed for tasks such as startup procedures and handling switches
- (2) Robot speeds used during tasks such as teaching
- (3) Methods for workers to signal each other when two or more workers perform tasks
- (4) Steps that the worker should take when a problem or emergency occurs
- (5) Steps to take after the robot has come to a stop when the emergency stop device was triggered, including checks for cancelling the problem or error state and safety checks in order to restart the robot.
- (6) In cases other than above, the following actions should be taken as needed to prevent hazardous situations due to sudden or unexpected robot operation or faulty robot operation, as listed below.
  1. Show a display on the operator panel
  2. Ensure the safety of workers performing tasks within the robot movement range
  3. Clearly specify position and posture during work  
Position and posture where worker can constantly check robot movements and immediately move to avoid trouble if an error/problem occurs
  4. Install noise prevention measures
  5. Use methods for signaling operators of related equipment
  6. Use methods to decide that an error has occurred and identify the type of error

Implement the "work instructions" according to the type of robot, installation location, and type of work task.

When drawing up the "work instructions", make an effort to include opinions from the workers involved, equipment manufacture's technicians, and workplace safety consultants, etc.

**(32) Display a sign on operation panel during work**

Display an easy to understand sign or message on the programming box and operation panel during the job task, to prevent anyone other than the operators for that job task from mistakenly operating a start or selector switch. If needed, take other measures such as locking the cover on the operation panel.

**(33) Make daily and periodic inspections.**

- (1) Always make sure that daily and periodic inspections are performed, and make a pre-work check to ensure there are no problems with the robot or related equipment. If a problem or abnormality is found, then promptly repair it or take other measures as necessary.
- (2) When you make periodic inspections or repairs, make a record and store it for at least 3 years.

### **3 Industrial Robot Operating and Maintenance Personnel**

Operators or persons who handle the robot such as for teaching, programming, movement check, inspection, adjustment, and repair must receive appropriate training and also have the skills needed to perform the job correctly and safely. They must read the user's manual carefully to understand its contents before attempting the robot operation.

Tasks related to industrial robots (teaching, programming, movement check, inspection, adjustment, repair, etc.) must be performed by qualified persons who meet requirements established by local regulations and safety standards for industrial robots.

## 4 Robot Safety Functions

### (1) Overload detection

This function detects an overload applied to the motor and shuts off the servo power. If an overload error occurs, take the following measures.

1. Insert a timer in the program.
2. Reduce the acceleration coefficient.

### (2) Overheat detection

This function detects an abnormal temperature rise in the driver inside the controller and shuts off the servo power. If an overheat error occurs, take the following measures.

1. Insert a timer in the program.
2. Reduce the acceleration coefficient.

### (3) Soft limits

Soft limits can be set on each axis to limit the working envelope in manual operation after return-to-origin and during automatic operation.

Note: The working envelope is the area limited by soft limits.

#### **⚠ WARNING**

Soft limits must be set within the movement range (mechanical stopper). If the soft limit is set outside the movement range, the robot axis may collide with the mechanical stopper at high speed, causing the object gripped by the end effector to fly or drop and the robot to malfunction.

### (4) Mechanical stoppers

If the servo power is suddenly shut off during high-speed operation by emergency stop or safety functions, these mechanical stoppers prevent the axis from exceeding the movement range. The movement ranges of the X-axis arm can be limited as needed by use of mechanical stoppers. (Excluding the YK250X(H), YK350X(H) and YK400X(H))

On the Y-axis arm, mechanical stoppers are fixed at both ends of the maximum movement range.

The Z-axis has a mechanical stopper at the upper end and lower end.

No mechanical stopper is provided on the R-axis.

Note: The movement range is the area limited by mechanical stoppers.

#### **⚠ WARNING**

Axis movement will not stop immediately after the servo power supply is shut off by emergency stop or other safety functions.

### (5) Z-axis (vertical axis) brake

An electromagnetic brake is installed on the Z-axis to prevent the Z-axis from sliding down when servo power is turned off. This brake is working when the controller is off or the Z-axis servo power is off even when the controller is on. The Z-axis brake can be released by means of the programming box or by a command in the program when the controller is on.

**⚠ WARNING**

The Z-axis will slide down when the Z-axis brake is released, creating a hazardous situation.

- Press the emergency stop button and prop the Z-axis with a support stand before releasing the brake.
  - Use caution not to let your body get caught between the Z-axis and installation base when releasing the brake to perform direct teach.
- 

---

## **5 Safety Measures for the System**

Since the robot is commonly used in conjunction with an automated system, dangerous situations are more likely to occur from the automated system than from the robot itself. Accordingly, appropriate safety measures must be taken on the part of the system manufacturer according to the individual system. The system manufacturer should provide a proper instruction manual for safe, correct operation and servicing of the system.

## 6 Trial Operation

After making installations, adjustments, inspections, maintenance or repairs to the robot, make a trial run using the following procedures.

- (1) If a safeguard enclosure has not yet been provided right after installation of the robot, rope off or chain off around the movement area of the manipulator in place of the safeguard enclosure, and observe the following points.
  1. Use sturdy, stable posts which will not fall over easily.
  2. The rope or chain should be easily visible by everyone around the robot.
  3. Place a sign to keep the operator or other personnel from entering the movement range of the manipulator.
- (2) Check the following points before turning on the controller.
  1. Is the robot securely and correctly installed?
  2. Are the electrical connections to the robot correct?
  3. Are items such as air pressure correctly supplied?
  4. Is the robot correctly connected to peripheral equipment?
  5. Have safety measures (safeguard enclosure, etc.) been taken?
  6. Does the installation environment meet the specified standards?
- (3) After the controller is turned on, check the following points from outside the safeguard enclosure.
  1. Does the robot start and stop as intended? Can the operation mode be selected correctly?
  2. Does each axis move as intended within the soft limits?
  3. Does the end effector move as intended?
  4. Are the signal transmissions to the end effector and peripheral equipment correct?
  5. Does emergency stop work?
  6. Are the teaching and playback functions normal?
  7. Are the safeguard enclosure and interlock working as intended?
  8. Does the robot move correctly during automatic operation?

## 7 Work Within the Safeguard Enclosure

- (1) When work is required inside the safeguard enclosure, always turn off the controller and place a sign indicating that the robot is being adjusted or serviced in order to keep any other person from touching the controller switch or operation panel, except for the following cases.
  - 1) Origin position setting (See Section 3 in Chapter 4.)
  - 2) Soft limit settings (See Section 4 in Chapter 4.)
  - 3) Standard coordinate settings (See Section 5 in Chapter 4.)
  - 4) Inspection of the X-axis motor cooling fan inside the base (YK550X only)  
(See (2) of Section 4 in Chapter 5.)
  - 5) Teaching

For items 1) to 4), follow the precautions and procedure for each section. To perform item 5), refer to the description in (2) below.

- (2) Teaching

When performing teaching within the safeguard enclosure, comply with the instructions listed below.

  - 1) Check or perform the following points from outside the safeguard enclosure.
    1. Make sure that no hazards are present within the safeguard enclosure by a visual check.
    2. Check that the programming box MPB/RPB operates correctly.
    3. Check that no failures are found in the robot.
    4. Check that emergency stop works correctly.
    5. Select teaching mode and prohibit automatic operation.
  - 2) Never enter the movement range of the manipulator while within the safeguard enclosure.

## 8 Automatic Operation

Automatic operation described here includes all operations in AUTO mode.

- (1) Check the following before starting automatic operation.
  1. No one is within the safeguard enclosure.
  2. The programming box and tools are in their specified locations.
  3. The alarm or error lamps on the robot and peripheral equipment do not flash.
  4. The safeguard enclosure is securely installed with safety interlocks actuated.
- (2) Observe the following during automatic operation or in cases where an error occurs.
  - 1) After automatic operation has started, check the operation status and warning lamp to ensure that the robot is in automatic operation.
  - 2) Never enter the safeguard enclosure during automatic operation.
  - 3) If an error occurs in the robot or peripheral equipment, observe the following procedure before entering the safeguard enclosure.
    1. Press the emergency stop button to set the robot to emergency stop.
    2. Place a sign on the start switch, indicating that the robot is being inspected in order to keep any other person from touching the start switch and restarting the robot.

## 9 Warranty

For information on the warranty period and terms, please contact our distributor where you purchased the product.

**This warranty does not cover any failure caused by:**

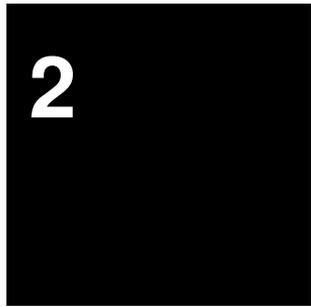
1. Installation, wiring, connection to other control devices, operating methods, inspection or maintenance that does not comply with industry standards or instructions specified in the YAMAHA manual;
2. Usage that exceeded the specifications or standard performance shown in the YAMAHA manual;
3. Product usage other than intended by YAMAHA;
4. Storage, operating conditions and utilities that are outside the range specified in the manual;
5. Damage due to improper shipping or shipping methods;
6. Accident or collision damage;
7. Installation of other than genuine YAMAHA parts and/or accessories;
8. Modification to original parts or modifications not conforming to standard specifications designated by YAMAHA, including customizing performed by YAMAHA in compliance with distributor or customer requests;
9. Pollution, salt damage, condensation;
10. Fires or natural disasters such as earthquakes, tsunamis, lightning strikes, wind and flood damage, etc;
11. Breakdown due to causes other than the above that are not the fault or responsibility of YAMAHA;

**The following cases are not covered under the warranty:**

1. Products whose serial number or production date (month & year) cannot be verified.
2. Changes in software or internal data such as programs or points that were created or changed by the customer.
3. Products whose trouble cannot be reproduced or identified by YAMAHA.
4. Products utilized, for example, in radiological equipment, biological test equipment applications or for other purposes whose warranty repairs are judged as hazardous by YAMAHA.

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# CHAPTER 2



## Functions

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# MEMO

# 1 Robot Manipulator

The YK-X series robots are available in 4-axis models having an X/Y-axis arm (equivalent to human arm) and a Z/R-axis (equivalent to human wrist).

With these 4 axes, the YK-X series robots can move as shown in Fig. 2-1. By attaching different types of end effector (gripper) to the end of the arm, a wide range of tasks can be performed with high precision at high speeds.

The (+) and (-) signs show the direction of axis movement when the jog keys on the programming box are pressed (standard setting at the factory). Fig. 2-2 to Fig. 2-6 on the subsequent pages show part names and functions of each robot model.

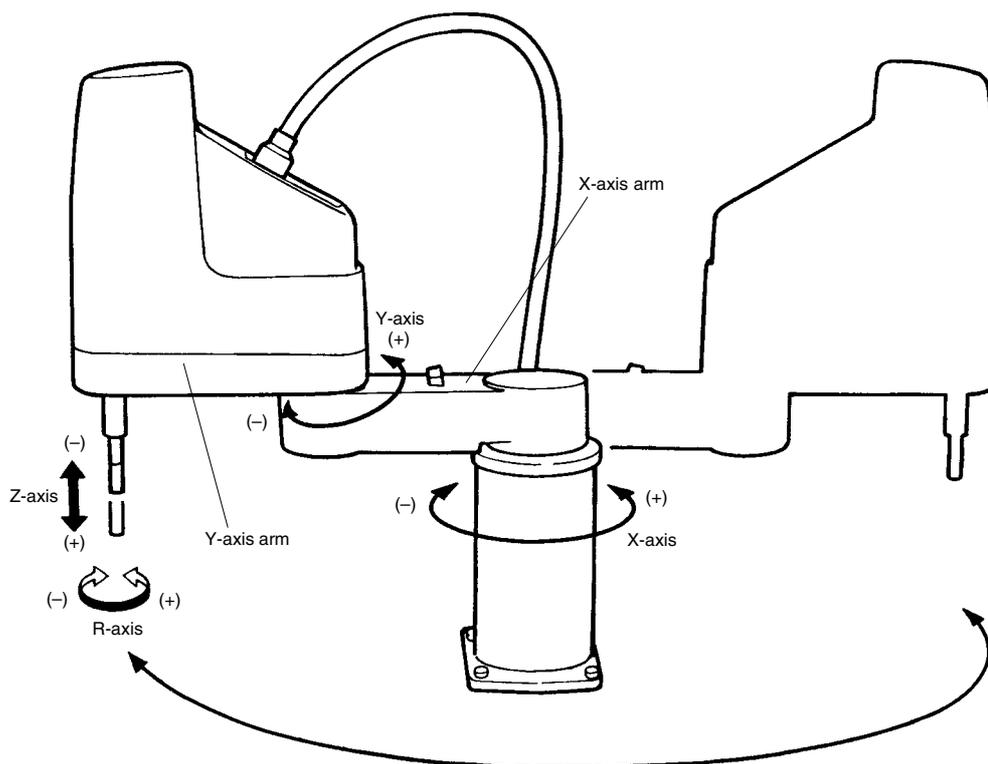


Fig. 2-1 Manipulator movement

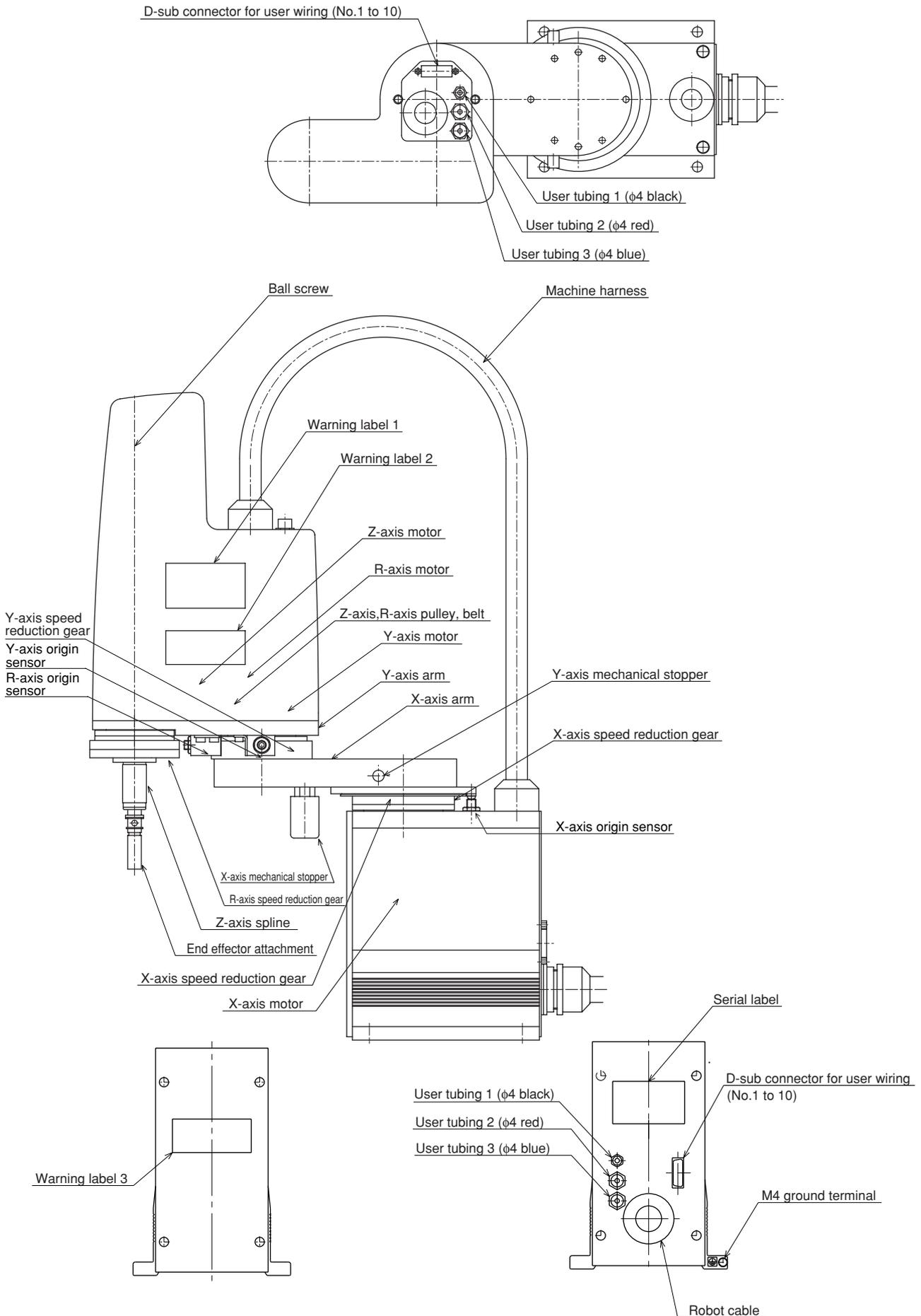


Fig. 2-2 YK250X(H), YK350X(H), YK400X(H)

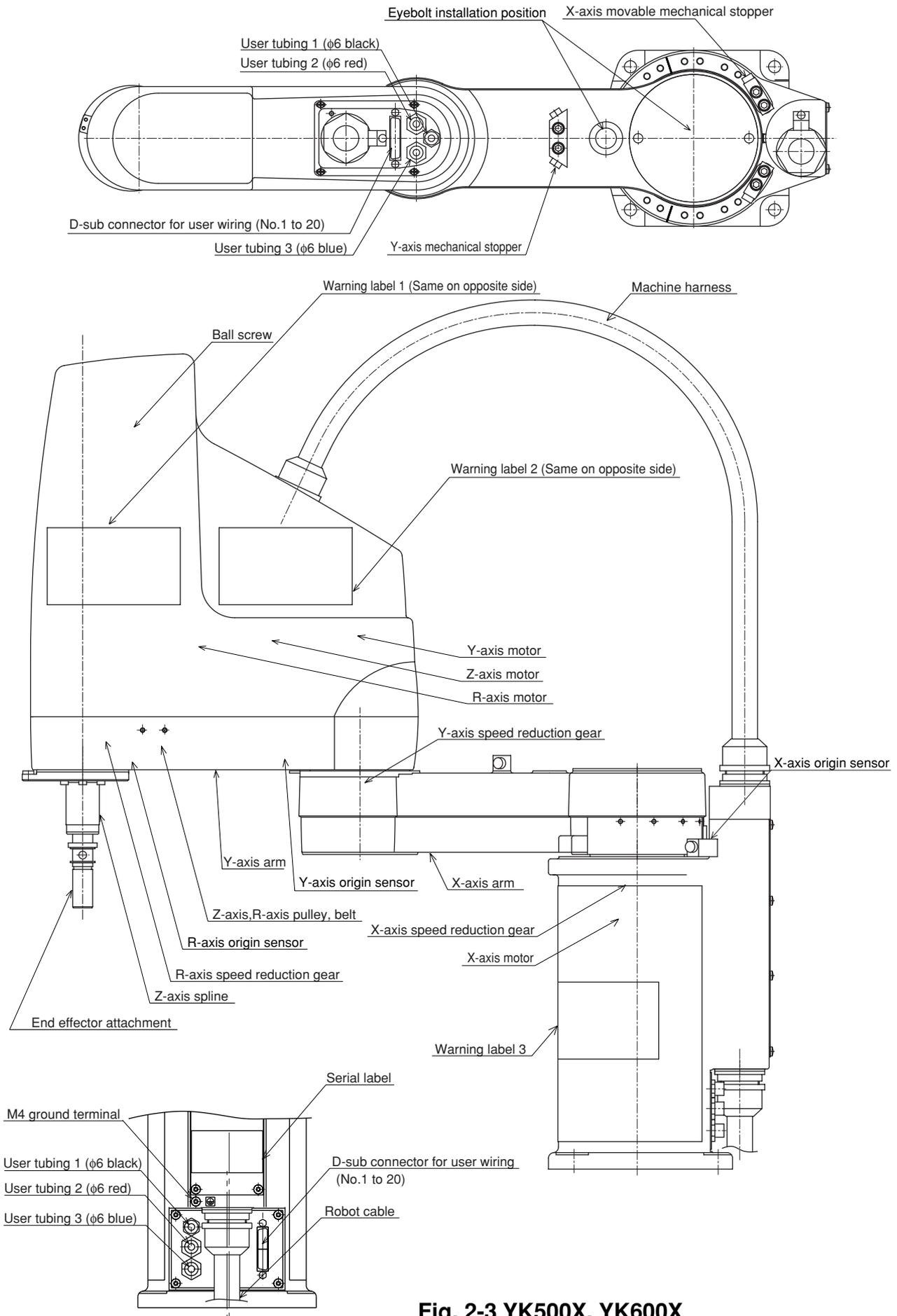
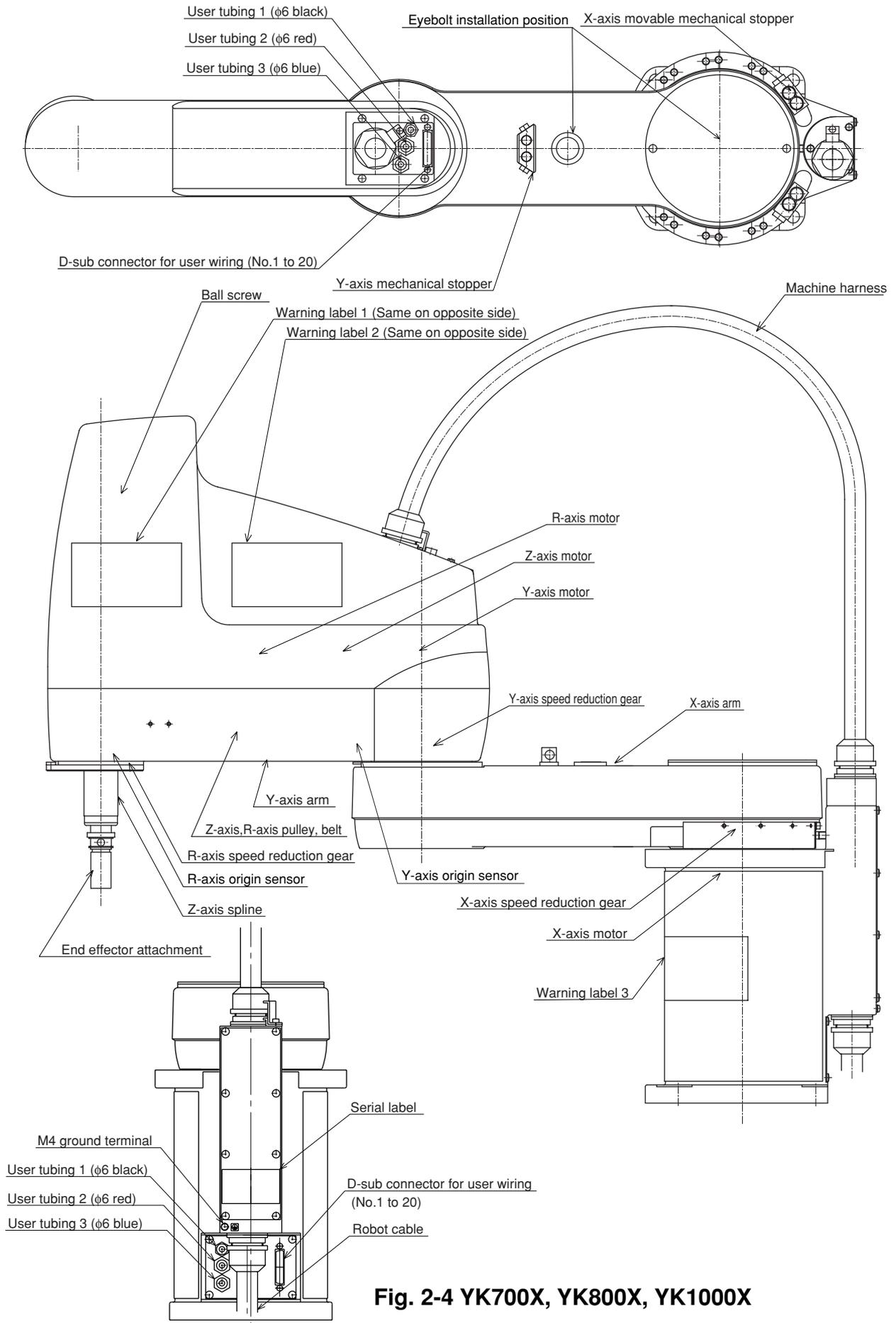


Fig. 2-3 YK500X, YK600X

**CHAPTER 2 Functions**



**Fig. 2-4 YK700X, YK800X, YK1000X**

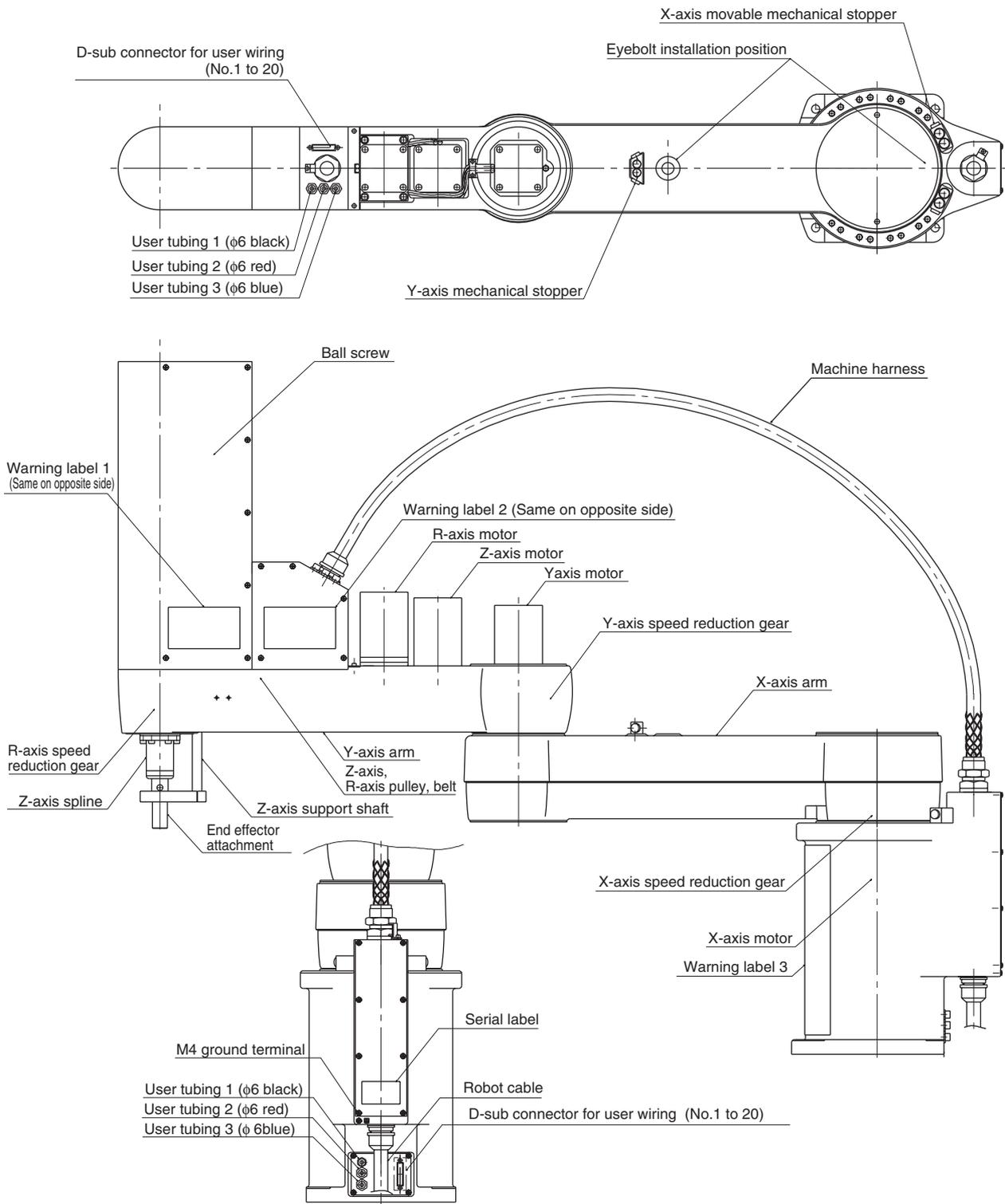


Fig. 2-5 YK1200X

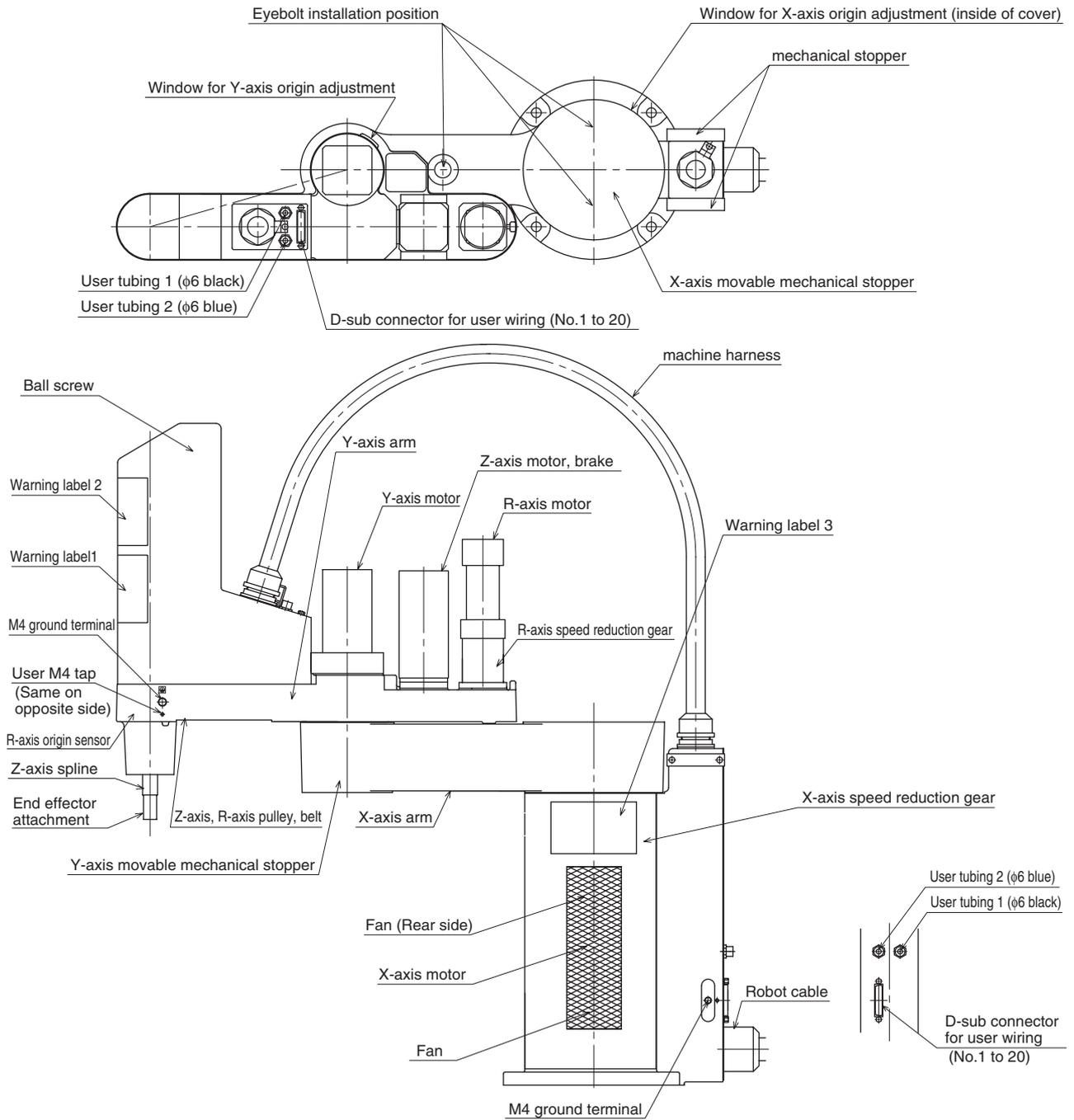


Fig. 2-6 YK550X

## 2 Robot Controller

The YK-X series robot comes supplied with a robot controller RCX142 or RCX240.

For more details, refer to the separate "YAMAHA Robot Controller User's Manual".

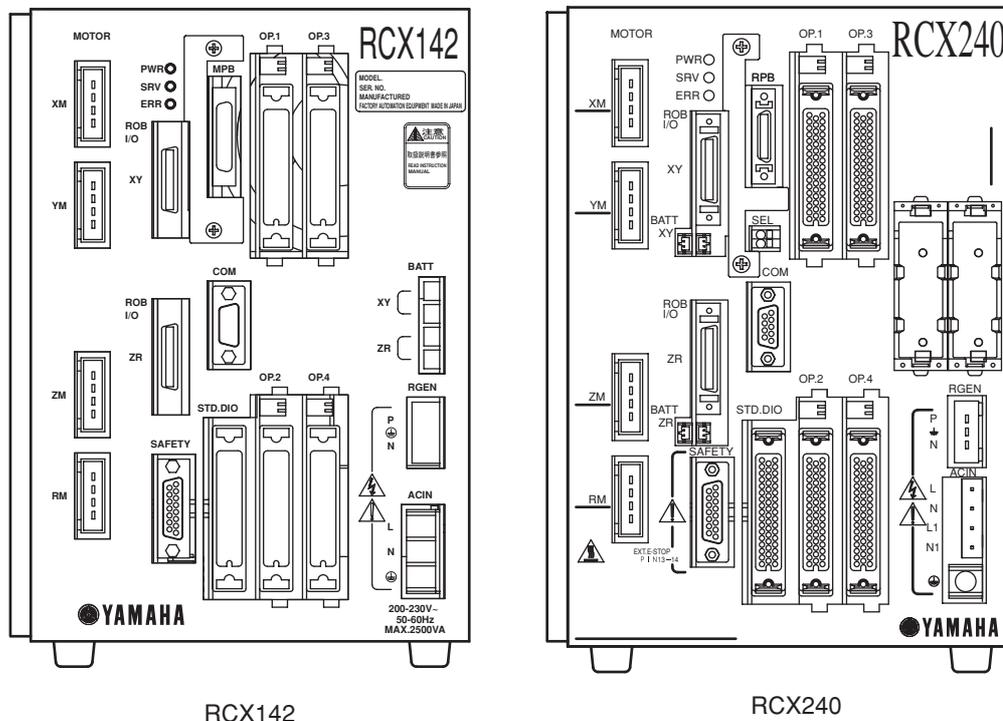


Fig. 2-7 Robot controller

### 3 Robot initialization number list

The YK-X series robots are initialized for optimum setting (default setting) according to the robot model prior to shipping. The robot controllers do not have to be reinitialized during normal operation. However, if for some reason the controller must be reinitialized, proceed while referring to the list below.

#### CAUTION

Absolute reset must be performed after reinitializing the controller. Before reinitializing the controller, read the descriptions in "3. Adjusting the origin" in Chapter 4 and make sure you thoroughly understand the procedure.

#### CAUTION

When the controller is initialized, the "ARM LENGTH" and "OFFSET PULSE" settings in the axis parameters will be erased, making the standard coordinate settings invalid.

(For details on standard coordinates, see "5. Setting the Standard Coordinates" in Chapter 4.)

If you do not want to change the origin position by initializing, make a note of the "ARM LENGTH" and "OFFSET PULSE" settings before initializing, and re-enter their settings after initialization is complete.

Robot initialization number list (Origin mark model)

Robot initialization number	Model name
2000	YK250X(H) Z150
2001	YK350X(H) Z150
2002	YK400X(H) Z150
2003	YK500X Z200
2004	YK600X Z200
2005	YK700X Z200
2006	YK800X Z200
2007	YK1000X Z200
2008	YK1200X Z400
2009	YK550X

Robot initialization number	Model name
2010	YK500X Z300
2011	YK600X Z300
2012	YK700X Z400
2013	YK800X Z400
2014	YK1000X Z400
2015	YK550XH

YK550X: Standard R-axis specifications  
YK550XH: High-speed R-axis specifications

Robot initialization number list (Origin sensor model)

Robot initialization number	Model name
2100	YK250X(H) Z150
2101	YK350X(H) Z150
2102	YK400X(H) Z150
2103	YK500X Z200
2104	YK600X Z200
2105	YK700X Z200
2106	YK800X Z200
2107	YK1000X Z200

Robot initialization number	Model name
2110	YK500X Z300
2111	YK600X Z300
2112	YK700X Z400
2113	YK800X Z400
2114	YK1000X Z400

\* When initializing the robot controllers for clean room models and dust/drip proof models, use the robot initialization number for the robot models containing the same number.

[Example] YK250XC(H) Z150 : Origin sensor model )  
YK250XP Z150 : Origin sensor model ) → Robot initialization number: 2100 (YK250X(H) Z150 : Same as origin sensor model)

# CHAPTER 3

## Installation

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# 1 Robot Installation Conditions

## 1-1 Installation environments

Be sure to install the robot in the following environments.

Items	Specifications
Allowable ambient temperature	0 to 40°C
Allowable ambient humidity	35 to 85% RH (non condensation)
Altitude	0 to 1000 meters above sea level
Ambient environments	Avoid installing near water, cutting water, oil, dust, metallic chips and organic solvent.
	Avoid installation near corrosive gas and corrosive materials.
	Avoid installation in atmosphere containing inflammable gas, dust or liquid.
	Avoid installation near objects causing electromagnetic interference, electrostatic discharge or radio frequency interference.
Vibration	Do not subject to impacts or vibrations.
Air supply pressure, etc.	Below 0.58MPa (6.0kgf/cm <sup>2</sup> ); clean dry air not containing deteriorated compressor oil; filtration 40 μm or less
Working space	Allow sufficient space margin to perform jobs (teaching, inspection, repair, etc.)

For detailed information on how to install the robot controller, refer to the separate "YAMAHA Robot Controller User's Manual".

### **⚠ WARNING**

Avoid installing the robot in locations where the ambient conditions may exceed the allowable temperature or humidity, or in environments where water, corrosive gases, metallic powder or dust are generated. Malfunction, failure or short circuits may otherwise result.

### **⚠ WARNING**

- This robot was not designed for operation in environments where inflammable or explosive substances are present.
- Do not use the robot in environments containing inflammable gas, dust or liquids. Explosions or fire could otherwise result.

### **⚠ WARNING**

Avoid using the robot in locations subject to electromagnetic interference, electrostatic discharge or radio frequency interference. Malfunction may otherwise occur.

**⚠ WARNING**

Do not use the robot in locations subject to excessive vibration. Robot installation bolts may otherwise become loose causing the manipulator to fall over.

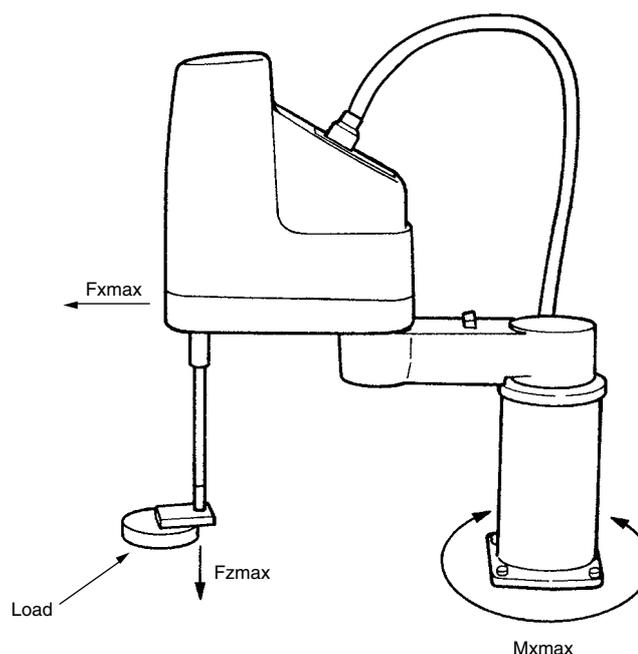
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## 1-2 Installation base

- 1) Prepare a sufficiently rigid and stable installation base, taking account of the robot weight including the end effector (gripper), workpiece and reaction force while the robot is operating. The maximum reaction force (see Fig. 3-1) applied to the X-axis and Z-axis of each robot during operation is shown in the table below. These values are an instantaneous force applied to the robot during operation and do not indicate the maximum load capacity.

### The maximum reaction force

Robot Model	F <sub>xmax</sub>		M <sub>xmax</sub>		F <sub>zmax</sub>	
	N	kgf	Nm	kgfm	N	kgf
YK250X(H)	305	31	56	6	40	4
YK350X(H)	330	34	56	6	40	4
YK400X(H)	391	40	56	6	40	4
YK500X	708	72	137	14	89	9
YK600X	735	75	137	14	89	9
YK700X	1653	169	304	31	159	16
YK800X	1707	174	304	31	159	16
YK1000X	1618	165	333	34	127	13
YK1200X	3293	336	1029	105	108	11
YK550X	628	64	216	22	135	14



**Fig. 3-1 Maximum reaction force applied during operation**

- 2) The parallelism of the installation base surface must be machined within a precision of  $\pm 0.05\text{mm}/500\text{mm}$ . The robot base mount must be installed facing down and in a level position (except ceiling-mount models which should be installed with the base mount facing up).
- 3) Tap holes into the surface of the installation base. For machining dimensions and positions, refer to "1-2 External view and dimensions" in Chapter 7.

- 4) Securely fix the installation base on the floor with anchor bolts.

**⚠ WARNING**

Do not place the robot on a moving installation base. Excessive loads will be applied to the robot arm by movement of the installation base, resulting in damage to the robot.

---

**⚠ CAUTION**

The manipulator positioning might decrease if the installation surface precision is insufficient.

---

**⚠ CAUTION**

If the installation base is not sufficiently rigid and stable or a thin metallic plate is attached to the installation base, vibration (resonance) may occur during operation, causing detrimental effects on the manipulator work.

---

# 2 Installation

## 2-1 Unpacking

**⚠ WARNING**

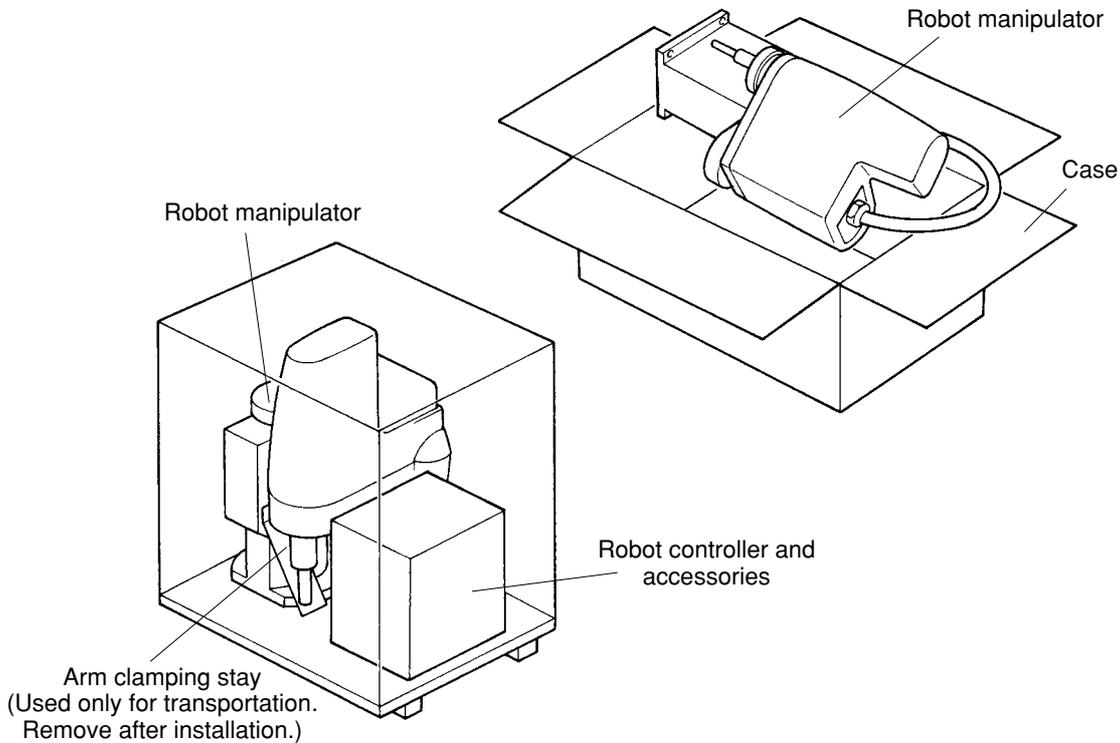
The robot and controller are heavy. Take sufficient care not to drop them during moving or unpacking as this may damage the equipment or cause bodily injury.

**⚠ CAUTION**

When moving the robot or controller by equipment such as a forklift that require a license, only properly qualified personnel may operate it. The equipment and tools used for moving the robot should be serviced daily.

The YK-X series robot comes packed with a robot controller and accessories, according to the order specifications. Using a carrying cart (dolly) or forklift, move the package to near the installation base. Take sufficient care not to apply shocks to the equipment when unpacking it.

YK250X(H), YK350X(H), YK400X(H)



YK500X, YK600X, YK700X, YK800X, YK1000X, YK1200X, YK550X

**Fig. 3-2 Packed state**

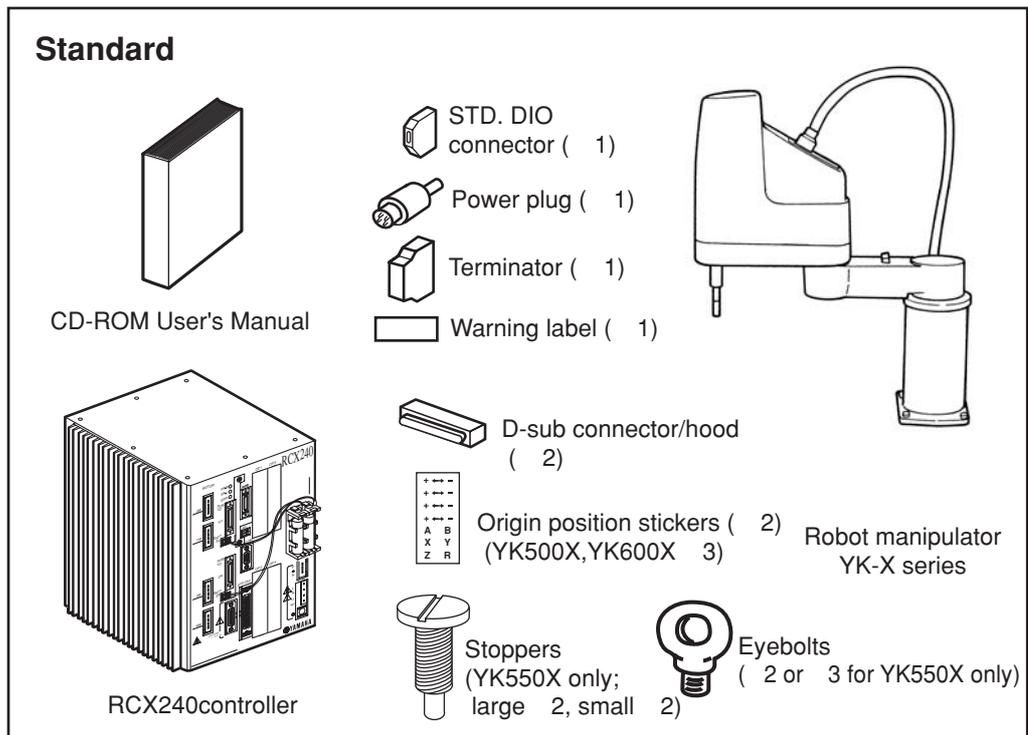
## 2-2 Checking the product

After unpacking, check the product configuration and conditions. The following configurations are typical examples, so please check that the product is as specified in your order.

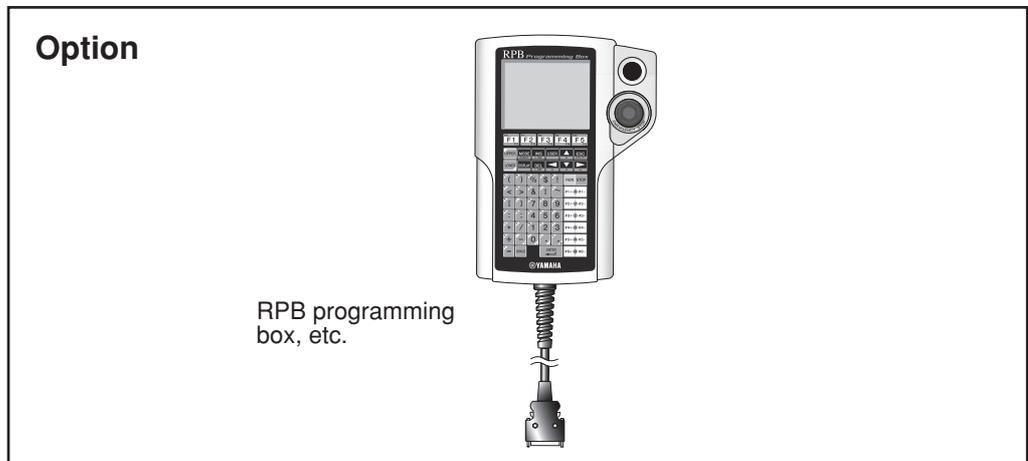
### CAUTION

If there is any damage due to transportation or insufficient parts, please notify your YAMAHA sales office or dealer immediately.

Controller : RCX240  
 Robot : YK250X(H), YK350X(H), YK400X(H), YK500X, YK600X, YK700X, YK800X, YK1000X, YK1200X, YK550X



Eyebolts are not supplied with the YK250X, YK350X and YK400X



\* Refer to the "YAMAHA Robot Controller User's Manual" for details on the controller accessories and options.

**Fig. 3-3 Product configurations**

## 2-3 Moving the robot

### **⚠ WARNING**

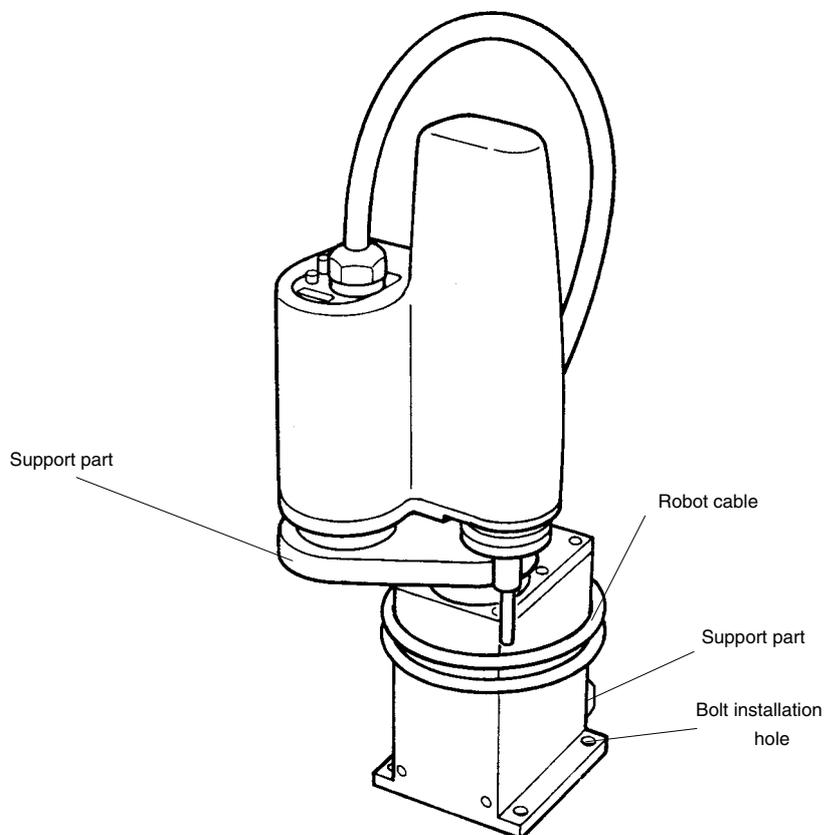
Serious injury may occur if the robot falls and pins someone under it.

- Do not allow any part of your body to enter the area beneath the robot during work.
- Always wear a helmet, safety shoes and gloves during work.

To check the mass of each robot, refer to "1-1 Basic specifications" in Chapter 7.

### 2-3-1 Moving the YK250X(H), YK350X(H), YK400X(H)

- 1) Fold the X and Y axis arms as shown in Fig. 3-4, and wind the robot cable around the upper part of the pedestal, then fasten the robot cable with adhesive tape so as not to cover the bolt installation holes.
- 2) Holding the support parts as shown in the figure with both hands, place the robot on the installation base and secure it temporarily by tightening the bolts. (For tightening torque to secure the robot firmly, see the next section, "2-4 Installing the robot".)



**Fig. 3-4**

## 2-3-2 Moving the YK500X, YK600X, YK700X, YK800X, YK1000X, YK1200X, YK550X

### **⚠ WARNING**

---

Serious injury may occur if the robot falls and pins someone under it.

- Check that there are no cracks and corrosion on the eyebolt installation. If found, do not use eyebolts to move the robot.
  - Screw the eyebolts securely into the tapped holes until the bearing surface of eyebolt makes tight contact with the bearing surface on the arm.
  - Use a hoist and rope with carrying capacity strong enough to support the robot weight.
  - Make sure the rope stays securely on the hoist hook.
  - Remove all loads attached to the robot manipulator end. If any load is still attached, the robot may lose balance while being carried, and topple over causing accidents.
- 

### **⚠ CAUTION**

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- When moving the robot by equipment such as cranes that require a license, only properly qualified personnel may operate it.
  - The equipment and tools used for moving the robot should be serviced daily.
- 

To move a robot (for example, the YK500X) correctly and safely, follow the procedure below. (See Fig. 3-5.) Use the same procedure to move other robots.

- 1) If the Z-axis is not at the origin position, perform return-to-origin from outside the safeguard enclosure. Then, turn off the controller and unplug the robot cable from the controller. (The Z-axis is fixed at the origin position prior to shipping.)
- 2) Remove the X-axis arm cover and set screws.
- 3) Fold the X and Y-axis arms as shown in the drawing, and clamp the Y axis arm to the robot pedestal by using the stay and bolts that come with the robot. If the arms cannot be folded in the carrying position due to the X-axis mechanical stoppers, then remove them. (When the robot is shipped, the mechanical stoppers are installed to provide the maximum movement range.)
- 4) Screw the two eyebolts securely into the tapped hole on the machined bearing surface of the X-axis arm.  
(Use three eyebolts for the YK550X.)
- 5) Wind the robot cable around the upper part of the robot pedestal so that it does not hang up on the base mount, then fasten the cable end with adhesive tape.

- 6) Prepare two looped ropes with the same length to allow a good lifting balance, then pass each rope through each eyebolt and catch it on the hoist hook. (3 looped ropes are needed for the YK550X.)
- 7) Slightly lift the hoist so that each rope has light tension to hold the robot. In this state, remove the bolts securing the robot base to the pallet supplied or installation base (if robot is to be moved to another installation base).
- 8) Using caution to keep the balance of the robot and avoid subjecting it to any strong vibrations and shocks, operate the hoist carefully to move to the installation base. The angle between each rope and the arm surface should be kept at 45 degrees or more.
- 9) Slightly lower the robot on the installation base and temporarily secure it by tightening the bolts.  
(For tightening torque to secure the robot firmly, see the next section, "2-4 Installing the robot".)
- 10) Remove the ropes, eyebolts and arm clamping stay, then reattach the cover and the set screws on the X-axis arm. (Be sure to fit the set screws and the cover in position to protect the tapped holes for eyebolts.) Keep the eyebolts, arm clamping stay, bolts and pallet for future use in case the robot needs to be moved or transported.

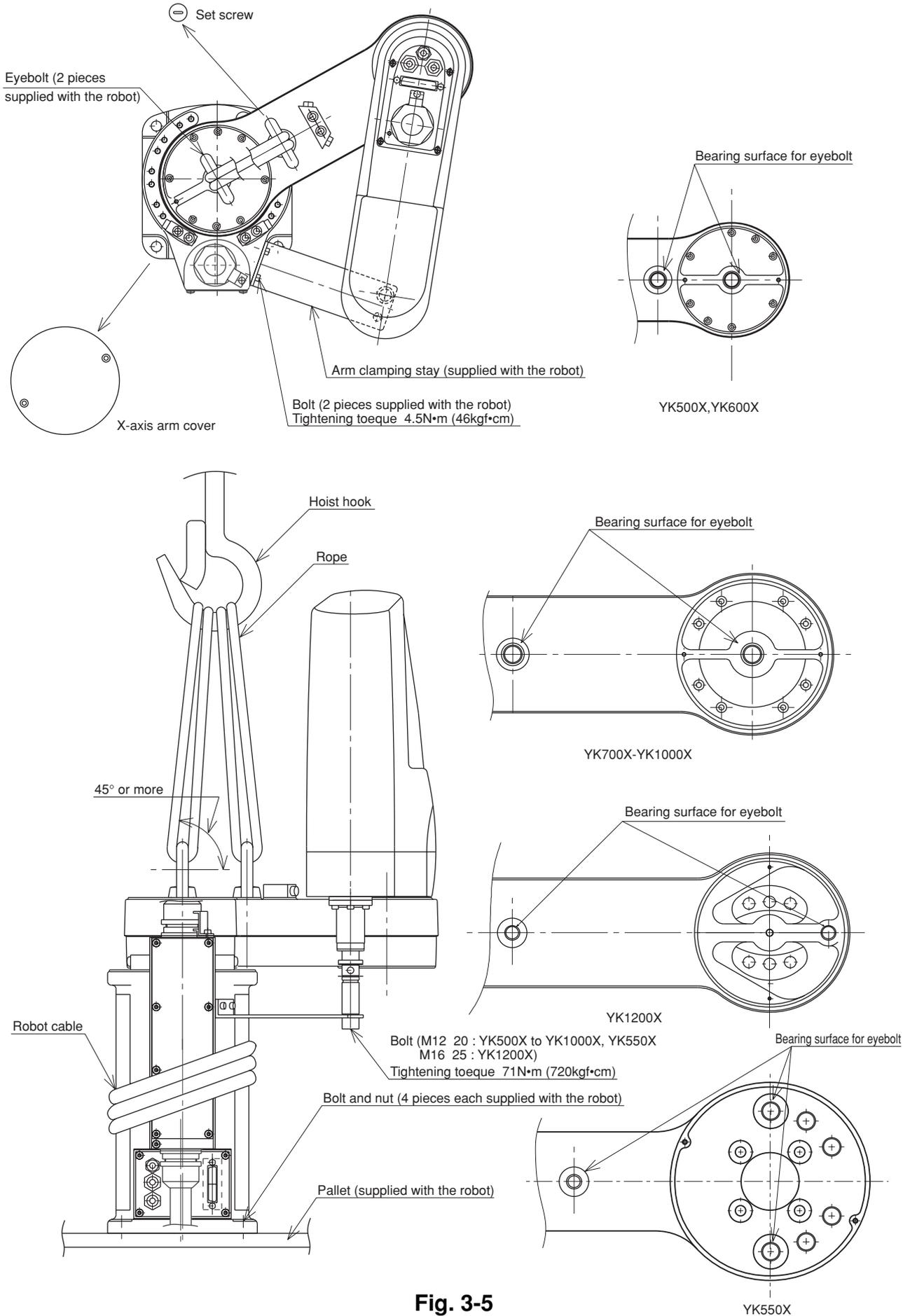


Fig. 3-5

## 2-4 Installing the robot

Install the robot securely with the four hex socket head bolts as shown in Fig. 3-6.

**⚠ WARNING**

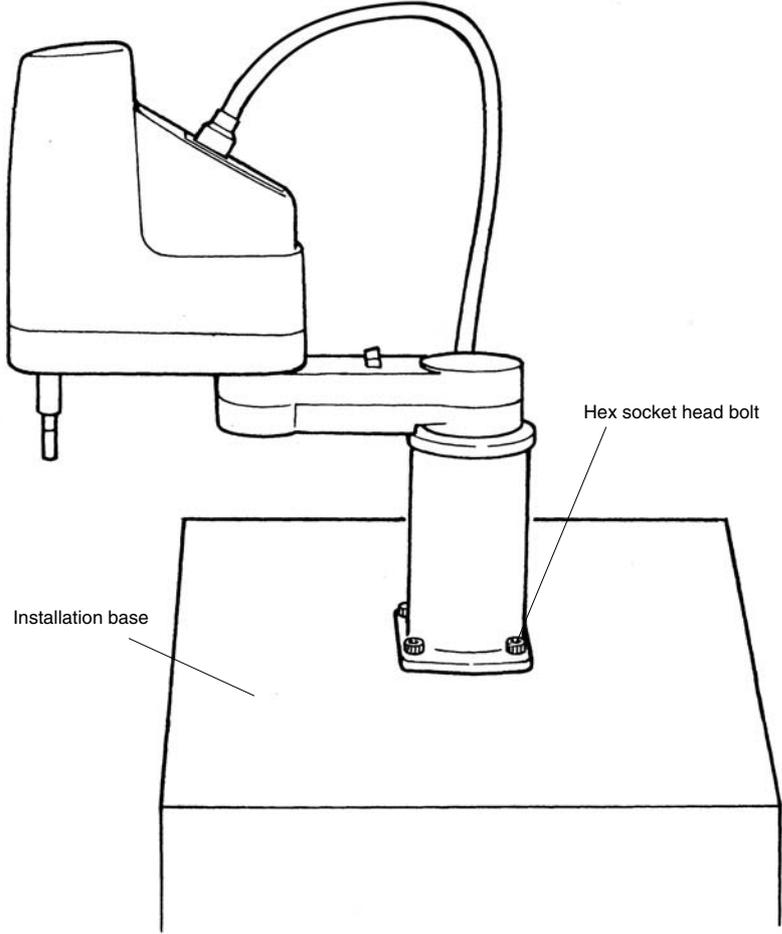
When installing the robot, be sure to use the specified size and quantity of bolts that match the depth of tapped holes in the installation base, and securely tighten the bolts to the correct torque. If the bolts are not tightened correctly, the robot might fall over during operation causing a serious accident.

**Tightening torque**

Robot Model	Bolts Used	Tightening torque
YK250X(H), YK350X(H), YK400X(H)	M8	37N·m (380kgf·cm)
YK500X, YK600X, YK550X	M10	71N·m (720kgf·cm)
YK700X, YK800X, YK1000X, YK1200X	M12	128N·m (1310kgf·cm)

Depth of tapped holes in installation base:

- Iron installation base                      Bolt diameter × 1.5 or more
- Aluminum installation base              Bolt diameter × 3 or more



**Fig. 3-6 Installing the robot**

## 3 Protective Bonding

**⚠ WARNING**

Be sure to ground the robot and controller to prevent electrical shock.

---

**⚠ WARNING**

Turn off the controller before grounding the robot.

---

The robot must be grounded as follows:

- 1) Provide a terminal marked "PE" for the protective conductor of the entire system and connect it to an external protective conductor. In addition, securely connect the ground terminal on the robot pedestal to the same protective conductor. (See Fig. 3-7 for example of the YK500X.)



**(Symbol 417-IEC-5019)**

- 2) When the end effector uses an electrical device which, if it malfunctions, might make contact with the power supply, the user must provide proper grounding on his own responsibility. The YK-X series robots do not have a ground terminal for this purpose.
- 3) For details on protective bonding on the robot body to comply with CE marking, follow the instructions on protective bonding explained in the "YAMAHA Robot Controller User's Manual".
- 4) Use a ground cable with a conductor wire cross section of at least 2.0mm<sup>2</sup> and a length within 1 meter.

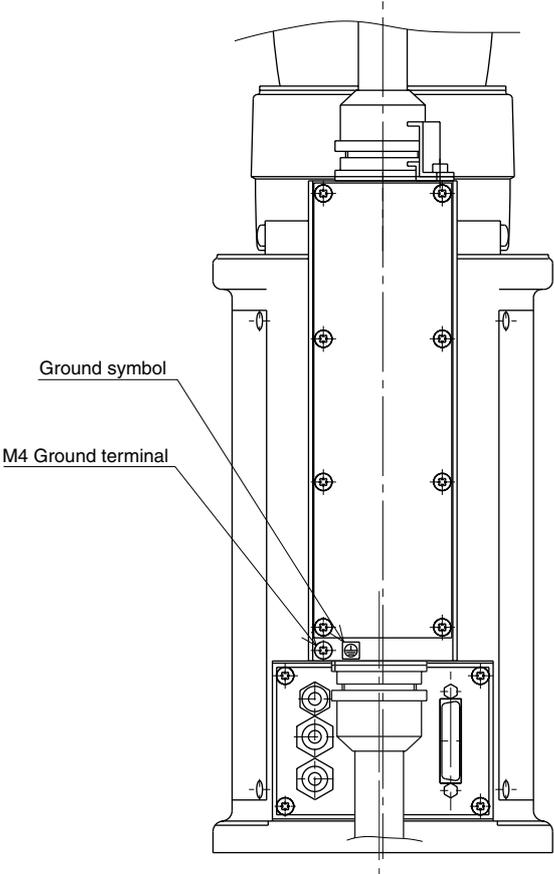


Fig. 3-7 Ground terminal

## 4 Robot Cable Connection

The robot cable is pre-connected to the YK-X series robot. For details on connections to the robot controller, refer to Fig. 3-8 and the "YAMAHA Robot Controller User's Manual". After making connections, check the operation while referring to "6 Trial operation" in Chapter 1.

---

**⚠ WARNING**

- Before connecting the cables, check that there are no bends or breaks in the connector pins of the robot cable and that the cables are not damaged. Bent or broken pins or cable damage may cause malfunction of the robot.
  - Ensure that the controller is off before connecting the robot cable to the controller.
- 

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**⚠ WARNING**

In the RCX142/RCX240 controller, the MOTOR connectors XM and ZM, and YM and RM each have identical shapes. In addition, the PI connectors XY and ZR have identical shapes. Do not confuse these connectors when making connections. Wrong connections may result in malfunction and hazardous situations.

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**⚠ WARNING**

- If the connector installation is inadequate or if there are contact failures in the pins, the robot may malfunction causing a hazardous situation. Reconfirm that each connector is securely installed before turning on the controller.
  - To attach the PI connector securely, tighten the screws supplied with the robot.
  - Take caution not to apply an excessive load to the connectors due to stress or tension on the cables.
- 

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**⚠ WARNING**

Lay out the cables so that they do not obstruct the movement of the manipulator. Determine the robot work area in which the robot cables will not interfere with the load or workpiece picked up by the manipulator. If the robot cables interfere with the movable parts of the robot, the cables may be damaged causing malfunction and hazardous situations. Refer to "1-2 External view and dimensions" in Chapter 7.

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**⚠ WARNING**

Lay out the robot cables so as to keep the operator or any other person from tripping on them. Bodily injury may result if someone trips on the cables.

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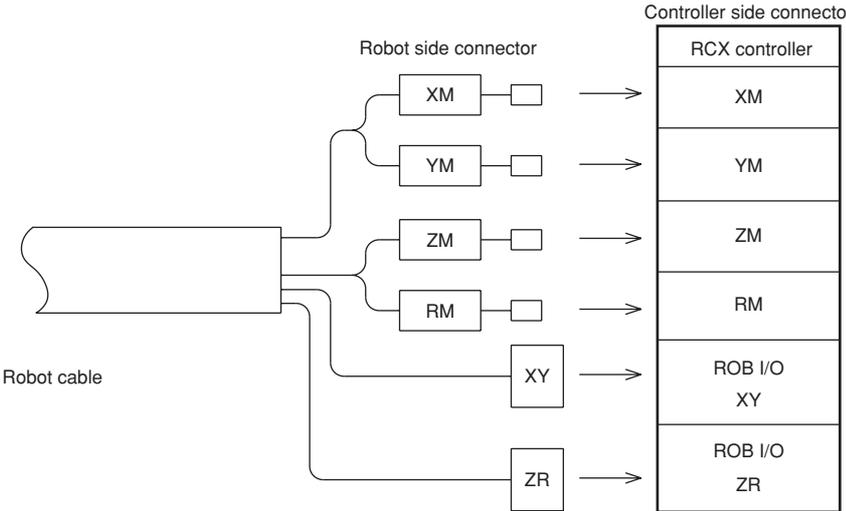


Fig. 3-8 Robot cable connections

## 5 User Wiring and User Tubing

### **⚠ WARNING**

Always turn off the controller and shut off air supply before attempting wiring and piping work. If air or power is supplied during this work, the manipulator may move erroneously causing a hazardous situation.

- 1) The YK-X series robots are equipped with user wires and air tubes in the machine harness. The table below shows the number of wires and air tubes available for each robot model.

Robot model	User wiring	User tubing
YK250X(H), YK350X(H), YK400X(H)	10wires	φ4, 3tubes
YK500X, YK600X, YK700X, YK800X, YK1000X, YK1200X	20wires	φ6, 3tubes
YK550X	20wires	φ6, 2tubes

(Robot models for custom specifications may have different wiring or tubing.)

The specifications of the user wires and air tubes are shown below. Always observe the specifications.

#### User Wiring

Rated voltage	30V
Allowable current	1.5A
Nominal cross-section area of conductor	0.2mm <sup>2</sup>
Shield	Yes

#### User Tubing

Maximum pressure	0.58MPa (6Kgf/cm <sup>2</sup> )
Outer diameter × inner diameter	φ4mm×φ2.5mm
	φ6mm×φ4mm
Fluid	Dry clean air not containing deteriorated compressor oil; filtration 40μm or less

- 2) A D-sub connector for user wiring and a bulkhead union for user tubing are provided one each on the arm side and pedestal side. For the locations, refer to "1-2 External view and dimensions" in Chapter 7.

3) Signal wiring connections in the machine harness

1. YK250X(H), YK350X(H), YK400X(H)

Connector pins 1 to 10 can be used. Pin 15 is connected to a shield wire and cannot be used as a signal wire.

Signal	Connector	NO	Connection	NO	Connector	Color
User signal line	I O (Arm side)	1		1	I O (Base side)	Brown
		2		2		Red
		3		3		Orange
		4		4		Blue
		5		5		Violet
		6		6		Grey
		7		7		White
		8		8		Black
		9		9		Brown
		10		10		Red
		11		11		Orange
		12		12		Blue
		13		13		Violet
		14		14		Grey
Shield		15		15		Green
Flame ground				1	FG	Green

(Robots models with non-standard specifications may have different wiring colors.)

2. YK500X, YK600X, YK700X, YK800X, YK1000X, YK1200X, YK550X

Connector pins 1 to 20 can be used. Pin 25 is connected to a shield wire and cannot be used as a signal wire.

Signal	Connector	NO	Connection	NO	Connector	Color
User signal line	I O (Arm side)	1		1	I O (Base side)	Brown
		2		2		Red
		3		3		Orange
		4		4		Blue
		5		5		Violet
		6		6		Grey
		7		7		White
		8		8		Black
		9		9		Brown
		10		10		Red
		11		11		Orange
		12		12		Blue
		13		13		Violet
		14		14		Grey
		15		15		White
		16		16		Black
		17		17		Brown
		18		18		Red
		19		19		Orange
		20		20		Blue
21	21					
22	22					
23	23					
24	24					
25		25		25		Green
Shield						
Flame Ground				1	FG	Green

(FG wire is not provided for YK550X.)

(Robots models with non-standard specifications may have different wiring colors.)

- 4) As shown in Fig. 3-9, solder the user cable wires to the D-sub connector (supplied with the robot). Reattach the hood to the D-sub connector after soldering, then plug it into the user wiring connector. The connector pinouts as viewed from the solder side are shown below.

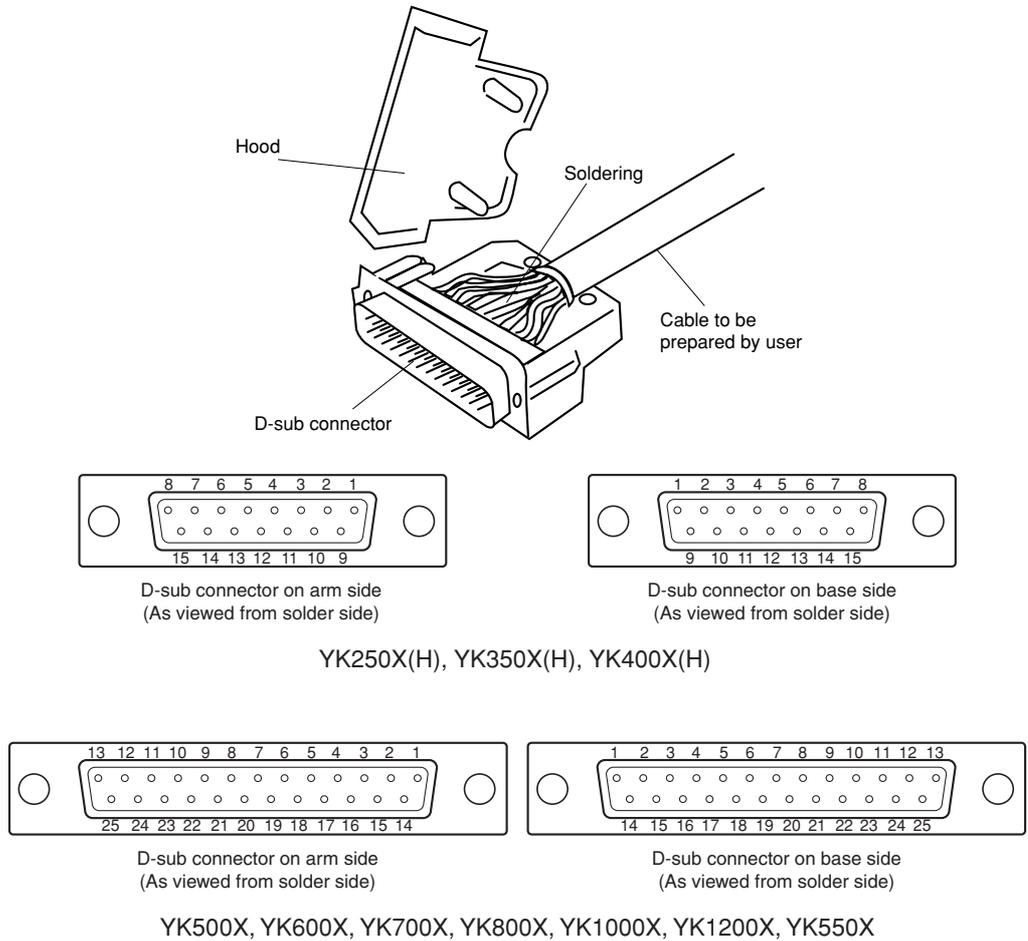


Fig. 3-9

**⚠ WARNING**

The user cable wires should have a shield wire. Connect it to the same No. pin in the D-sub connector on the robot side, which also connects to the shield wire. If this task is omitted, noise may cause malfunction of the robot.

**⚠ WARNING**

Securely attach the D-sub connector (supplied with the robot) into the D-sub connector on the robot side, by tightening the screws on the connector hood. If this connector comes loose or comes off, malfunction may result.

**⚠ WARNING**

Avoid fastening the user cable or tube with the machine harness, as this may lead to harness breakage and malfunction.

**⚠ WARNING**

Make sure that the user cable attached to the D-sub connector for user wiring and the tube attached to the bulkhead union for user tubing will not interfere with the robot movement, entangle around the robot or flap around during operation. Wiring and tubing might then be damaged causing malfunction of the robot.

**⚠ WARNING**

Lay out the user cable attached to the D-sub connector for user wiring and the tube attached to the bulkhead union for user tubing so that they do not obstruct the movement of the operator or any other persons. Bodily injury may result if anyone trips on the cable or air tube.

**⚠ CAUTION**

The D-sub connector supplied with the robot should be connected to the arm side by pin contact, and to the pedestal side by socket contact. Use caution at these points when soldering.

**⚠ CAUTION**

Be sure to use the D-sub connector and hood which are supplied with the robot. Using other types may result in contact failure.

**D-sub connectors (supplied with robot)**

Robot model	D-sub connector on arm side	D-sub connector on base side	Hood
YK250X(H), YK350X(H), YK400X(H)	DA-15P-NR	DA-15S-NR	DA-C1-J10R
YK500X, YK600X, YK700X, YK800X, YK1000X, YK1200X, YK550X	DB-25P-NR	DB-25S-NR	DB-C2-J9R

Manufacturer : Japan Aviation Electronics Industry, Limited.

- 5) To check the operation and signal transmission between the end effector and the controller or peripheral equipment after making connections, refer to "6. Trial operation" in Chapter 1.

## 6 Attaching The End Effector

### 6-1 R-axis tolerable moment of inertia and acceleration coefficient

- 1) The moment of inertia of a load (end effector and workpiece) that can be attached to the R-axis is limited by the strength of the robot drive unit and residual vibration during positioning. It is therefore necessary to reduce the acceleration coefficient in accordance with the moment of inertia.
- 2) The R-axis tolerable moment of inertia and the acceleration coefficient versus R-axis moment of inertia for each robot model are shown in Fig. 3-10 to Fig. 3-78 on the subsequent pages. The symbols  $A_X$ ,  $A_Y$ , and  $A_R$  in each figure respectively indicate the acceleration coefficients of the X-axis, Y-axis and R-axis. The symbol  $I_R$  ( $J_R$ ) is the moment of inertia of the load around the R-axis and  $m$  is the tip mass.

Example: YK250X

Assume that the mass of the load installed to the R-axis is 1.5kg and the moment of inertia around the R-axis is  $0.02\text{kgm}^2$  ( $0.2\text{kgf}\cdot\text{cm}\cdot\text{sec}^2$ ). When the tip mass parameter is set to 2kg, the robot can be operated by reducing the X, Y and R-axis acceleration coefficients to 60%, as can be seen from Fig. 3-11.

Be sure to select an optimum tip mass and acceleration coefficient parameters that meet the mass of the load and moment of inertia before using the robot.

To make settings for the tip mass and acceleration coefficient, refer to the separate "YAMAHA Robot Controller User's Manual".

- 3) Methods for calculating the moment of inertia of the load are shown in Section 6-2, however, it is not easy to precisely figure out these values. If a calculated value smaller than the actual moment of inertia is set, residual vibrations may occur. If this happens, reduce the acceleration coefficient parameter even further.

#### CAUTION

The robot must be operated with correct tolerable moment of inertia and acceleration coefficients according to the manipulator tip mass and moment of inertia. If this is not observed, premature end to the life of the drive units, damage to the robot parts or residual vibration during positioning may result.

**⚠ CAUTION**

Depending on the Z-axis position, vibration may occur when the X, Y or R-axis moves. If this happens, reduce the X, Y or R-axis acceleration to an appropriate level.

---

**⚠ CAUTION**

If the moment of inertia is too large, vibration may occur on the Z-axis depending on its operation position. If this happens, reduce the Z-axis acceleration to an appropriate level.

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6-1-1 Acceleration coefficient vs. moment of inertia (YK250X(H))

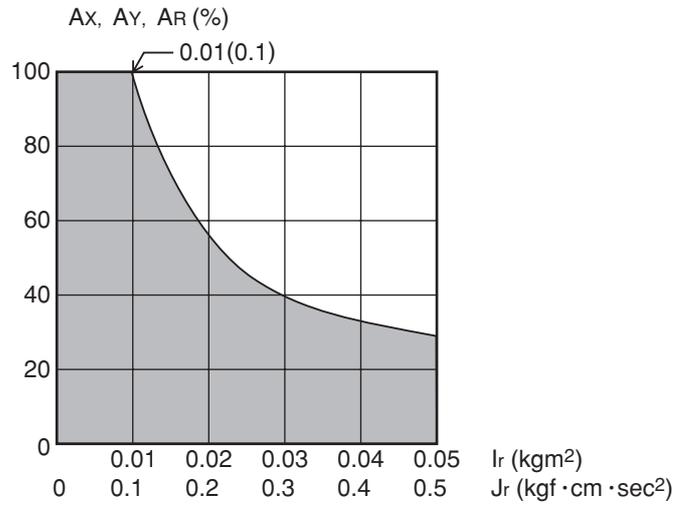


Fig. 3-10 m=1kg

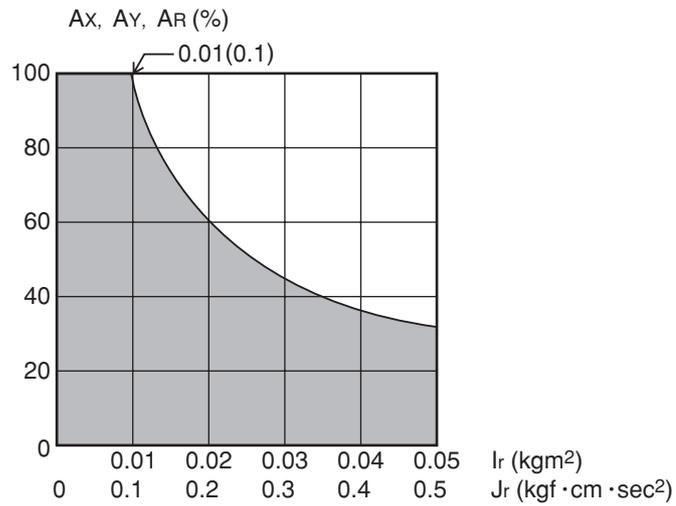


Fig. 3-11 m=2kg

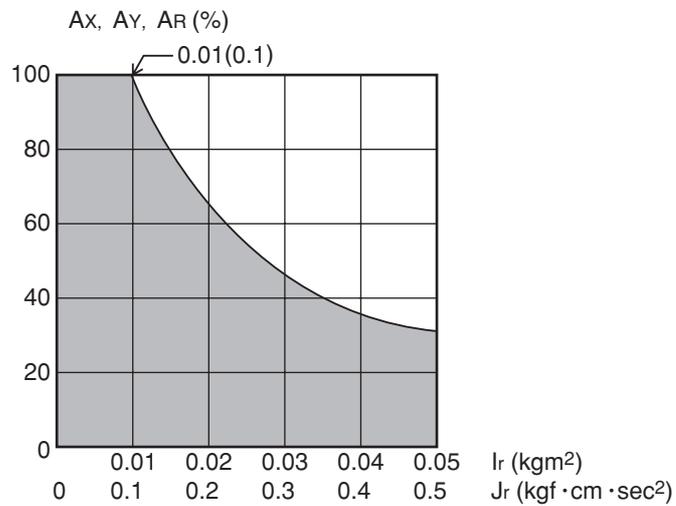


Fig. 3-12 m=3kg

6-1-2 Acceleration coefficient vs. moment of inertia (YK350X(H))

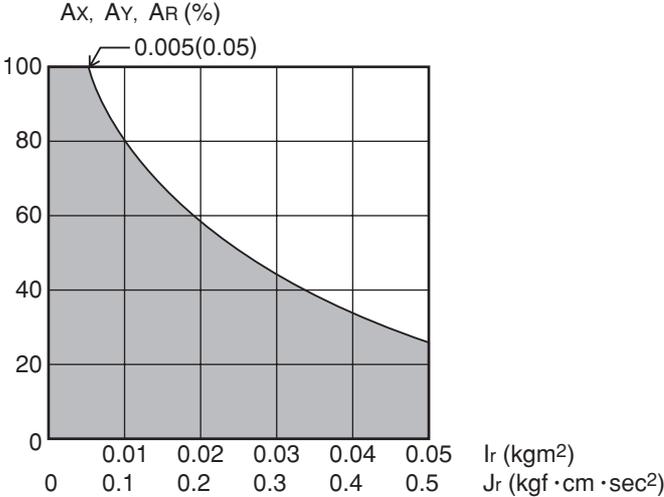


Fig. 3-13 m=1kg

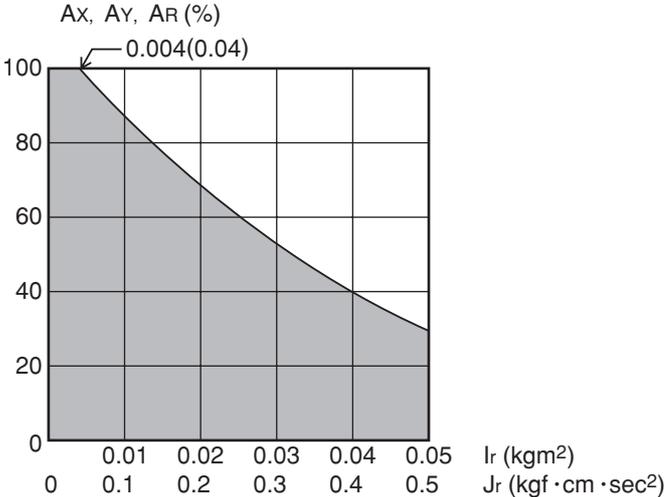


Fig. 3-14 m=2kg

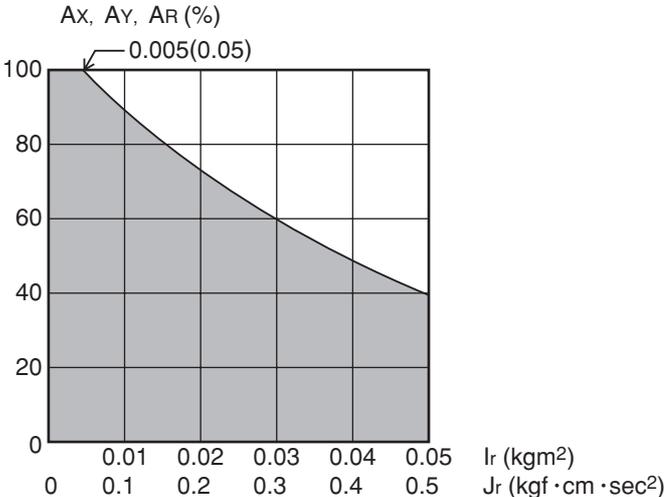


Fig. 3-15 m=3kg

6-1-3 Acceleration coefficient vs. moment of inertia (YK400X(H))

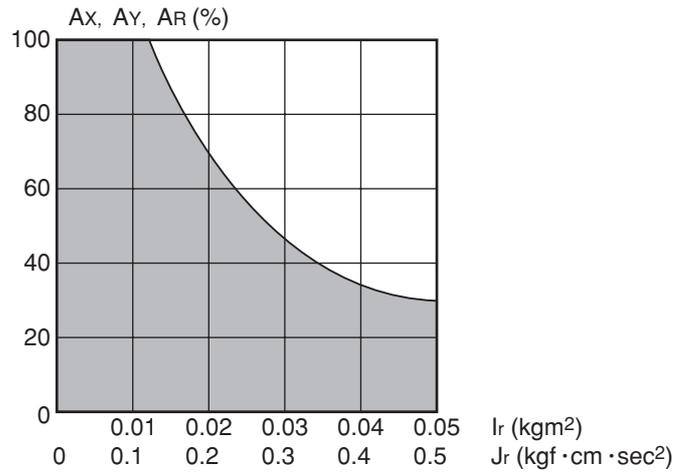


Fig. 3-16 m=1kg

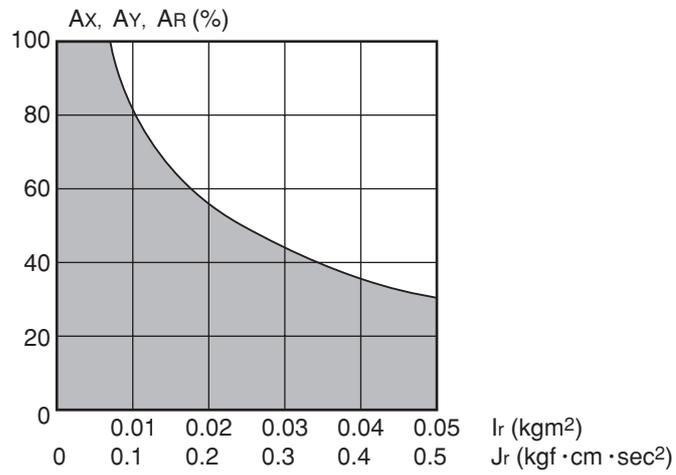


Fig. 3-17 m=2kg

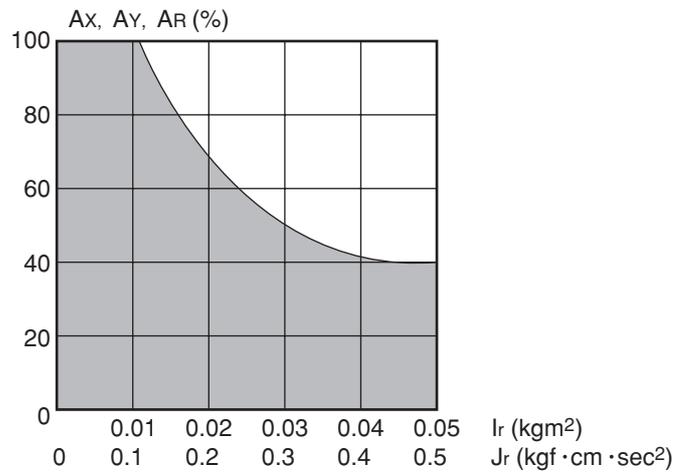


Fig. 3-18 m=3kg

6-1-4 Acceleration coefficient vs. moment of inertia (YK500X)

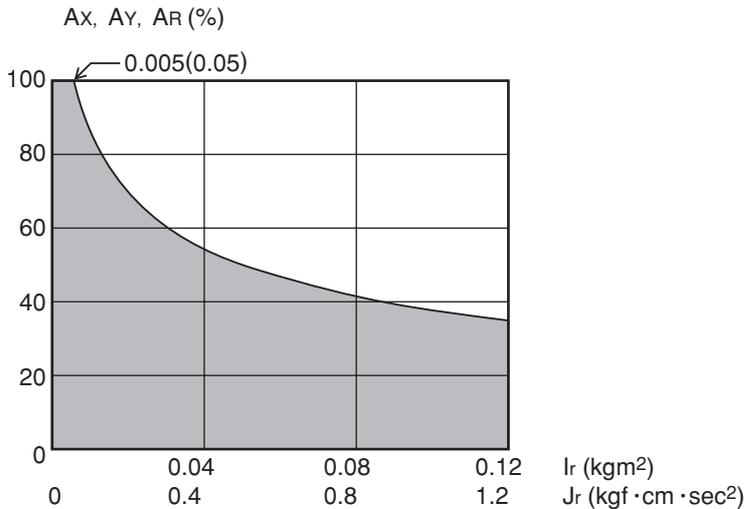


Fig. 3-19 m=1kg

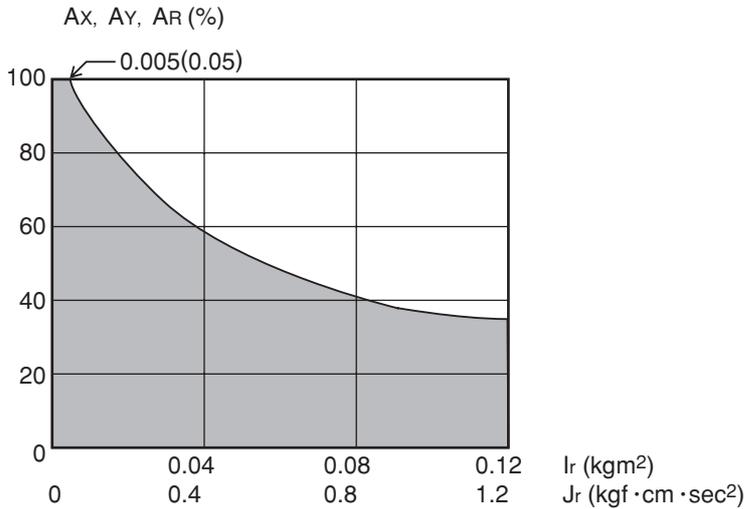


Fig. 3-20 m=2kg

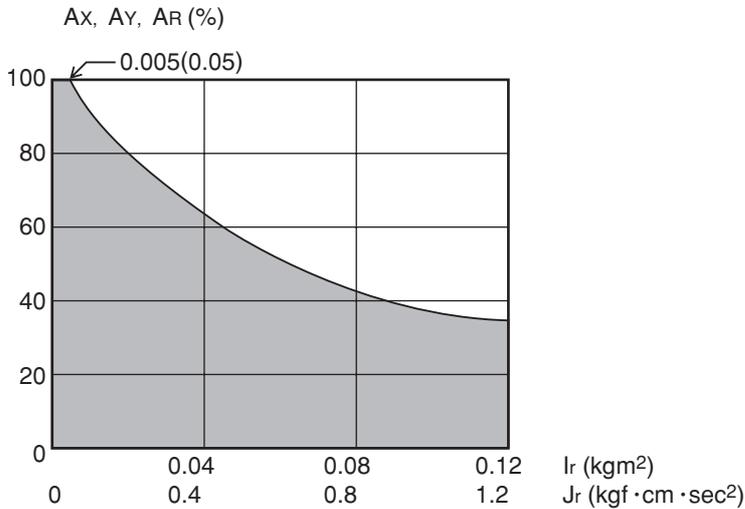


Fig. 3-21 m=3kg

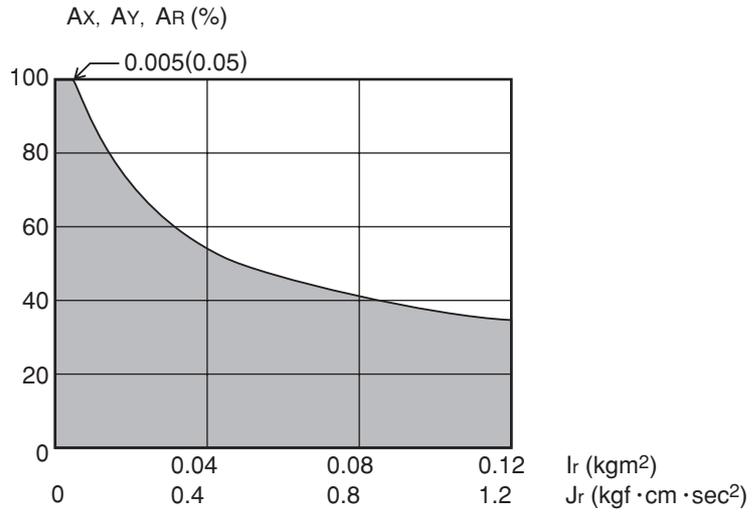


Fig. 3-22 m=4kg

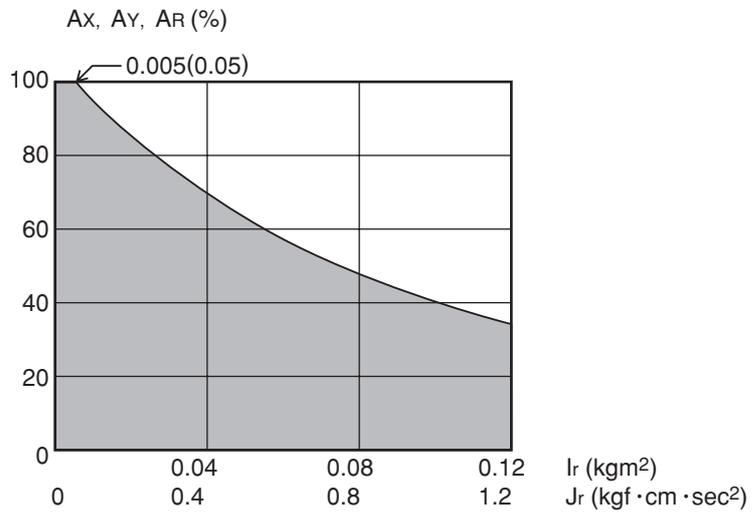


Fig. 3-23 m=5kg

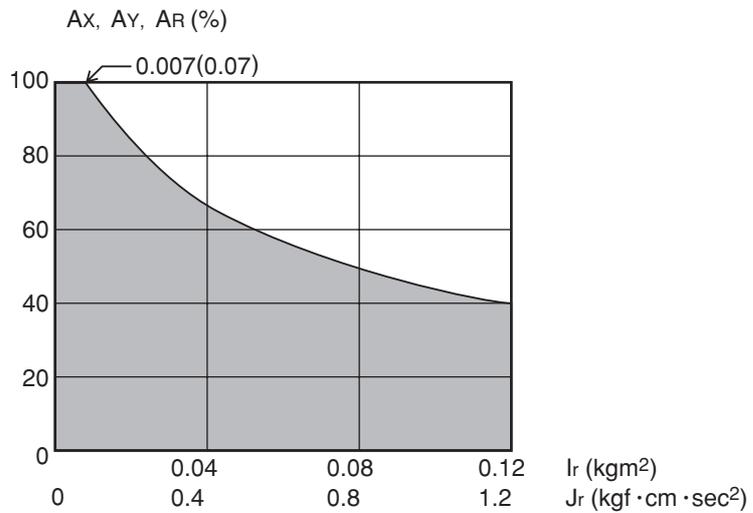


Fig. 3-24 m=6, 7kg

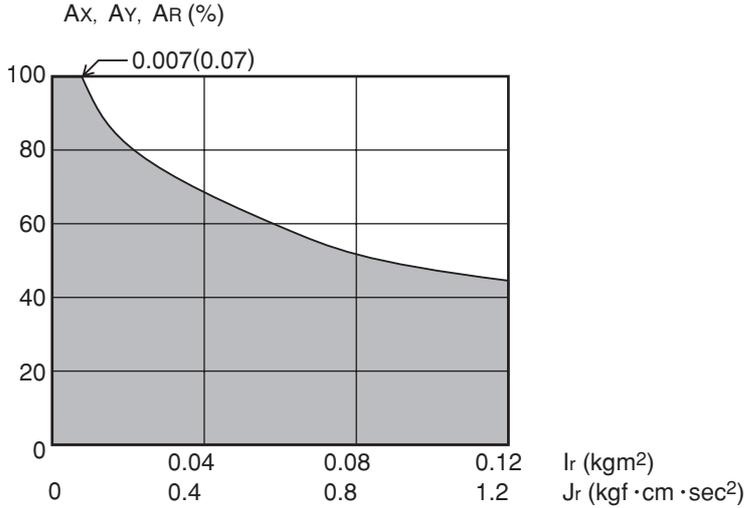


Fig. 3-25 m=8, 9kg

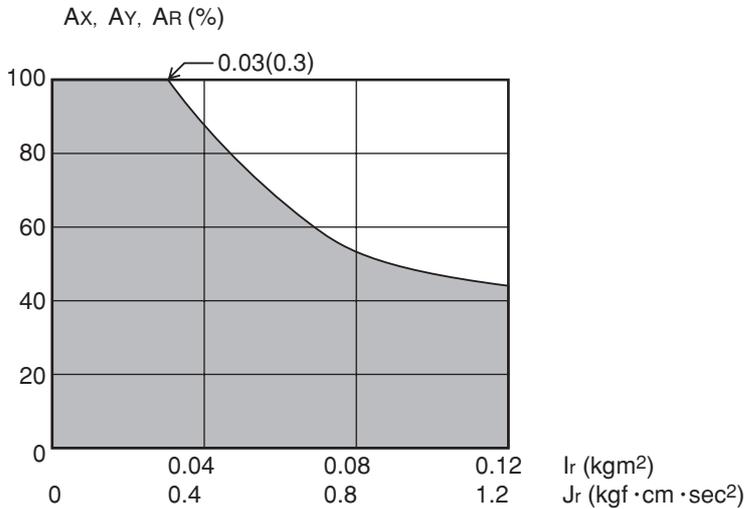


Fig. 3-26 m=10kg

6-1-5 Acceleration coefficient vs. moment of inertia (YK600X)

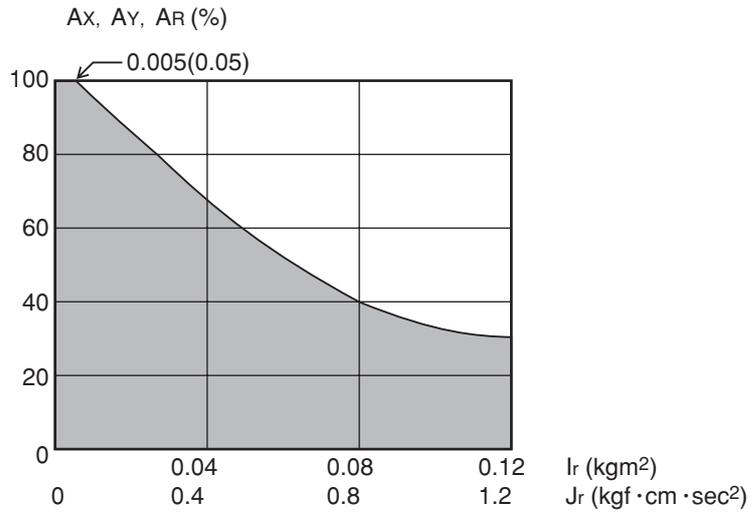


Fig. 3-27 m=1kg

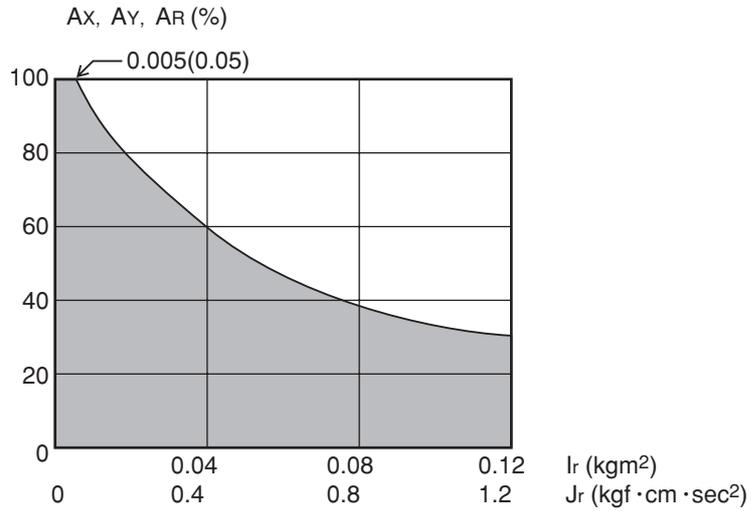


Fig. 3-28 m=2kg

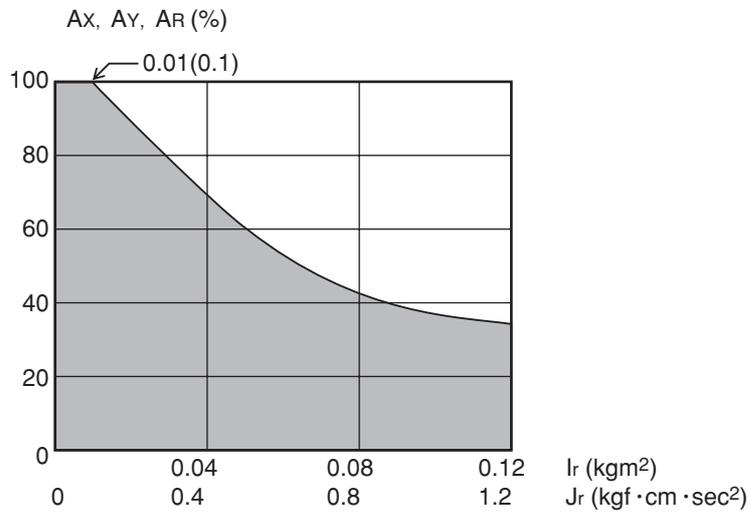


Fig. 3-29 m=3kg

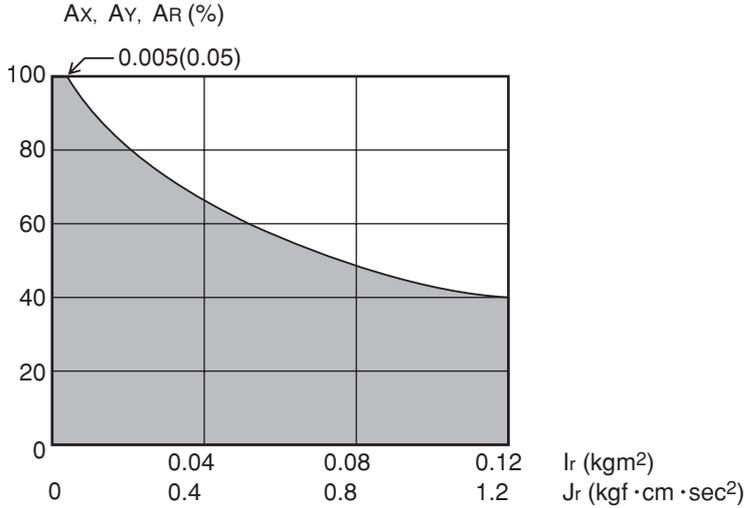


Fig. 3-30 m=4kg

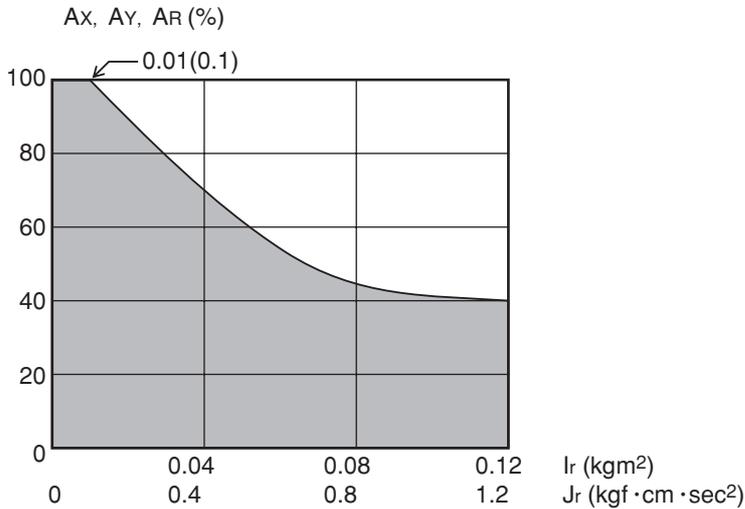


Fig. 3-31 m=5kg

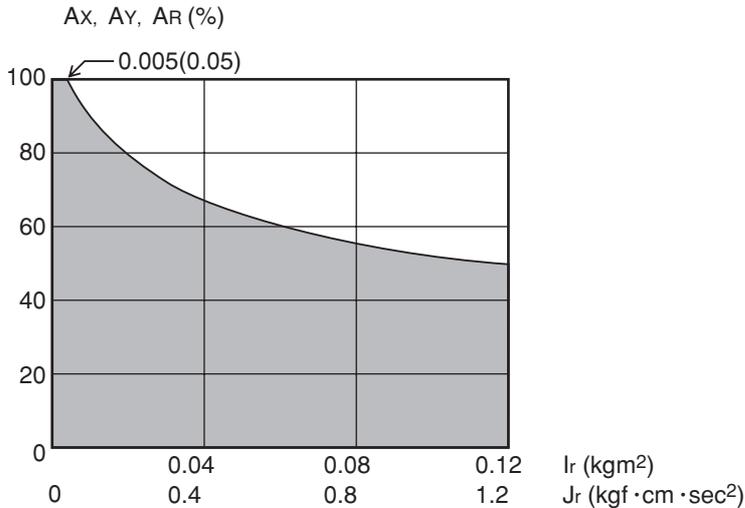
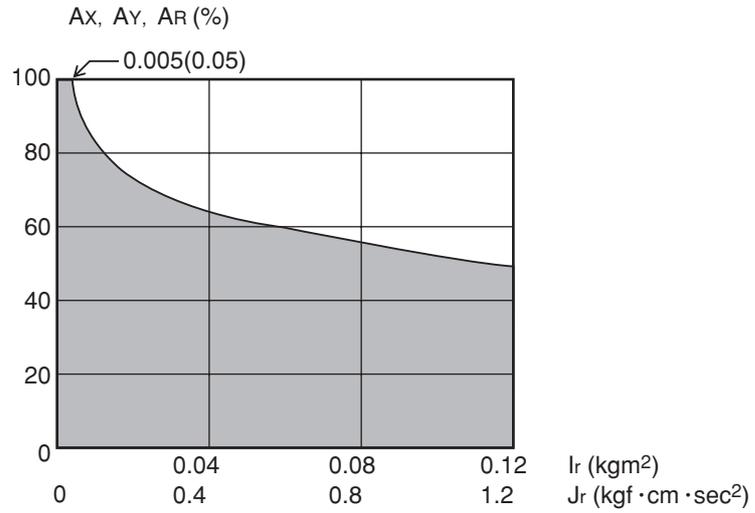
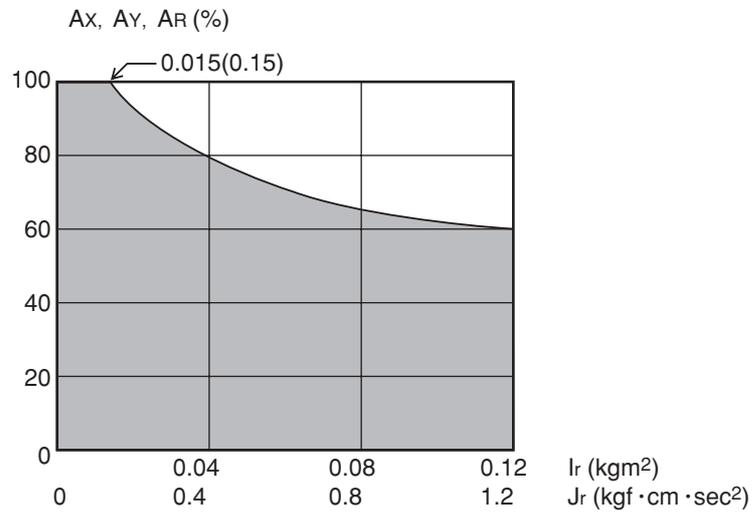


Fig. 3-32 m=6, 7kg



**Fig. 3-33 m=8, 9kg**



**Fig. 3-34 m=10kg**

6-1-6 Acceleration coefficient vs. moment of inertia (YK700X)

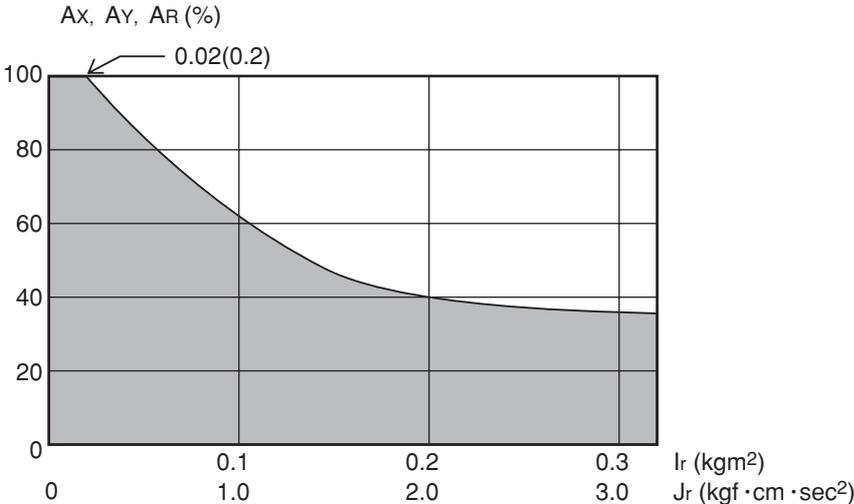


Fig. 3-35 m=1kg

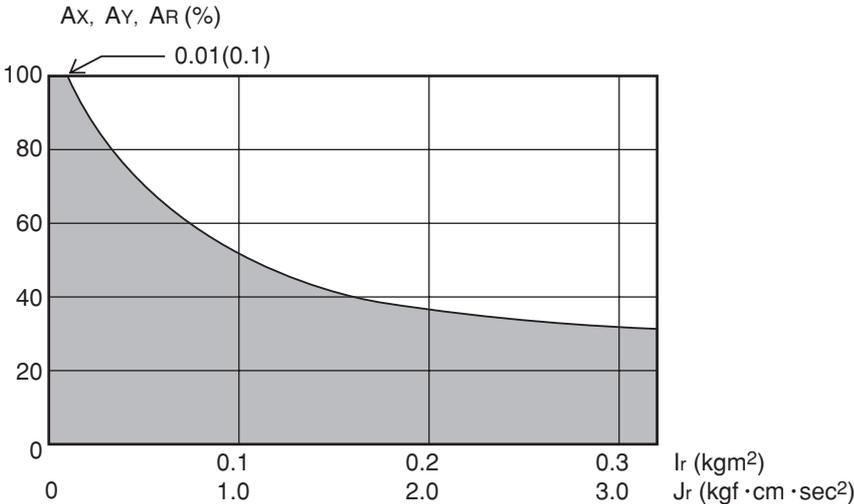


Fig. 3-36 m=2kg

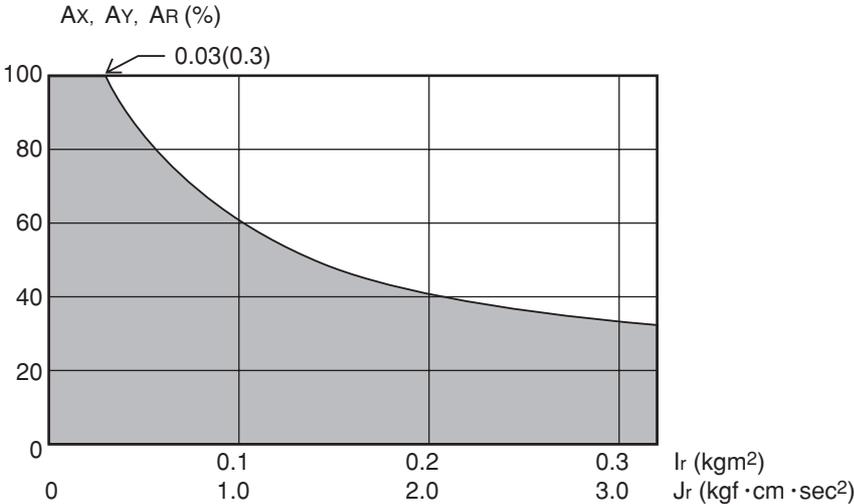
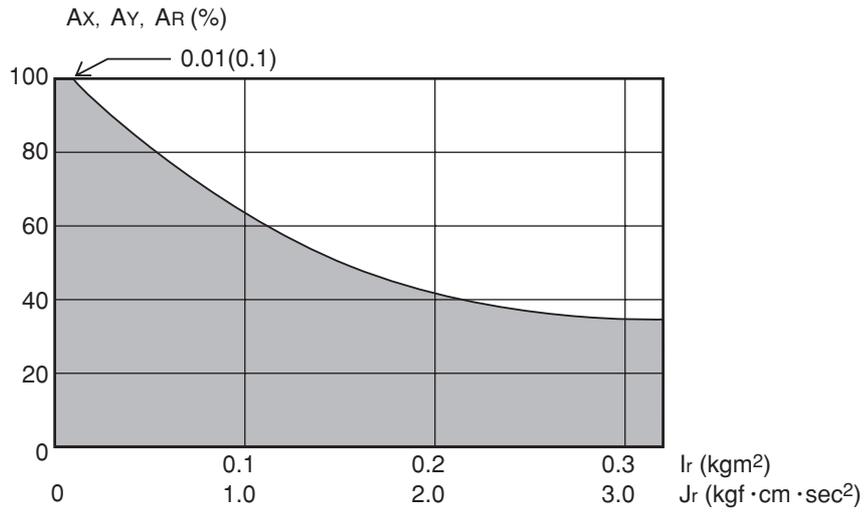
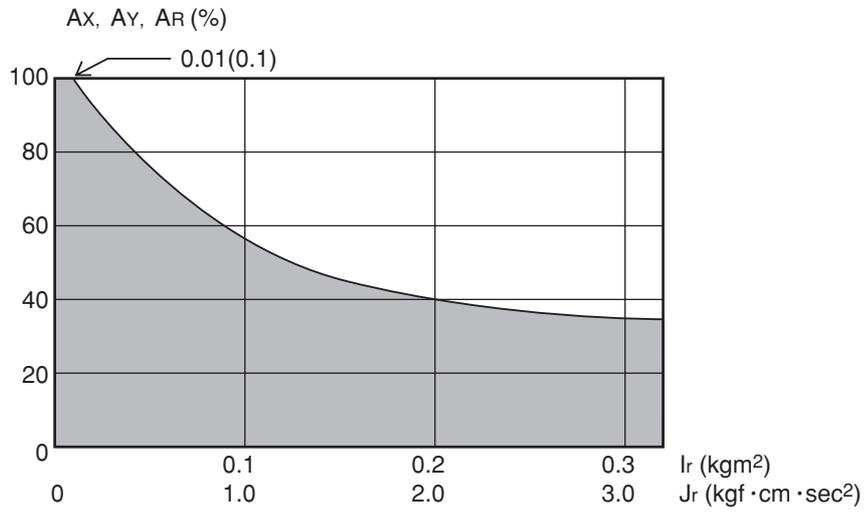


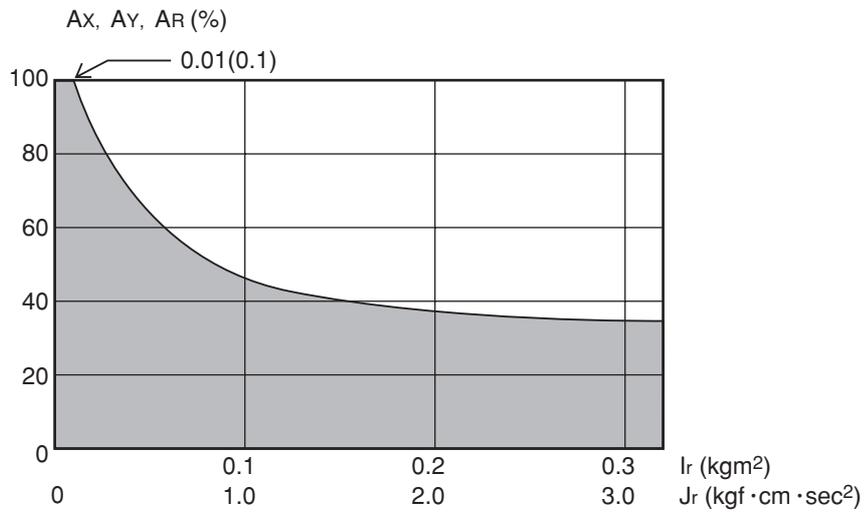
Fig. 3-37 m=3, 4kg



**Fig. 3-38 m=5, 6kg**



**Fig. 3-39 m=7, 8kg**



**Fig. 3-40 m=9, 10kg**

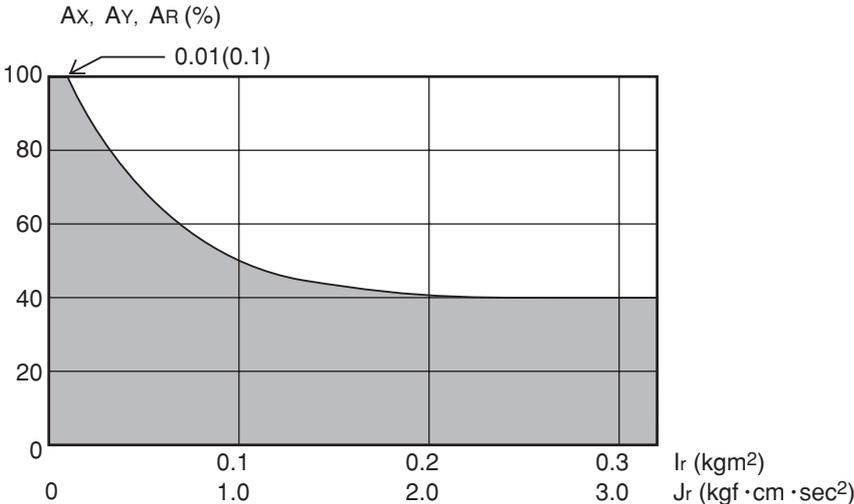


Fig. 3-41 m=11 to 13kg

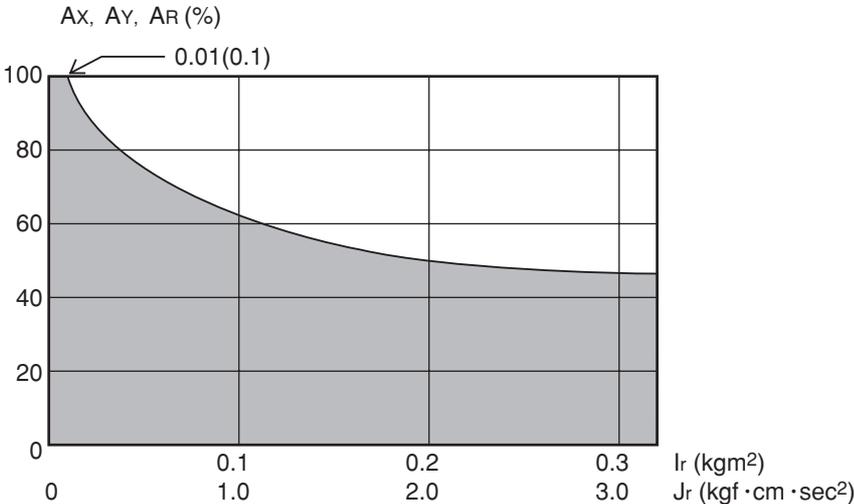


Fig. 3-42 m=14 to 16kg

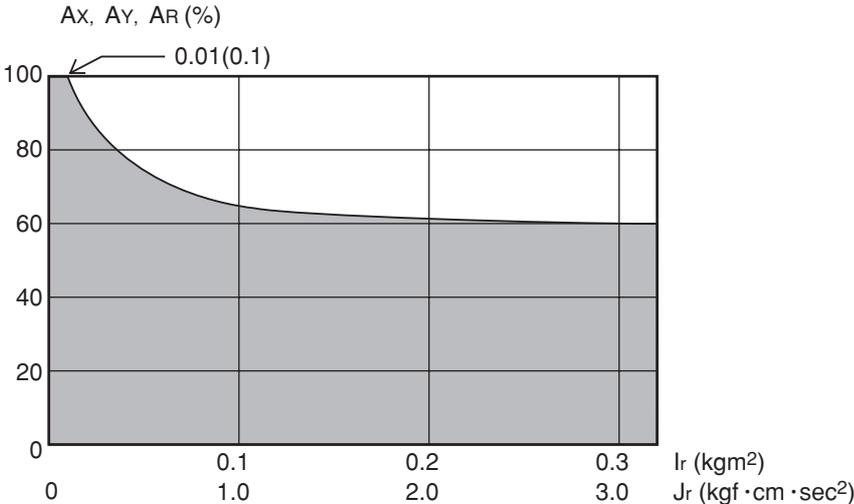


Fig. 3-43 m=17 to 20kg

6-1-7 Acceleration coefficient vs. moment of inertia (YK800X)

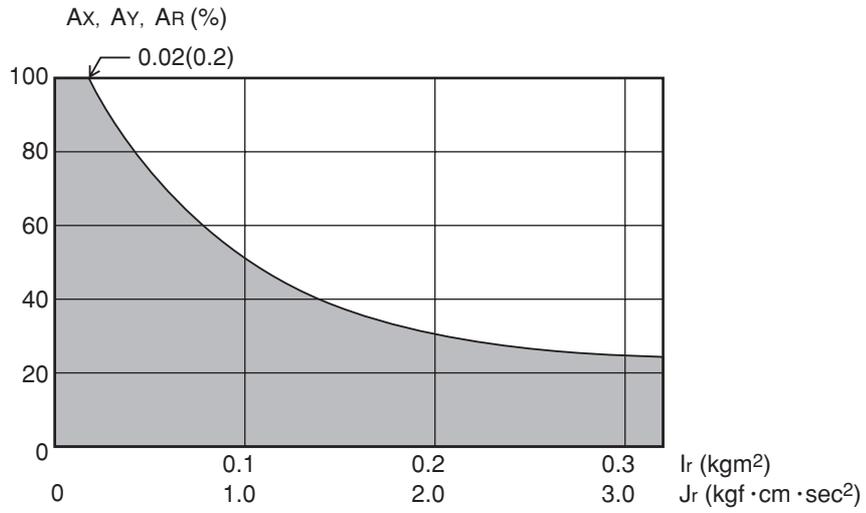


Fig. 3-44 m=1kg

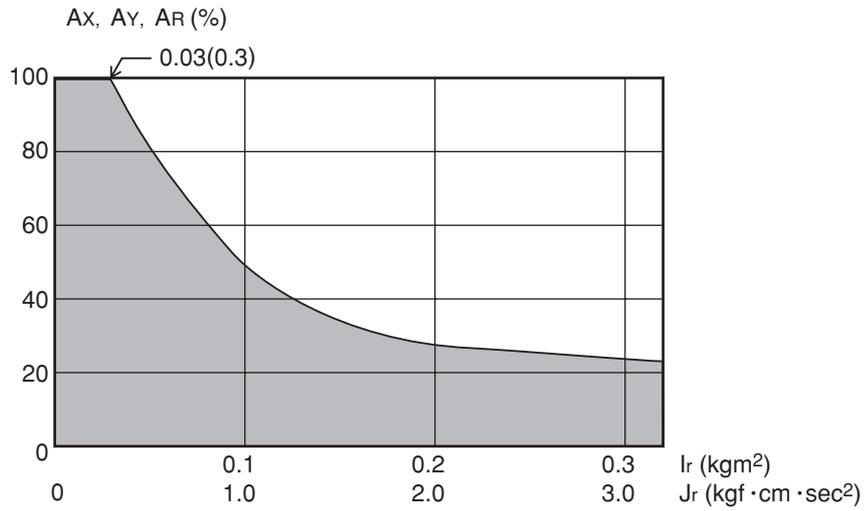


Fig. 3-45 m=2kg

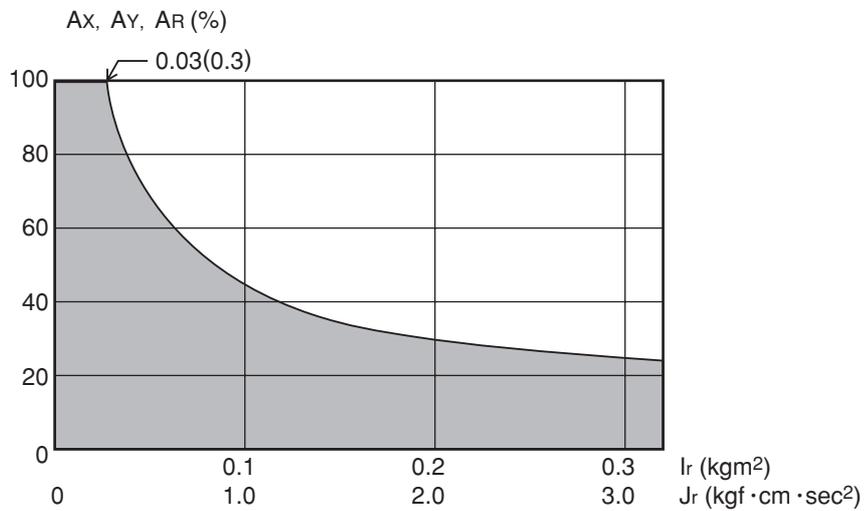


Fig. 3-46 m=3, 4kg

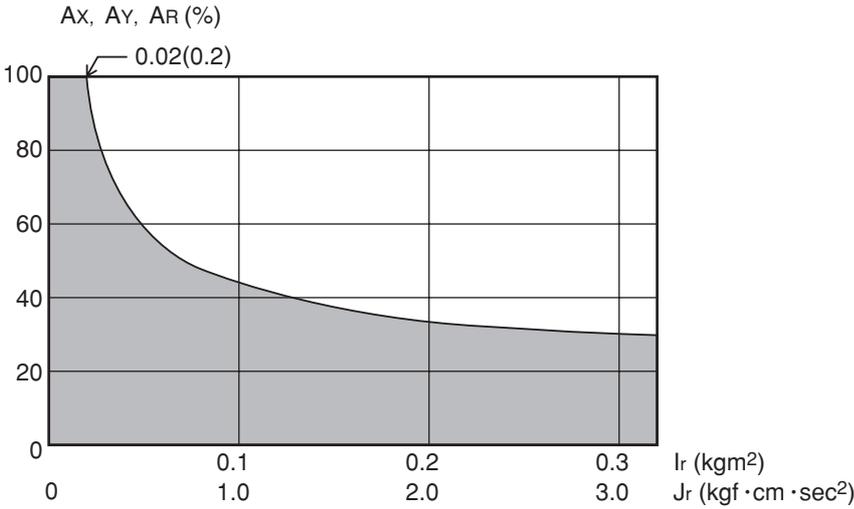


Fig. 3-47 m=5, 6kg

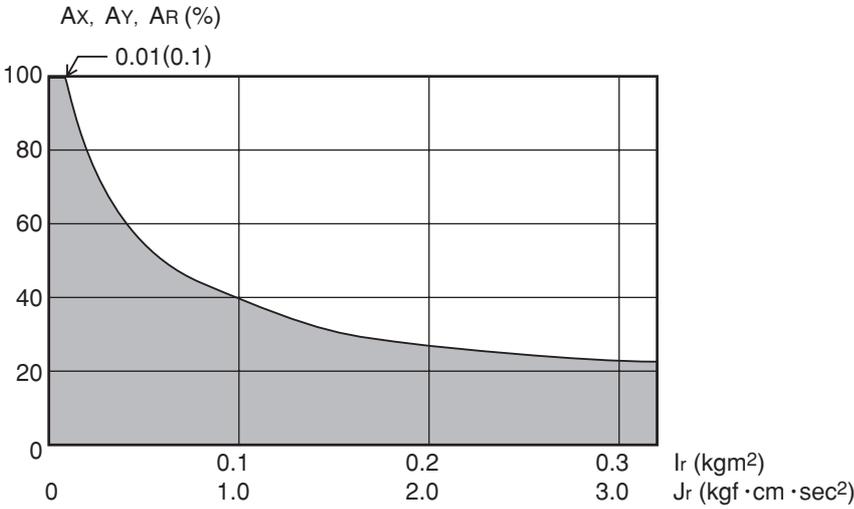


Fig. 3-48 m=7, 8kg

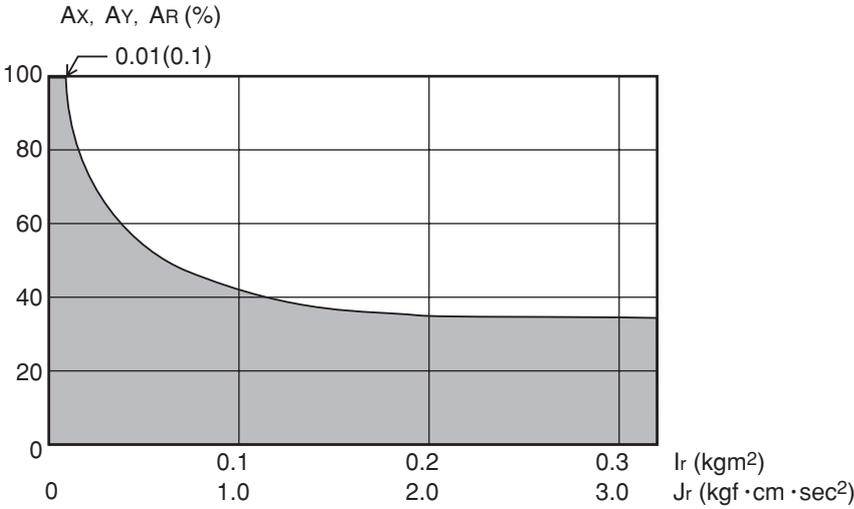


Fig. 3-49 m=9, 10kg

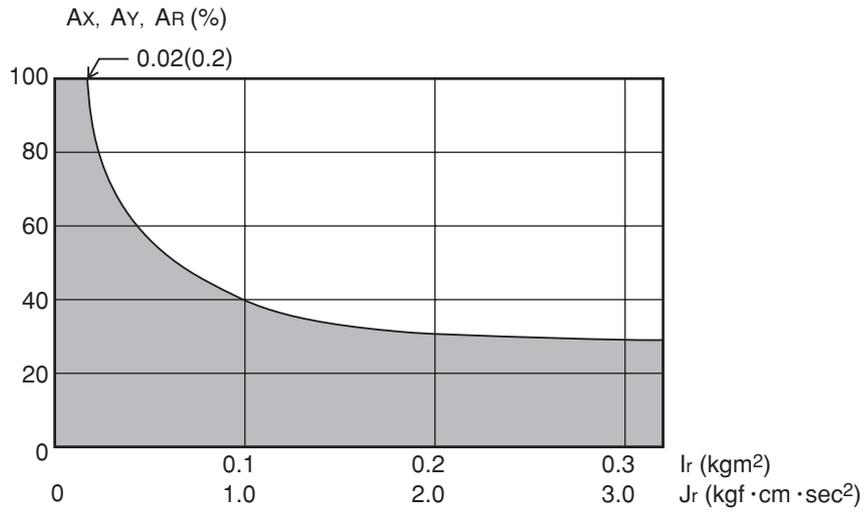


Fig. 3-50 m=11 to 13kg

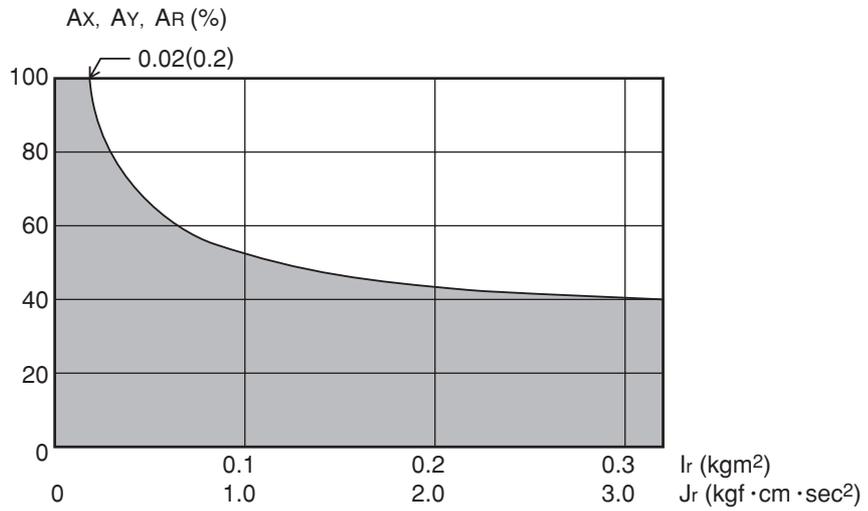


Fig. 3-51 m=14 to 16kg

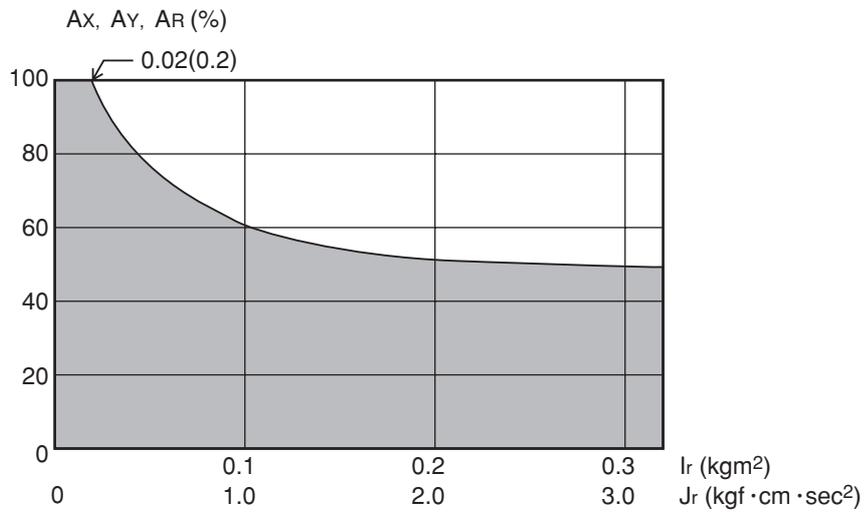


Fig. 3-52 m=17 to 20kg

6-1-8 Acceleration coefficient vs. moment of inertia (YK1000X)

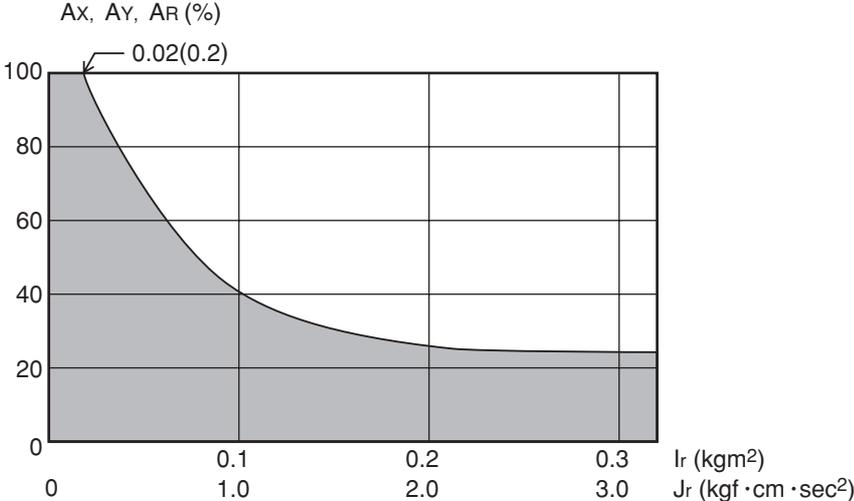


Fig. 3-53 m=1kg

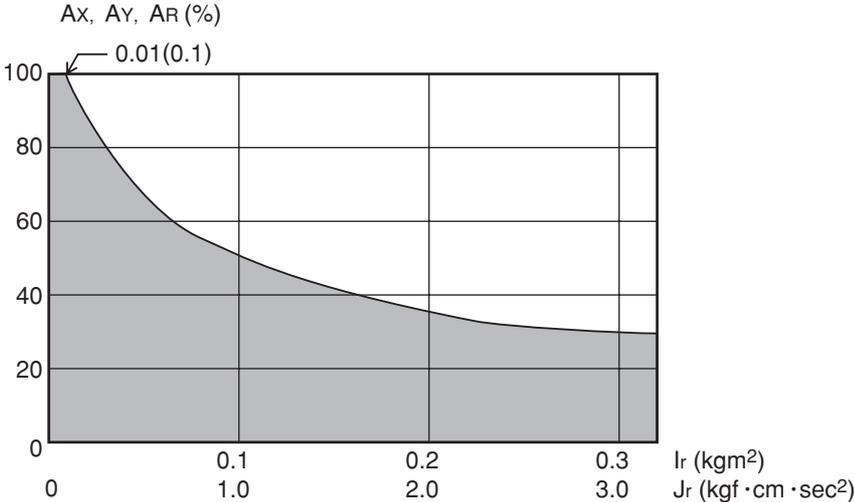


Fig. 3-54 m=2kg

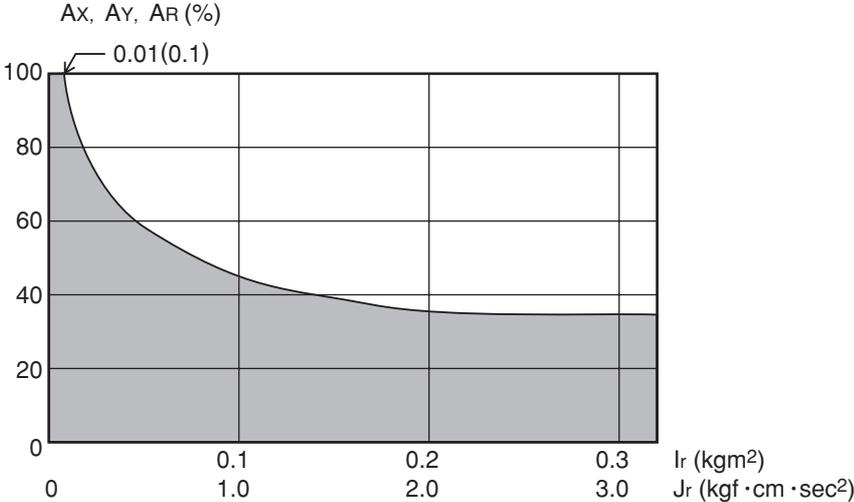


Fig. 3-55 m=3, 4kg

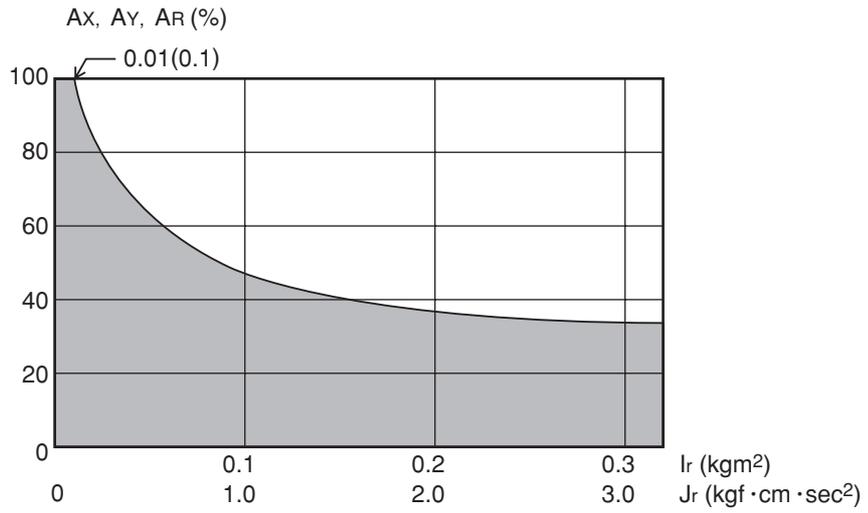


Fig. 3-56  $m=5, 6\text{kg}$

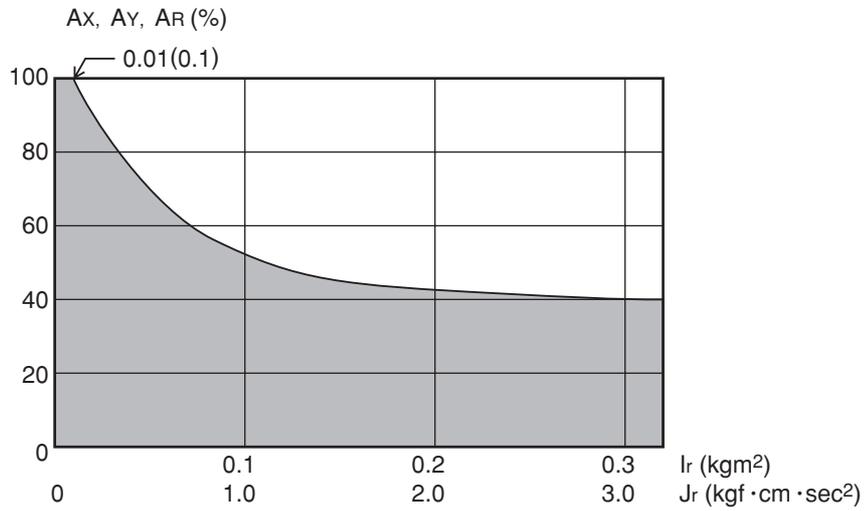


Fig. 3-57  $m=7, 8\text{kg}$

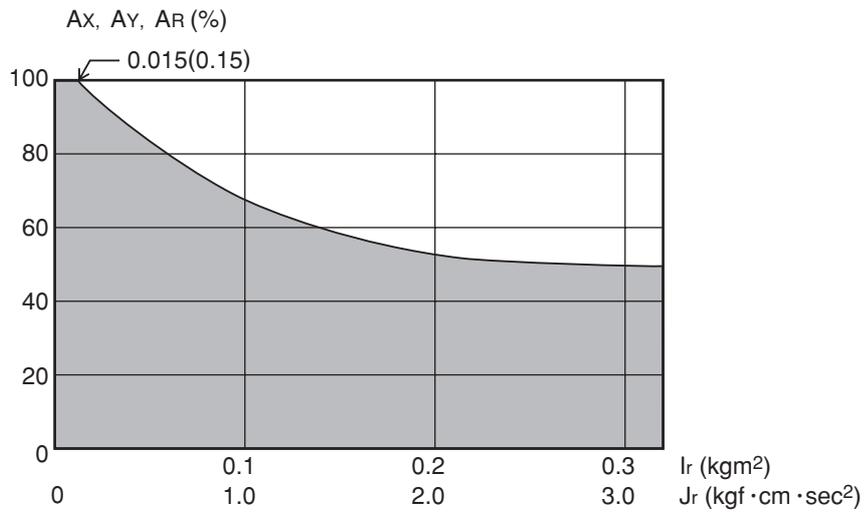


Fig. 3-58  $m=9, 10\text{kg}$

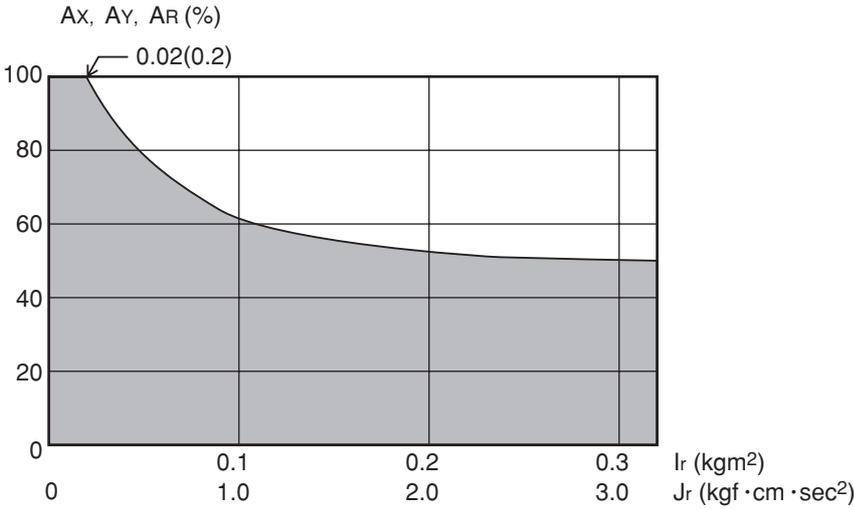


Fig. 3-59 m=11 to 13kg

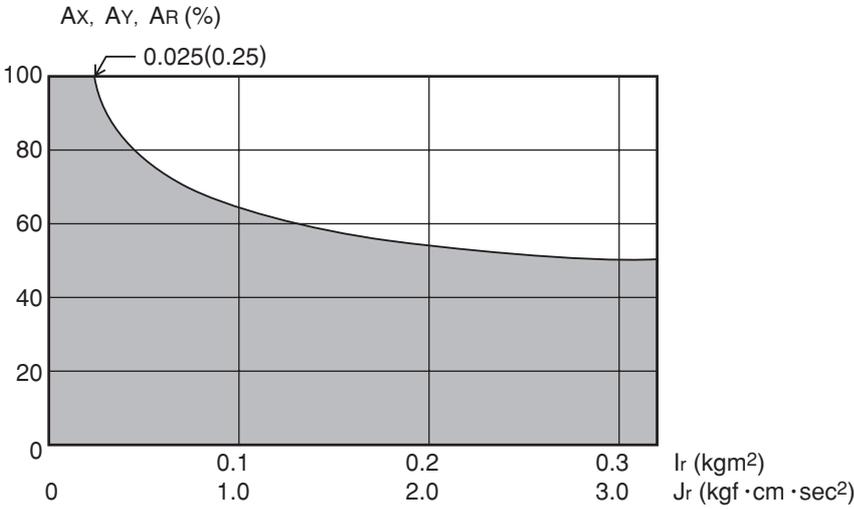


Fig. 3-60 m=14 to 16kg

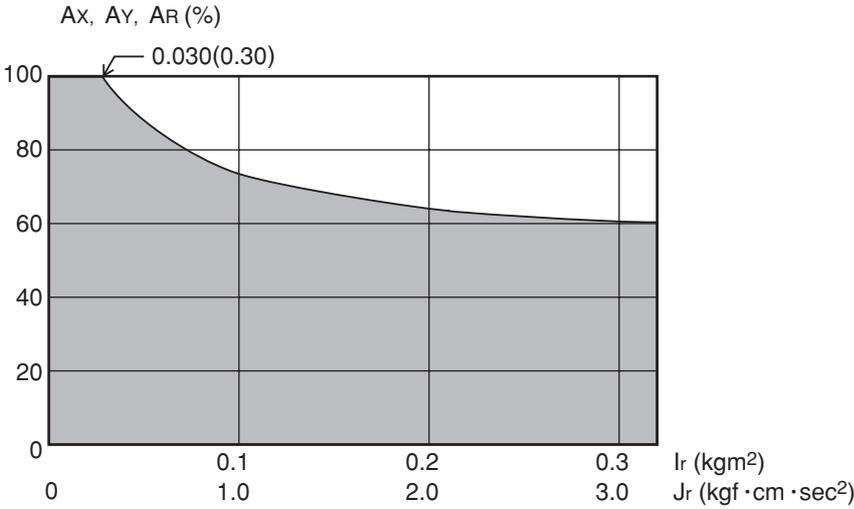
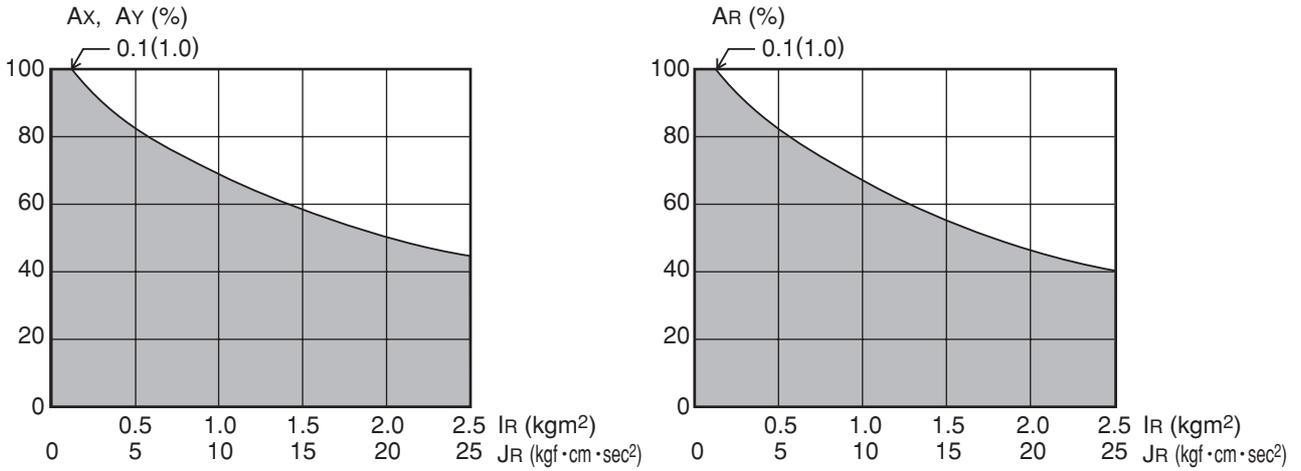
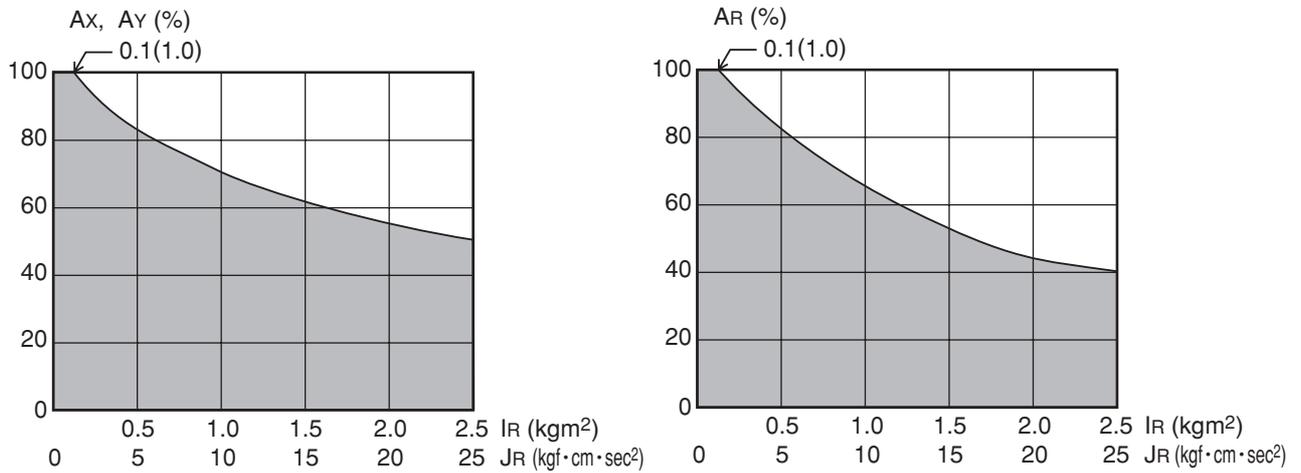


Fig. 3-61 m=17 to 20kg

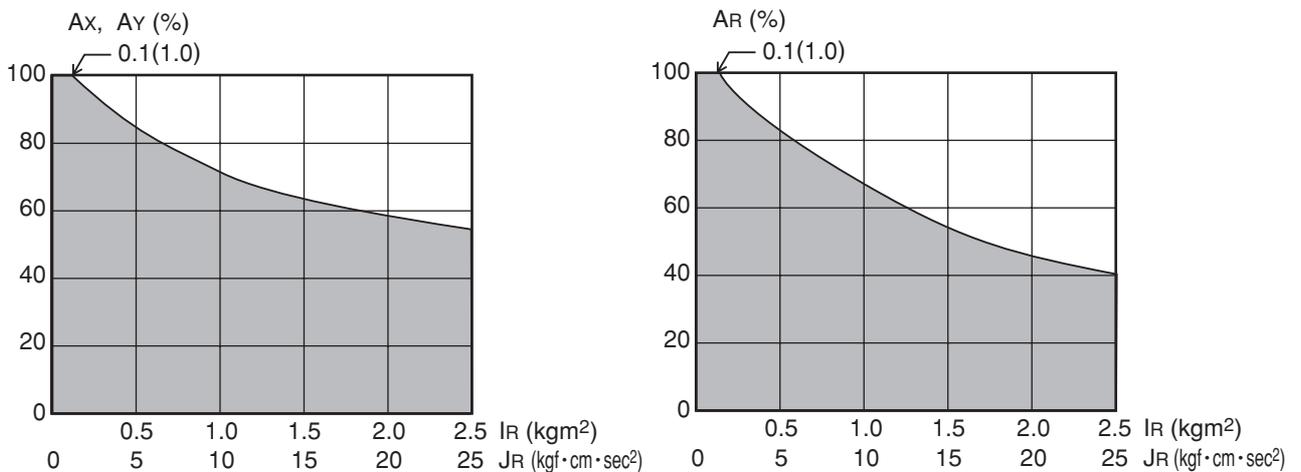
**6-1-9 Acceleration coefficient vs. moment of inertia (YK1200X)**



**Fig. 3-62 m=0 to 5kg**



**Fig. 3-63 m=6 to 10kg**



**Fig. 3-64 m=11 to 15kg**

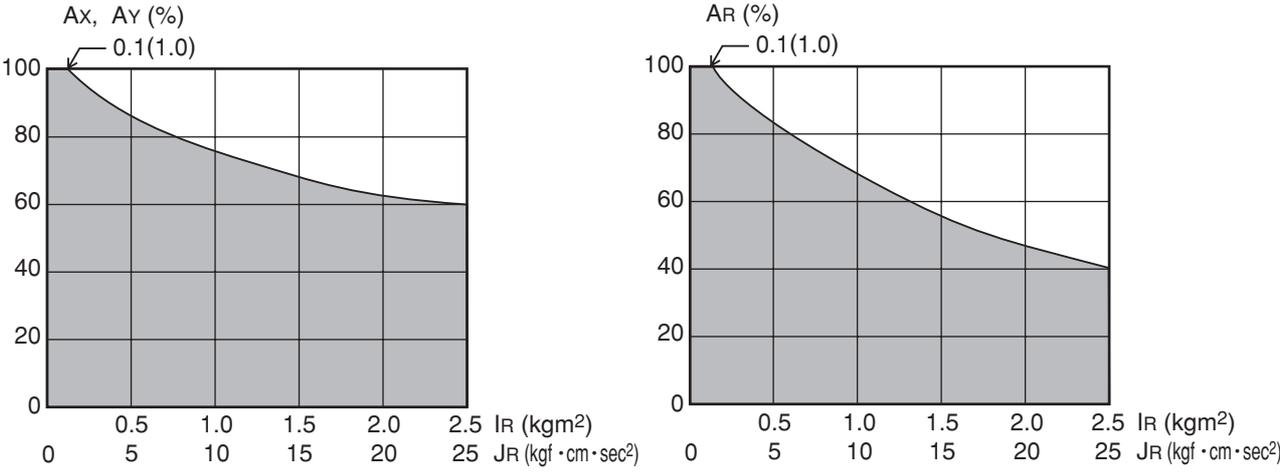


Fig. 3-65 m=16 to 20kg

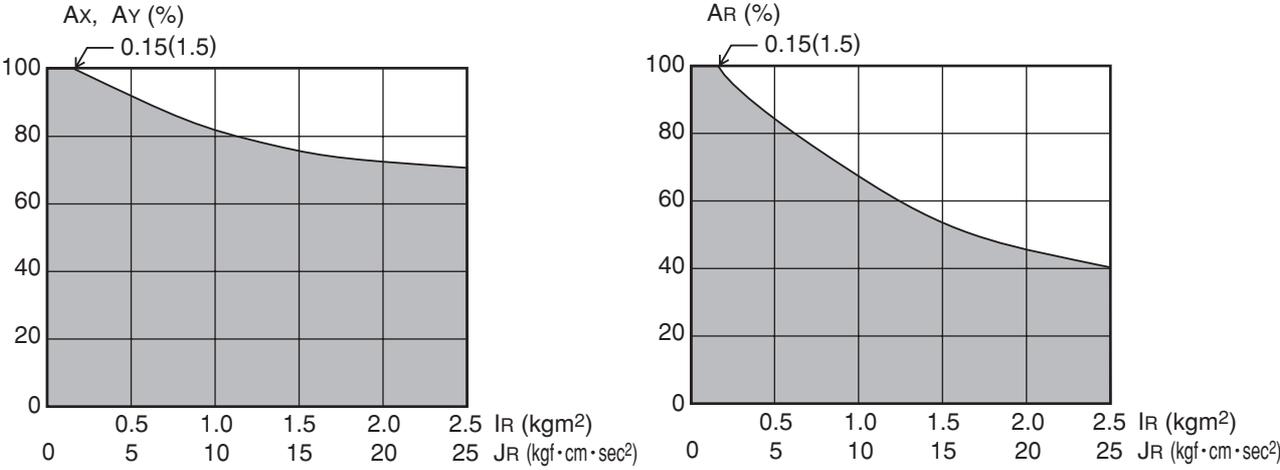


Fig. 3-66 m=21 to 25kg

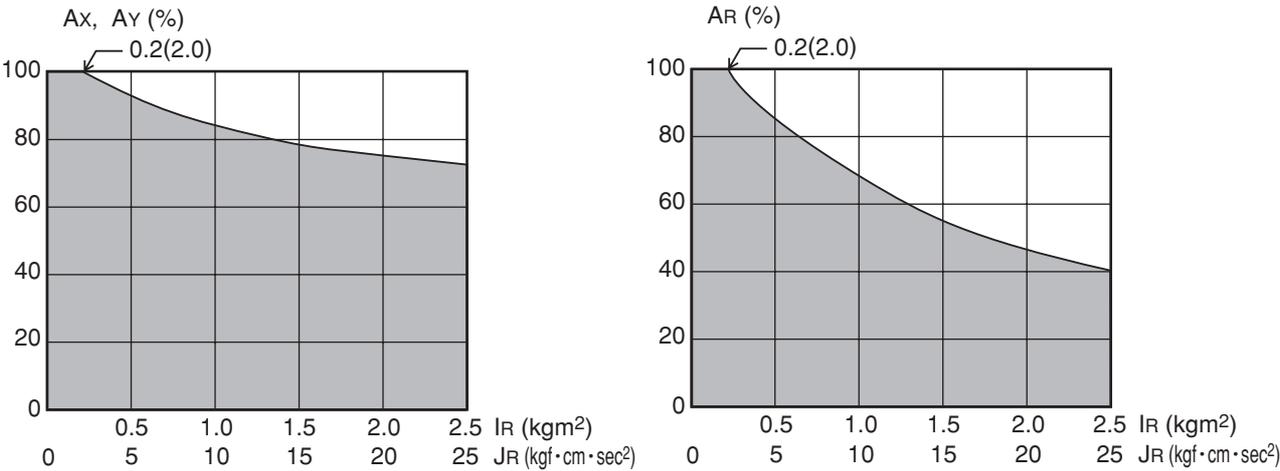


Fig. 3-67 m=26 to 30kg

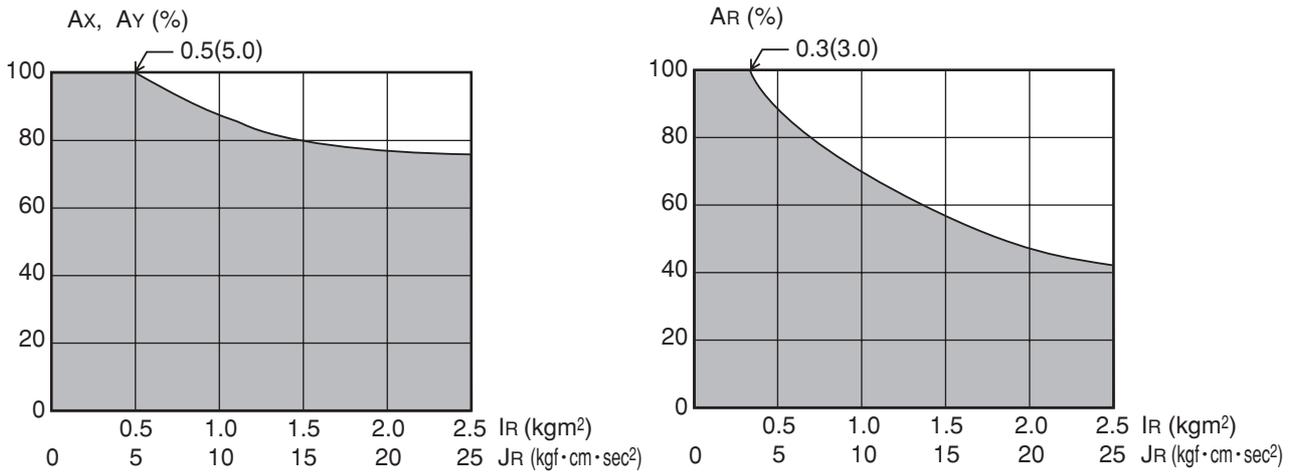


Fig. 3-68 m=31 to 35kg

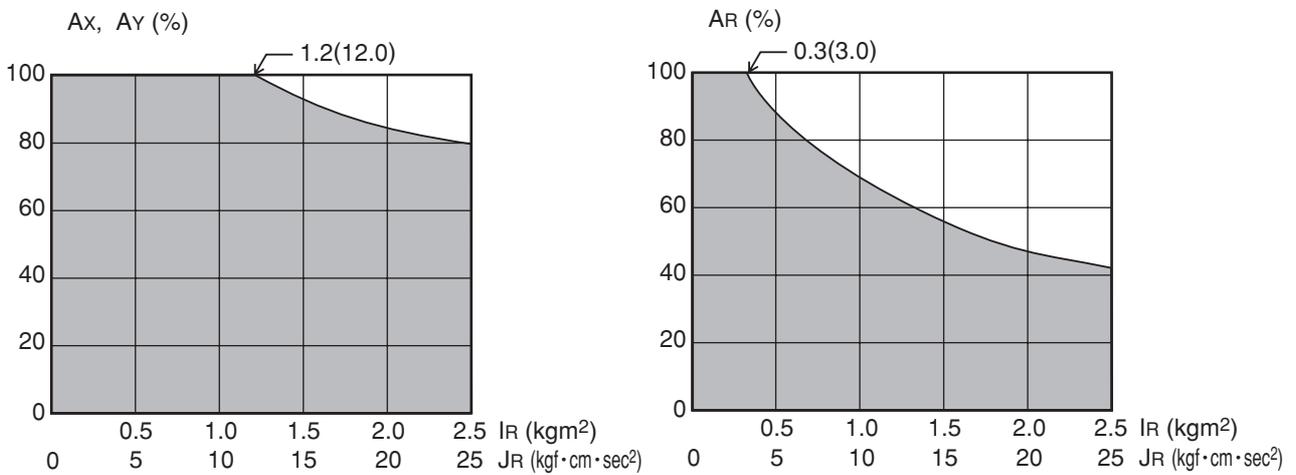


Fig. 3-69 m=36 to 40kg

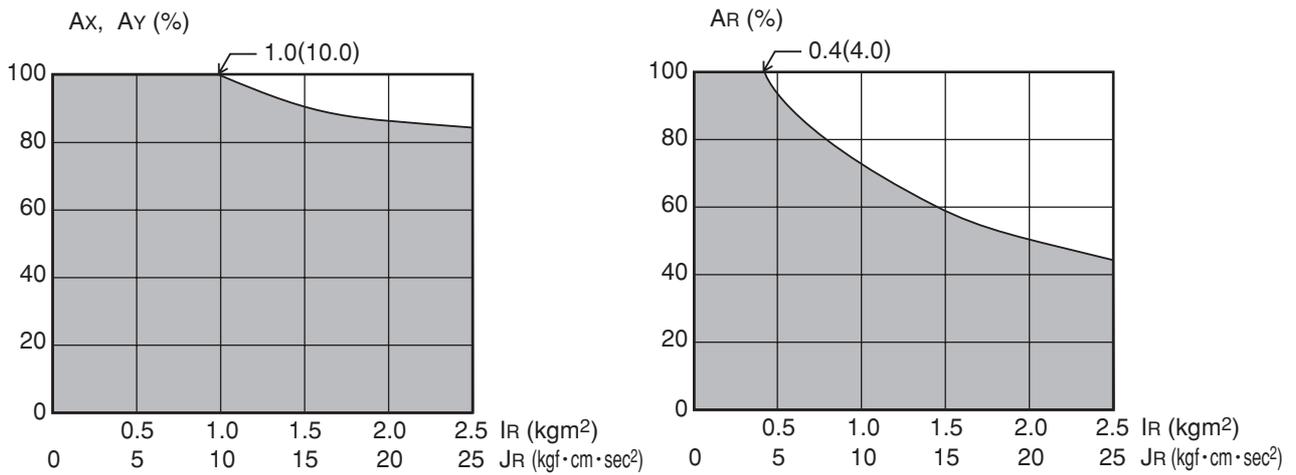
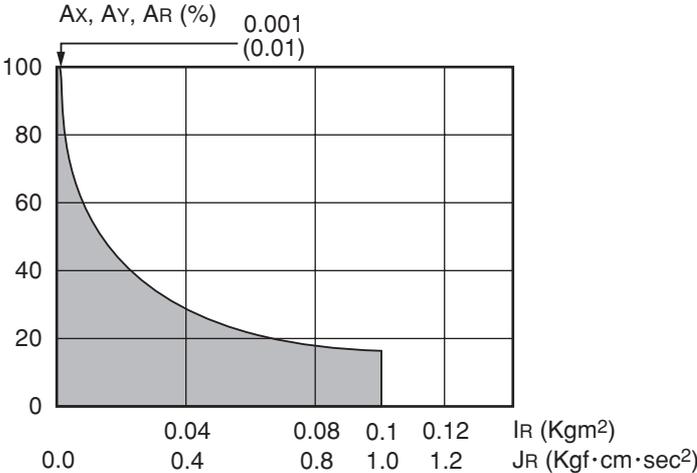


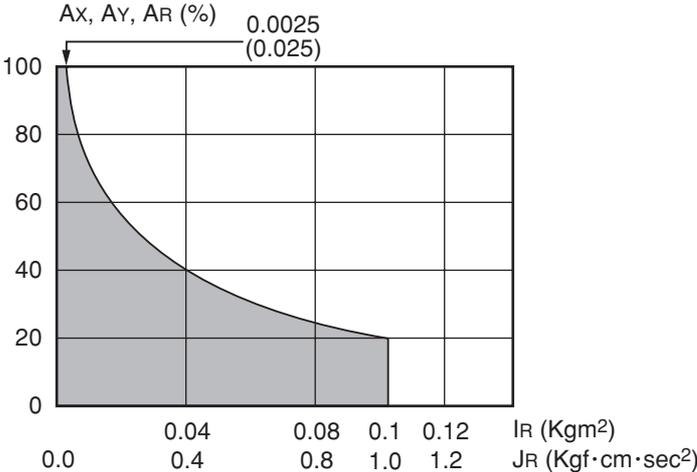
Fig. 3-70 m=41 to 50kg

**6-1-10 Acceleration coefficient vs. moment of inertia (YK550X with standard R-axis specifications)**

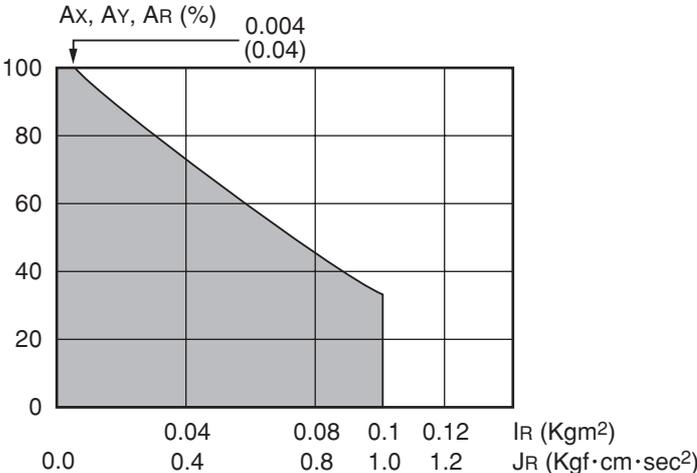
For YK550X with high-speed R-axis specifications, refer to Section 6-1-11.



**Fig. 3-71 m=1, 2kg**



**Fig. 3-72 m=3, 4kg**

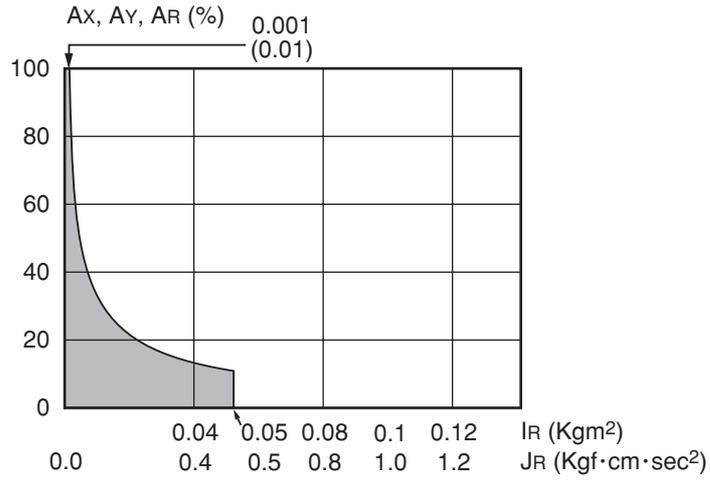


**Fig. 3-73 m=5kg**

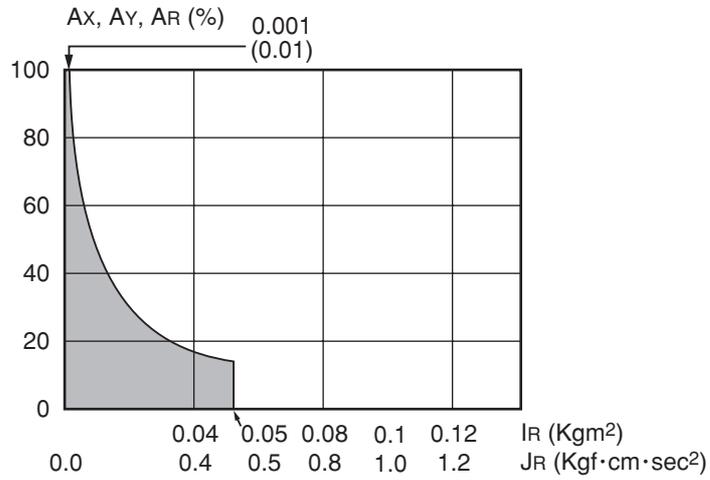
**6-1-11 Acceleration coefficient vs. moment of inertia  
(YK550X with high-speed R-axis specifications)**

**CAUTION**

If the acceleration on the X, Y or R axis is too high compared to the moment of inertia of the load, feedback error 2 or over-current error may occur. If this happens, reduce the acceleration.



**Fig. 3-74  $m=1\text{kg}$**



**Fig. 3-75  $m=2\text{kg}$**

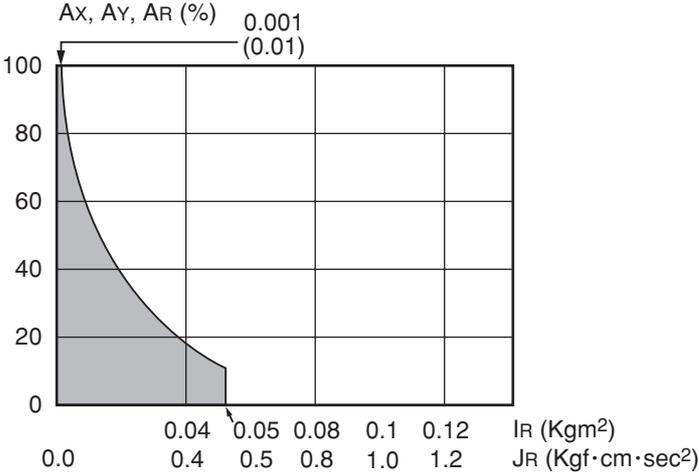


Fig. 3-76 m=3kg

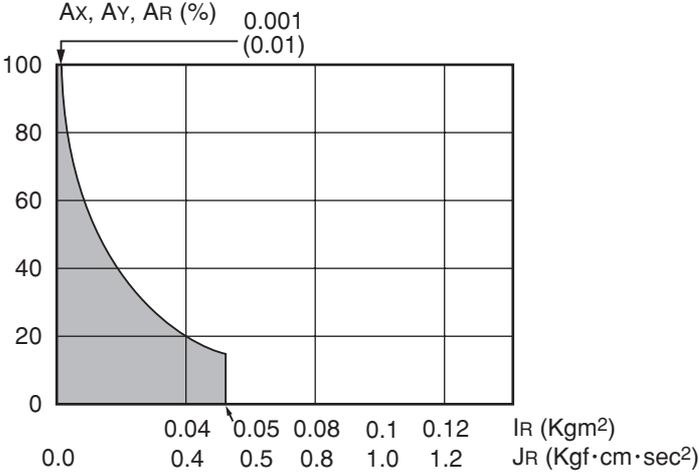


Fig. 3-77 m=4kg

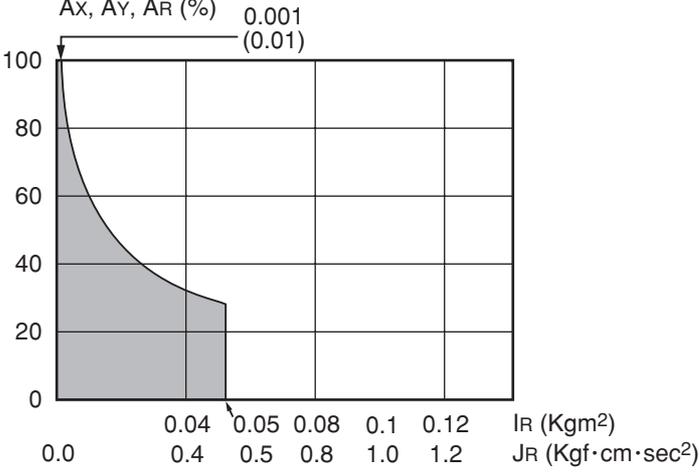


Fig. 3-78 m=5kg

## 6-2 Equation for moment of inertia calculation

Usually the R axis load is not a simple form, and the calculation of the moment of inertia is not easy.

As a method, the load is replaced with several factors that resemble a simple form for which the moment of inertia can be calculated. The total of the moment of inertia for these factors is then obtained.

The objects and equations often used for the calculation of the moment of inertia are shown below. Incidentally, there is the following relation:

$$J \text{ (kgf}\cdot\text{cm}\cdot\text{sec}^2) = I \text{ (kgm}^2) \times 10.2.$$

### 1) Moment of inertia for material particle

The equation for the moment of inertia for a material particle that has a rotation center such as shown in Fig. 3-79 is as follows:

This is used as an approximate equation when  $x$  is larger than the object size.

$$I = mx^2 \text{ (kgm}^2)$$

$$J = \frac{Wx^2}{g} \text{ (kgf}\cdot\text{cm}\cdot\text{sec}^2)$$

... (Eq. 3.1)

$g$  : Gravitational acceleration (cm/sec<sup>2</sup>)

$m$  : Mass of material particle (kg)

$W$  : Weight of material particle (kgf)

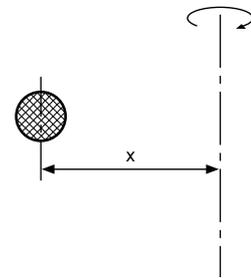


Fig. 3-79

### 2) Moment of inertia for cylinder (part 1)

The equation for the moment of inertia for a cylinder that has a rotation center such as shown in Fig. 3-80 is given below.

$$I = \frac{\rho\pi D^4 h}{32} = \frac{mD^2}{8} \text{ (kgm}^2)$$

$$J = \frac{\rho\pi D^4 h}{32g} = \frac{WD^2}{8g} \text{ (kgf}\cdot\text{cm}\cdot\text{sec}^2)$$

... (Eq. 3.2)

$\rho$  : Density (kg/m<sup>3</sup>, kg/cm<sup>3</sup>)

$g$  : Gravitational acceleration (cm/sec<sup>2</sup>)

$m$  : Mass of cylinder (kg)

$W$  : Weight of cylinder (kgf)

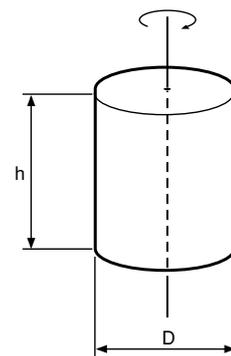


Fig. 3-80

3) Moment of inertia for cylinder (part 2)

The equation for the moment of inertia for a cylinder that has a rotation center such as shown in Fig. 3-81 is given below.

$$I = \frac{\rho \pi D^2 h}{16} \left( \frac{D^2}{4} + \frac{h^2}{3} \right) = \frac{m}{4} \left( \frac{D^2}{4} + \frac{h^2}{3} \right) \text{ (kgm}^2\text{)}$$

$$J = \frac{\rho \pi D^2 h}{16g} \left( \frac{D^2}{4} + \frac{h^2}{3} \right) = \frac{W}{4g} \left( \frac{D^2}{4} + \frac{h^2}{3} \right) \text{ (kgf} \cdot \text{cm} \cdot \text{sec}^2\text{)}$$

... (Eq. 3.3)

- $\rho$  : Density (kg/m<sup>3</sup>, kg/cm<sup>3</sup>)
- $g$  : Gravitational acceleration (cm/sec<sup>2</sup>)
- $m$  : Mass of cylinder (kg)
- $W$  : Weight of cylinder (kgf)

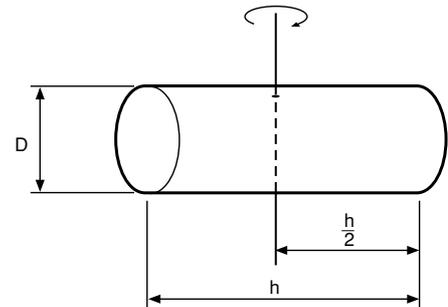


Fig. 3-81

4) Moment of inertia for prism

The equation for the moment of inertia for a prism that has a rotation center as shown in Fig. 3-82 is given as follows.

$$I = \frac{\rho abc(a^2 + b^2)}{12} = \frac{m(a^2 + b^2)}{12} \text{ (kgm}^2\text{)}$$

$$J = \frac{\rho abc(a^2 + b^2)}{12g} = \frac{W(a^2 + b^2)}{12g} \text{ (kgf} \cdot \text{cm} \cdot \text{sec}^2\text{)}$$

... (Eq. 3.4)

- $\rho$  : Density (kg/m<sup>3</sup>, kg/cm<sup>3</sup>)
- $g$  : Gravitational acceleration (cm/sec<sup>2</sup>)
- $m$  : Mass of prism (kg)
- $W$  : Weight of prism (kgf)

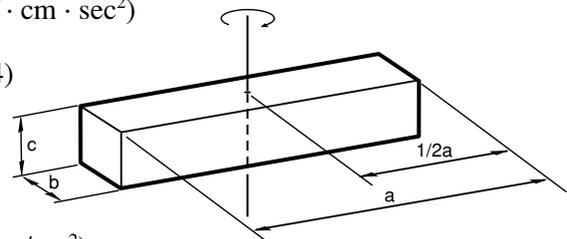


Fig. 3-82

- 5) When the object's center line is offset from the rotation center. The equation for the moment of inertia, when the center of the cylinder is offset by the distance "x" from the rotation center as shown in Fig. 3-83, is given as follows.

$$I = \frac{\rho\pi D^4 h}{32} + \frac{\rho\pi D^2 h x^2}{4} = \frac{mD^2}{8} + mx^2 \quad (\text{kgm}^2)$$

$$J = \frac{\rho\pi D^4 h}{32g} + \frac{\rho\pi D^2 h x^2}{4g}$$

$$= \frac{WD^2}{8g} + \frac{Wx^2}{g} \quad (\text{kgf} \cdot \text{cm} \cdot \text{sec}^2)$$

... (Eq. 3.5)

$\rho$  : Density (kg/m<sup>3</sup>, kg/cm<sup>3</sup>)  
 $g$  : Gravitational acceleration (cm/sec<sup>2</sup>)  
 $m$  : Mass of cylinder (kg)  
 $W$  : Weight of cylinder (kgf)

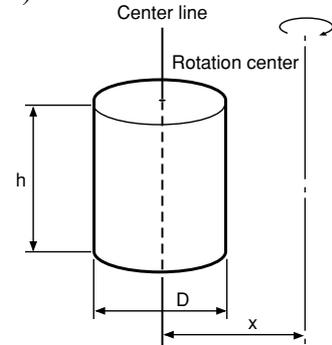


Fig. 3-83

In the same manner, the moment of inertia of a cylinder as shown in Fig. 3-84 is given by

$$I = \frac{\rho\pi D^2 h}{16} \left( \frac{D^2}{4} + \frac{h^2}{3} \right) + \frac{\rho\pi D^2 h x^2}{4} = \frac{m}{4} \left( \frac{D^2}{4} + \frac{h^2}{3} \right) + mx^2 \quad (\text{kgm}^2)$$

$$J = \frac{\rho\pi D^2 h}{16g} \left( \frac{D^2}{4} + \frac{h^2}{3} \right) + \frac{\rho\pi D^2 h x^2}{4g}$$

$$= \frac{W}{4g} \left( \frac{D^2}{4} + \frac{h^2}{3} \right) + \frac{Wx^2}{g} \quad (\text{kgf} \cdot \text{cm} \cdot \text{sec}^2)$$

... (Eq. 3.6)

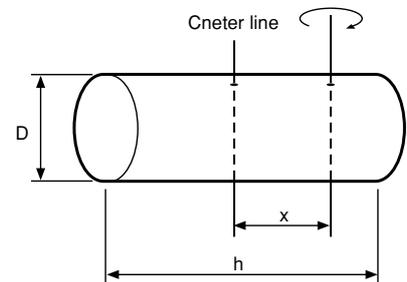


Fig. 3-84

In the same manner, the moment of inertia of a prism as shown in Fig. 3-85 is given by

$$I = \frac{\rho abc(a^2 + b^2)}{12} + \rho abc x^2 = \frac{m(a^2 + b^2)}{12} + mx^2 \quad (\text{kgm}^2)$$

$$J = \frac{\rho abc(a^2 + b^2)}{12g} + \frac{\rho abc x^2}{g}$$

$$= \frac{W(a^2 + b^2)}{12g} + \frac{Wx^2}{g} \quad (\text{kgf} \cdot \text{cm} \cdot \text{sec}^2)$$

... (Eq. 3.7)

$m$  : Mass of prism (kg)  
 $W$  : Weight of prism (kgf)

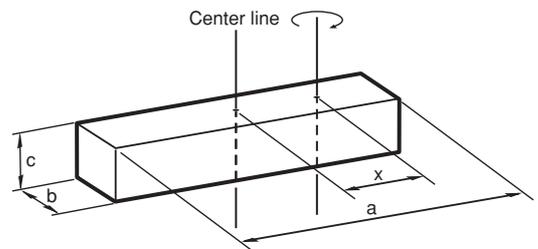


Fig. 3-85

6-3 Example of moment of inertia calculation

Let's discuss an example in which the chuck and workpiece are at a position offset by 10cm from the R-axis by a stay, as shown in Fig. 3-86. The moment of inertia is calculated with the following three factors, assuming that the load material is steel and its density  $\rho$  is  $0.0078\text{kg/cm}^3$ .

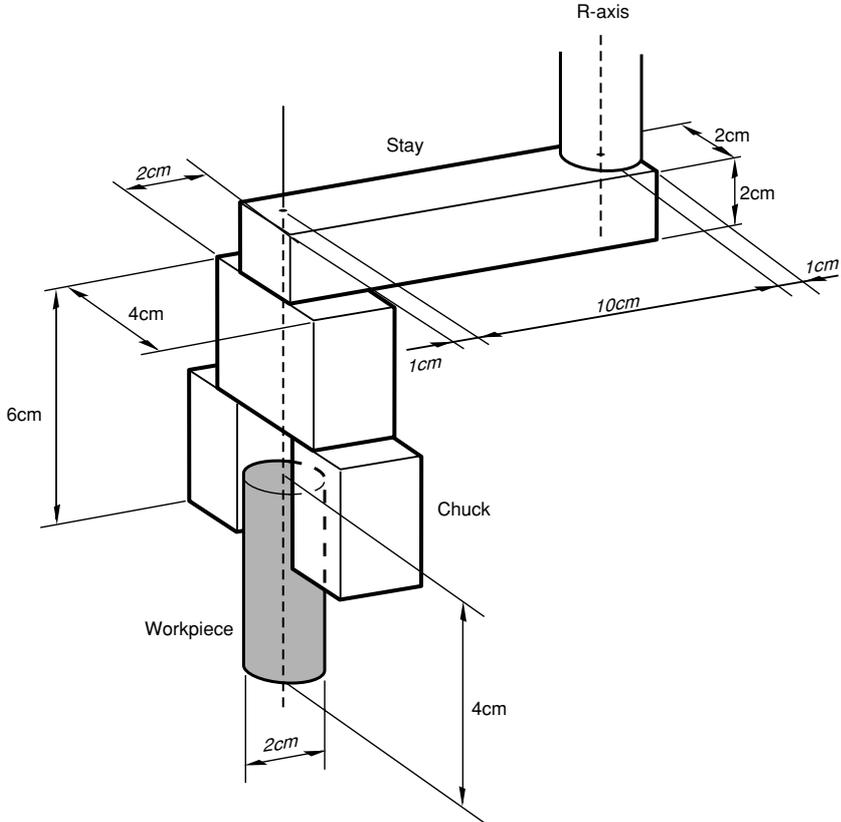


Fig. 3-86

1) Moment of inertia of the stay

From Fig. 3-87, the weight of the stay ( $W_s$ ) is given as follows:

$$W_s = \rho abc = 0.0078 \times 12 \times 2 \times 2 = 0.37 \text{ (kgf)}$$

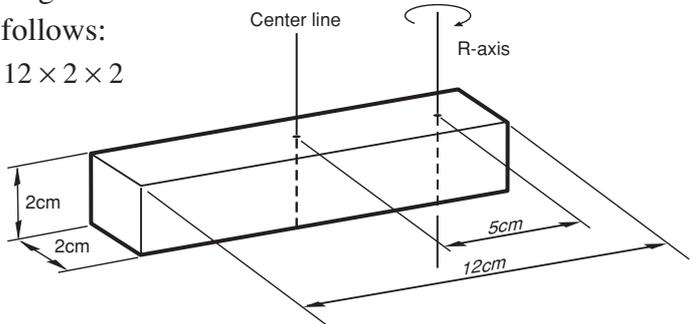


Fig. 3-87

The moment of inertia of the stay ( $J_s$ ) is then calculated from Eq. 3-7.

$$J_s = \frac{0.37 \times (12^2 + 2^2)}{12 \times 980} + \frac{0.37 \times 5^2}{980} = 0.014 \text{ (kgf} \cdot \text{cm} \cdot \text{sec}^2)$$

2) Moment of inertia of the chuck

When the chuck form resembles that shown in Fig. 3-88, the weight of the chuck ( $W_c$ ) is

$$W_c = 0.0078 \times 2 \times 4 \times 6 = 0.37 \text{ (kgf)}$$

The moment of inertia of the chuck ( $J_c$ ) is then calculated from Eq. 3-7.

$$J_c = \frac{0.37 \times (2^2 + 4^2)}{12 \times 980} + \frac{0.37 \times 10^2}{980} = 0.038 \text{ (kgf} \cdot \text{cm} \cdot \text{sec}^2)$$

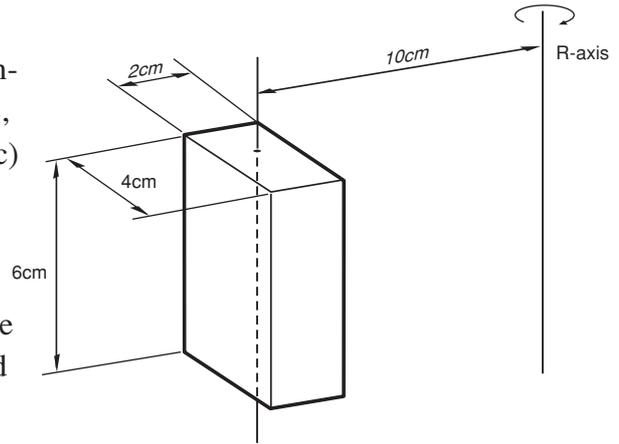


Fig. 3-88

3) Moment of inertia of workpiece

When the workpiece form resembles that shown in Fig. 3-89, the weight of the workpiece ( $W_w$ ) is

$$W_w = \frac{\rho \pi D^2 h}{4} = \frac{0.0078 \pi \times 2^2 \times 4}{4} = 0.098 \text{ (kgf)}$$

The moment of inertia of the workpiece ( $J_w$ ) is then calculated from Eq. 3-5.

$$J_w = \frac{0.097 \times 2^2}{8 \times 980} + \frac{0.097 \times 10^2}{980} = 0.010 \text{ (kgf} \cdot \text{cm} \cdot \text{sec}^2)$$

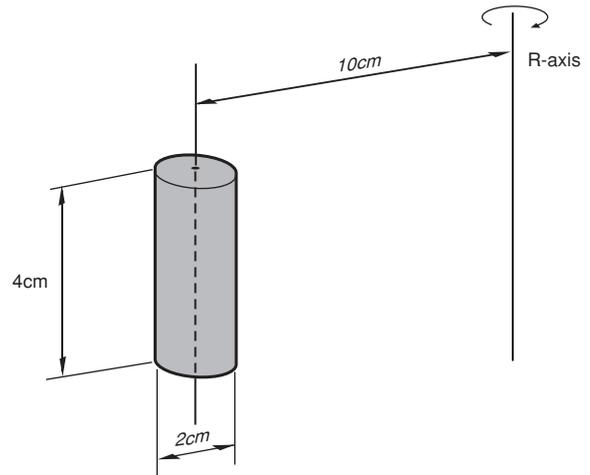


Fig. 3-89

4) Total weight

The total weight ( $W$ ) is calculated as follows:

$$W = W_s + W_c + W_w = 0.84 \text{ (kgf)}$$

5) Total moment of inertia

The total moment of inertia ( $J$ ) is then obtained as follows:

$$J = J_s + J_c + J_w = 0.062 \text{ (kgf} \cdot \text{cm} \cdot \text{sec}^2)$$

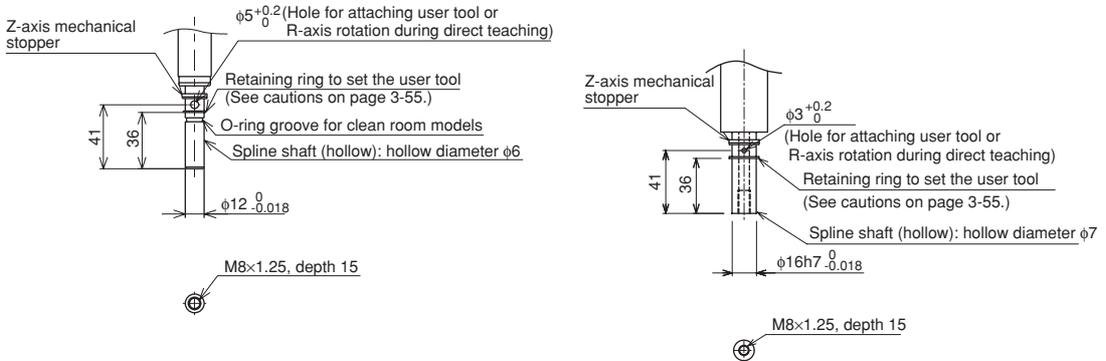
6-4 Attaching the end effector

**WARNING**

Before attaching the end effector, be sure to turn off the controller.

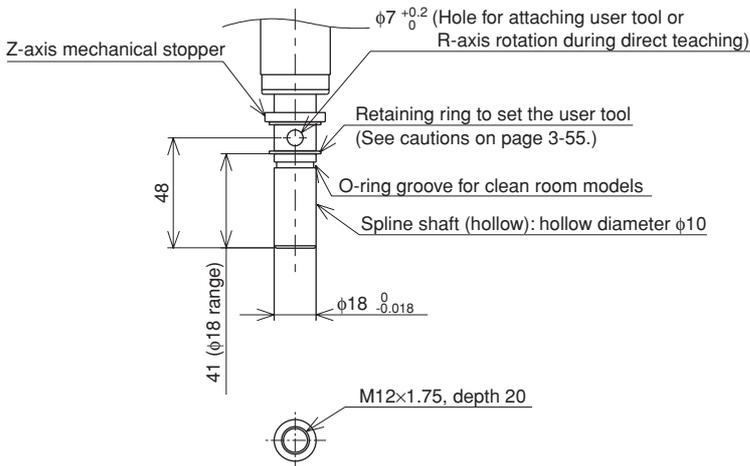
The manipulator part to which an end effector is attached must have adequate strength and rigidity, as well as gripping force to prevent positioning errors. Table 3-1 shows the maximum load that can be applied to the end effector attachment of each robot model. Recommended methods for attaching end effectors are shown in Table 3-2 and Fig. 3-92. Refer to Fig. 3-90 for details on the end effector attachment of each robot model. For YK550X, refer to "1-2 External view and dimensions" in Chapter 7.

When checking end effector operation, refer to "6 Trial Operation" in Chapter 1.



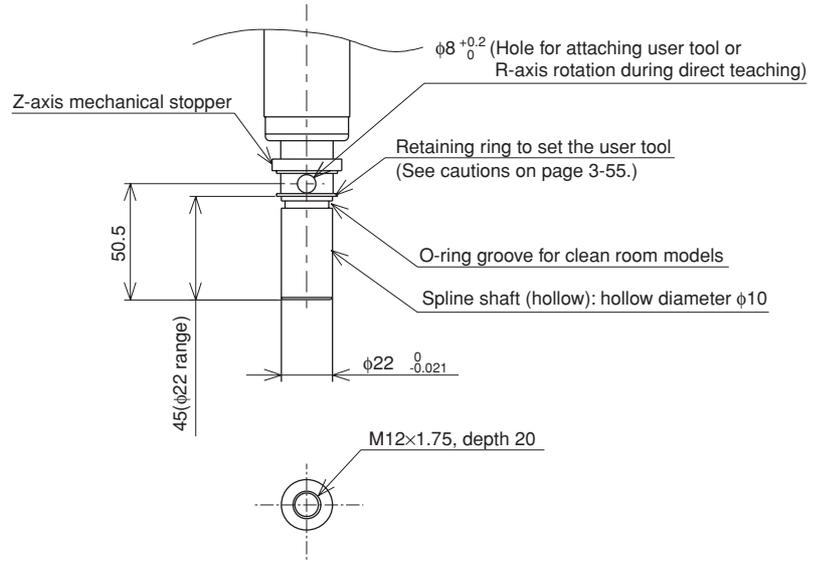
YK250X, YK350X, YK400X: Z-axis tip shape

YK250XH, YK350XH, YK400XH: Z-axis tip shape

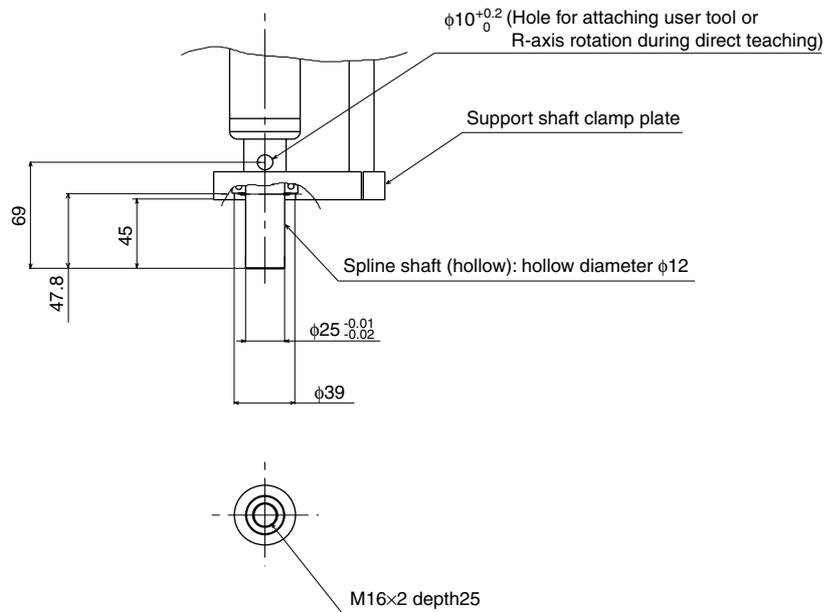


YK500X, YK600X: Z-axis tip shape

Fig. 3-90 (1)



YK700X, YK800X, YK1000X: Z-axis tip shape



YK1200X: Z-axis tip shape

Fig. 3-90 (2)

**CAUTION**

The horizontal hole provided in the spline is for attaching a user tool or R-axis rotation during direct teaching.  
 Do not insert a pin or rod into this hole in order to stop a user tool from rotating. Doing so may damage the spline.  
 When inserting a rod into this hole to rotate the R-axis, use a round rod with a diameter slightly smaller than the diameter of each hole. Avoid using a square rod because the spline might be damaged by the edge of the rod.

Table 3-1

Robot Model	F <sub>xy</sub> max		F <sub>z</sub> max		F <sub>R</sub> max		M <sub>R</sub> max		Mmax	
	N	kgf	N	kgf	N	kgf	Nm	kgfm	Nm	kgfm
YK250X(H)	46	5	40	4	121	12	6	0.6	5	0.5
YK350X(H)	46	5	40	4	121	12	6	0.6	5	0.5
YK400X(H)	46	5	40	4	121	12	6	0.6	5	0.5
YK500X	115	12	89	9	253	26	12	1.3	10	1.0
YK600X	115	12	89	9	253	26	12	1.3	10	1.0
YK700X	376	38	178	18	464	47	47	4.8	22	2.3
YK800X	376	38	159	16	464	47	47	4.8	20	2.0
YK1000X	341	35	159	16	464	47	43	4.4	20	2.0
YK1200X	441	45	39	4	1215	124	98	10.0	4.9	0.5
YK550X	300	31	135	14	295	30	18	1.8	19	1.9

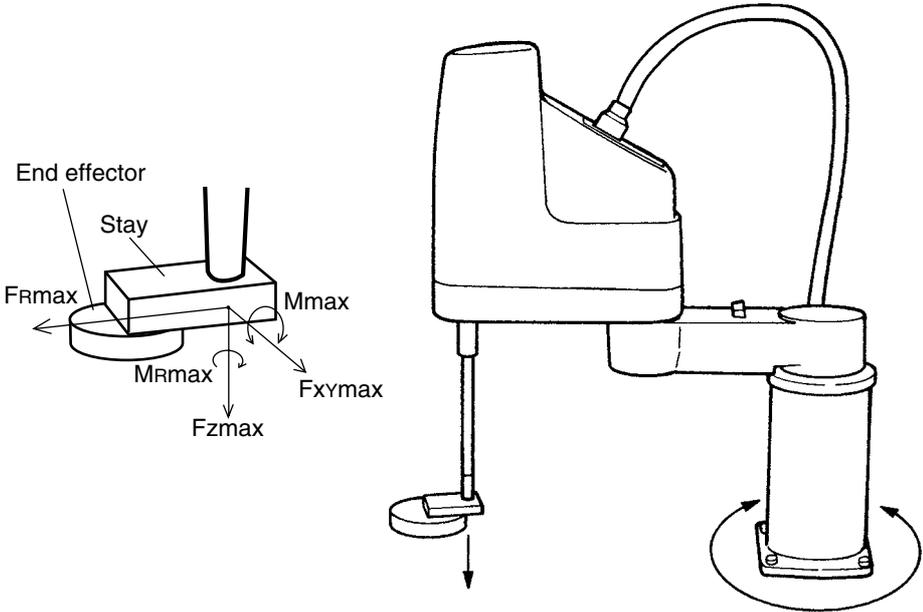


Fig. 3-91 Maximum load applied to end effector attachment

Table 3-2

Robot Model	Bolts Used	Number of bolts	Tightening torque		Hole diameter(mm)	
			Nm	kgf·cm		
YK250X(H)	M4 or lager	2 or more	4.5	46	12	$\begin{matrix} +0.018 \\ 0 \end{matrix}$
YK350X(H)	M4 or lager	2 or more	4.5	46	12	$\begin{matrix} +0.018 \\ 0 \end{matrix}$
YK400X(H)	M4 or lager	2 or more	4.5	46	12	$\begin{matrix} +0.018 \\ 0 \end{matrix}$
YK500X	M6 or lager	2 or more	15.3	156	18	$\begin{matrix} +0.018 \\ 0 \end{matrix}$
YK600X	M6 or lager	2 or more	15.3	156	18	$\begin{matrix} +0.018 \\ 0 \end{matrix}$
YK700X	M8 or lager	2 or more	37.0	380	22	$\begin{matrix} +0.021 \\ 0 \end{matrix}$
YK800X	M8 or lager	2 or more	37.0	380	22	$\begin{matrix} +0.021 \\ 0 \end{matrix}$
YK1000X	M8 or lager	2 or more	37.0	380	22	$\begin{matrix} +0.021 \\ 0 \end{matrix}$
YK1200X	M10 or lager	2 or more	74.0	760	25	$\pm 0.01$
YK550X	M6 or lager	2 or more	15.3	156	16	$\begin{matrix} +0.018 \\ 0 \end{matrix}$

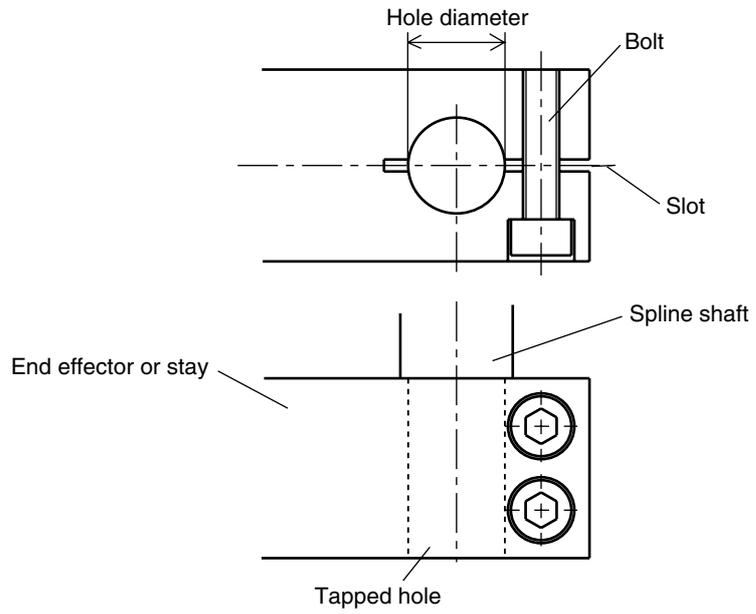


Fig. 3-92

**⚠ WARNING**

The end effector attachment must have adequate strength to withstand the loads listed in Table 3-1. If too weak, the attachment may break during robot operation and fragments fly off causing accidents or injuries.

---

**⚠ WARNING**

The end effector attachment must have sufficient rigidity versus the loads listed in Table 3-1. If this rigidity is inadequate, the end effector may vibrate during robot operation causing bad effects on the manipulator operation.

---

**⚠ WARNING**

- When the end effector is attached by slot clamping, always observe the conditions listed in Table 3-2. If these are ignored, the end effector may come loose and fly off during robot operation, resulting in an accident or injury.
  - In cases where other attachment methods are used, be sure that the end effector will not come off when the loads listed in Table 3-1 are applied.
- 

**⚠ WARNING**

- The tapped hole (see Figs. 3-90 and 3-92) provided on the lower part of the end effector attachment should be used only for preventing the end effector from coming loose.
  - Do not fasten the end effector just by using this tapped hole. If the end effector is fastened only with this tapped hole, it may come loose from the attachment during robot operation and fly off resulting in accidents or injuries.
- 

**⚠ CAUTION**

Do not attempt to secure the user tool to the spline shaft by using the tapped hole (see Figs. 3-90 and 3-92) at the lower part of the end effector attachment, which will apply an axial force to the user tool positioning circlip (retaining ring). Trying to secure the tool in this way will damage the retaining ring.

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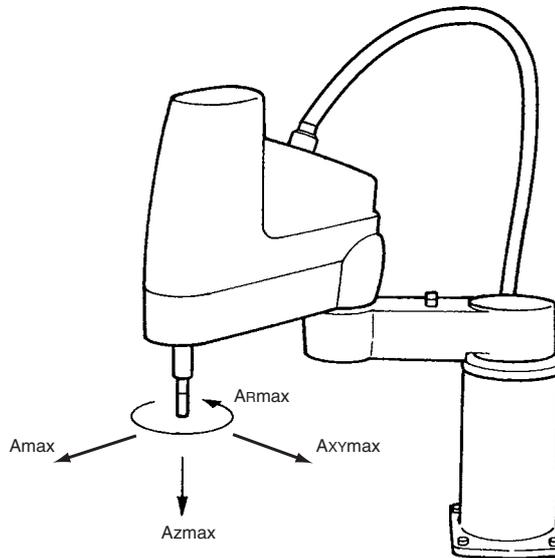
## 6-5 Gripping force of end effector

The gripping force of the end effector must have a sufficient extra margin of strength versus the workpiece weight and reaction force applied to the workpiece during robot operation.

The reaction force applied to the workpiece during operation can be calculated from the acceleration applied to the end effector attachment. The maximum acceleration on the end effector attachment of each robot model is listed in the table below. When the workpiece position is offset to the end effector attachment, the accelerations  $A_{max}$  and  $A_{xy\max}$  become larger by an amount equal to the offset versus the arm length. When the R-axis rotates during operation, this acceleration  $A_{R\max}$  must be taken into account.

**Table 3-3 Maximum acceleration during robot operation**

Robot Model	$A_{max}(m/sec^2)$	$A_{xy\max}(m/sec^2)$	$A_{z\max}(m/sec^2)$	$A_{R\max}(rad/sec^2)$
YK250X(H)	62	45	23	140
YK350X(H)	71	48	23	120
YK400X(H)	91	46	23	120
YK500X	48	32	38	140
YK600X	52	27	38	140
YK700X	64	46	32	160
YK800X	67	39	32	160
YK1000X	63	39	32	136
YK1200X	45	39	8	40
YK550X	59	60	56	240



**Fig. 3-93 Maximum acceleration on end effector attachment**

**⚠ WARNING**

The gripping force of the end effector must have a sufficient extra margin of strength to prevent the workpiece from coming loose and flying off during robot operation.

If the gripping force is too weak, the workpiece may come loose and fly off causing accidents or injuries.

## 7 Limiting the Movement Range with X-Axis Mechanical Stoppers (YK500X, YK600X, YK700X, YK800X, YK1000X, YK1200X)

In the YK-X series (YK500X, YK600X, YK700X, YK800X, YK1000X, YK1200X), the movement range can be limited by changing the X-axis mechanical stopper positions. (The Y-axis mechanical stopper positions are fixed and cannot be changed.)

When the robot is shipped from the factory, the movement range is set to the maximum. If the maximum movement range is too large compared to the actual work range, or the manipulator might interfere with peripheral units, then the movement range can be limited as outlined below.

The X-axis mechanical stopper positions may slightly differ depending on machining precision.

### **⚠ WARNING**

Always turn off the controller before changing the movement range with mechanical stoppers.

### **⚠ CAUTION**

When the mechanical stoppers are installed, the soft limits must be set to a point inside the mechanical stopper positions. (Refer to "4 Setting the Soft Limits" in Chapter 4.)

### **⚠ CAUTION**

When installing the mechanical stoppers, use caution not to allow the mechanical stoppers to make contact with the urethane damper (see Fig. 3-97 to 3-98). If these make contact, the urethane damper might come off.

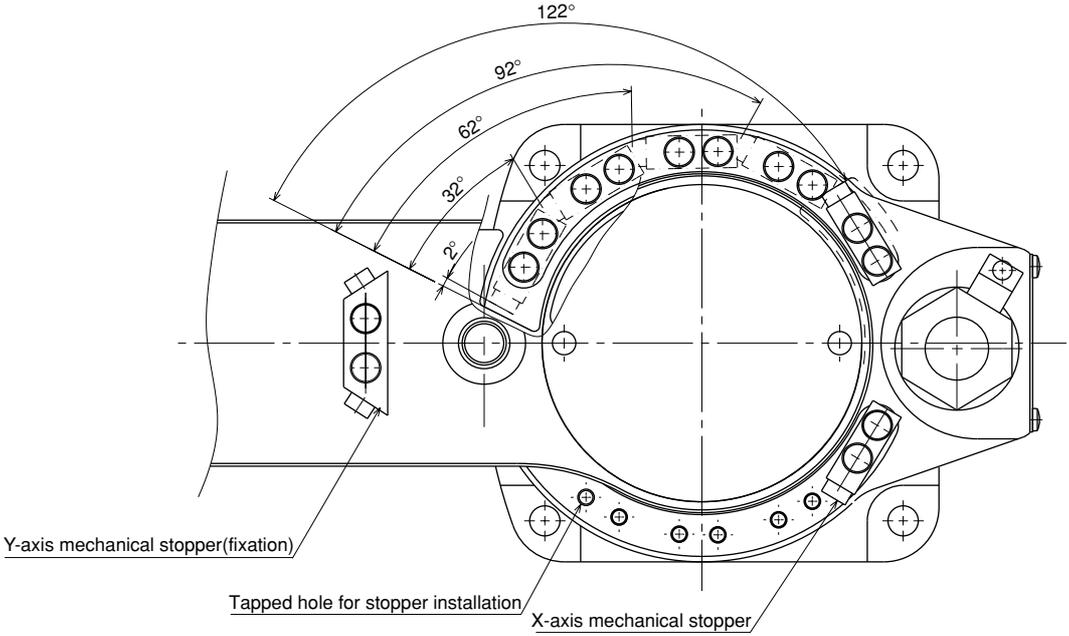
**7-1 YK500X, YK600X, YK700X, YK800X, YK1000X, YK1200X**

To change the X-axis mechanical stopper positions, use the procedure below.

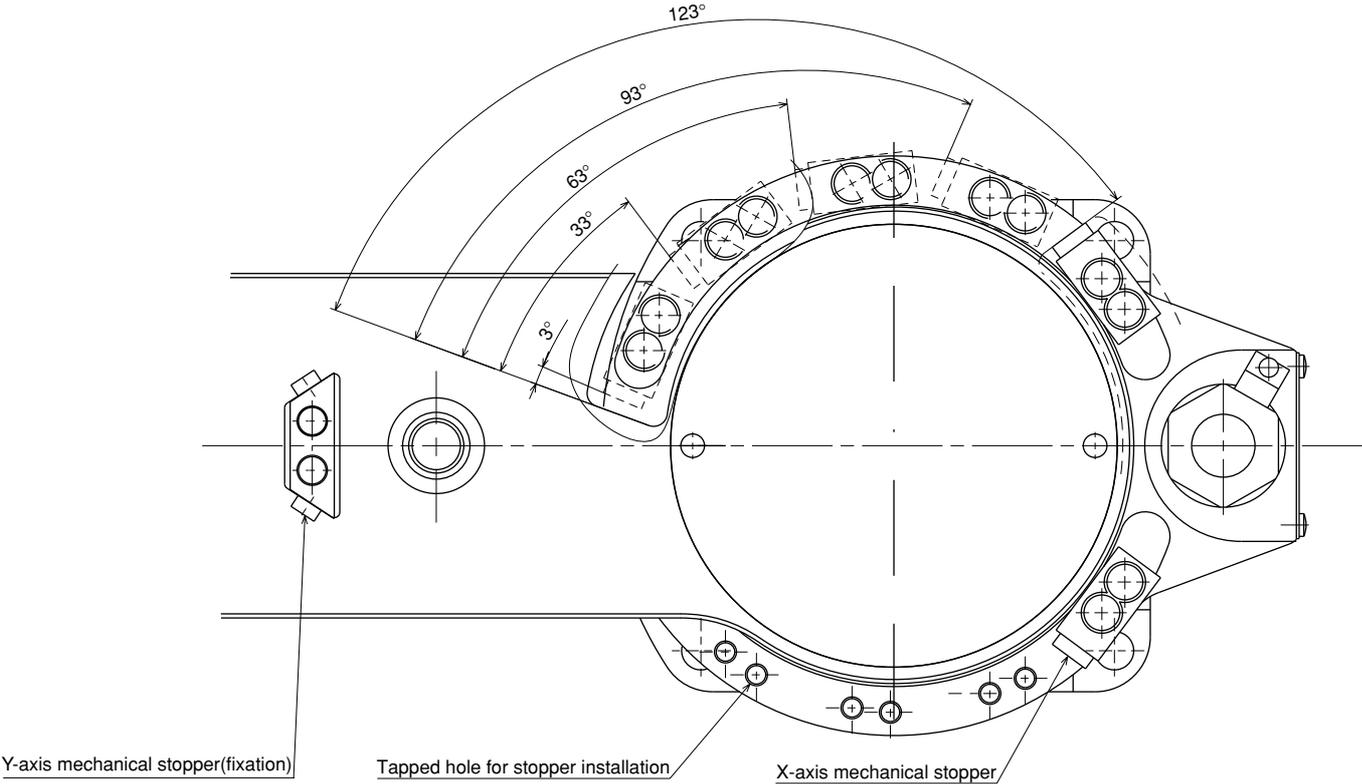
- 1) Prepare the necessary tools.  
Hex wrench set
- 2) Turn off the robot controller.
- 3) Place a sign indicating the robot is being adjusted, to keep others from touching the controller switch.
- 4) Enter the safeguard enclosure.
- 5) Remove the X-axis mechanical stoppers installed as shown in Fig. 3-94 to Fig. 3-96. Then reinstall the mechanical stoppers at the positions that determine the desired movement range by tightening them to the torque specified in Table 3-4.
- 6) Check that the movement range is limited by the mechanical stoppers as desired.
- 7) Go outside the safeguard enclosure.
- 8) Check that no one is inside the safeguard enclosure when turning on the controller.

**Table 3-4**

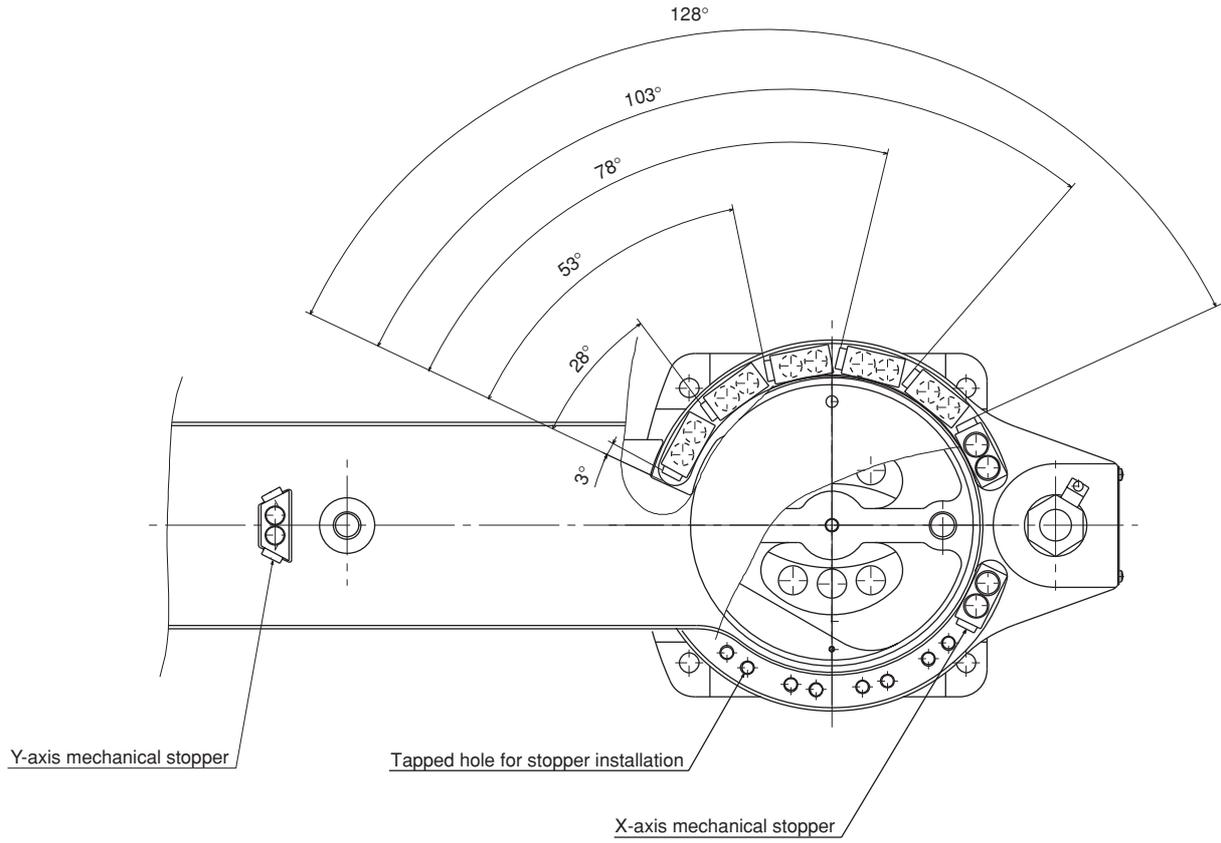
Robot Model	Bolt size	Tightening torque(kgf·cm)	Tightening torque(N·m)
YK500X,YK600X	M6	156	15.3
YK700X,YK800X,YK1000X	M8	380	37.2
YK1200X	M10	720	70.6



**Fig. 3-94 Mechanical stopper positions and movement range (YK500X, YK600X)**



**Fig. 3-95 Mechanical stopper positions and movement range (YK700X, YK800X, YK1000X)**



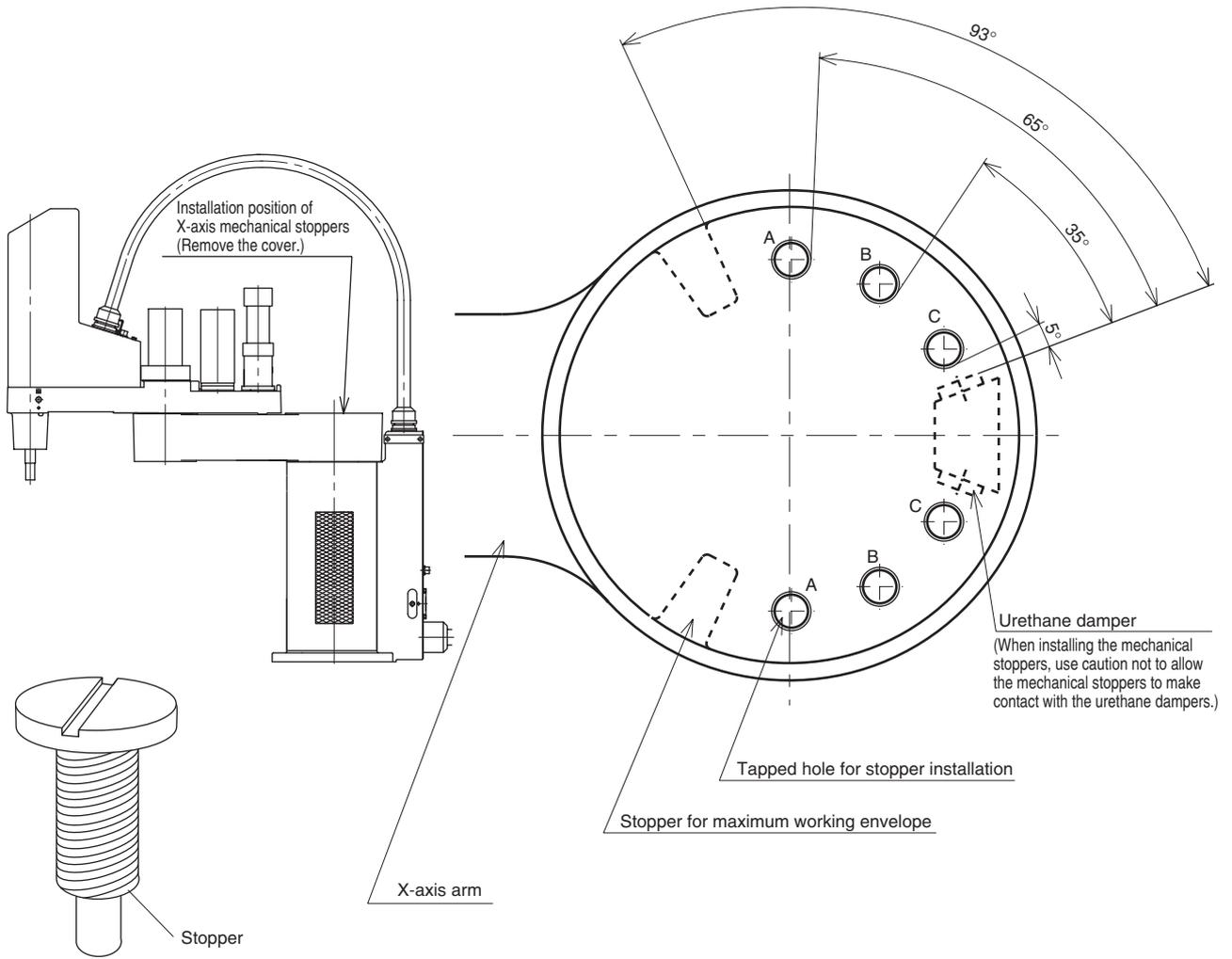
**Fig. 3-96 Mechanical stopper positions and movement range (YK1200X)**

## 7-2

## YK550X

To change the X-axis mechanical stopper positions, use the procedure below while referring to Fig. 3-97.

- 1) Turn the robot X-axis arm so that it faces the machine front.
- 2) Remove the cover on the X-axis.
- 3) The mechanical stoppers are not installed at the time of shipment, but the robot has fixed stoppers cast integrally with the arm. These are used for the maximum working envelope. To narrow the movement range, install the mechanical stoppers (supplied with the robot) securely in the desired positions A to C. Use a slotted screwdriver to tighten the stopper all the way into the tapped holes.  
For example, when the mechanical stoppers are installed in position A in Fig. 3-97, the X-axis arm is allowed to turn though an angle of 65 degrees from the front of the arm to the mechanical stopper.
- 4) Check that the movement range is limited by the mechanical stoppers as desired.
- 5) Reattach the cover to the X-axis.



**Fig. 3-97 X-axis mechanical stopper positions and movement range**

# 8 Limiting the Movement Range with Y-Axis Mechanical Stoppers

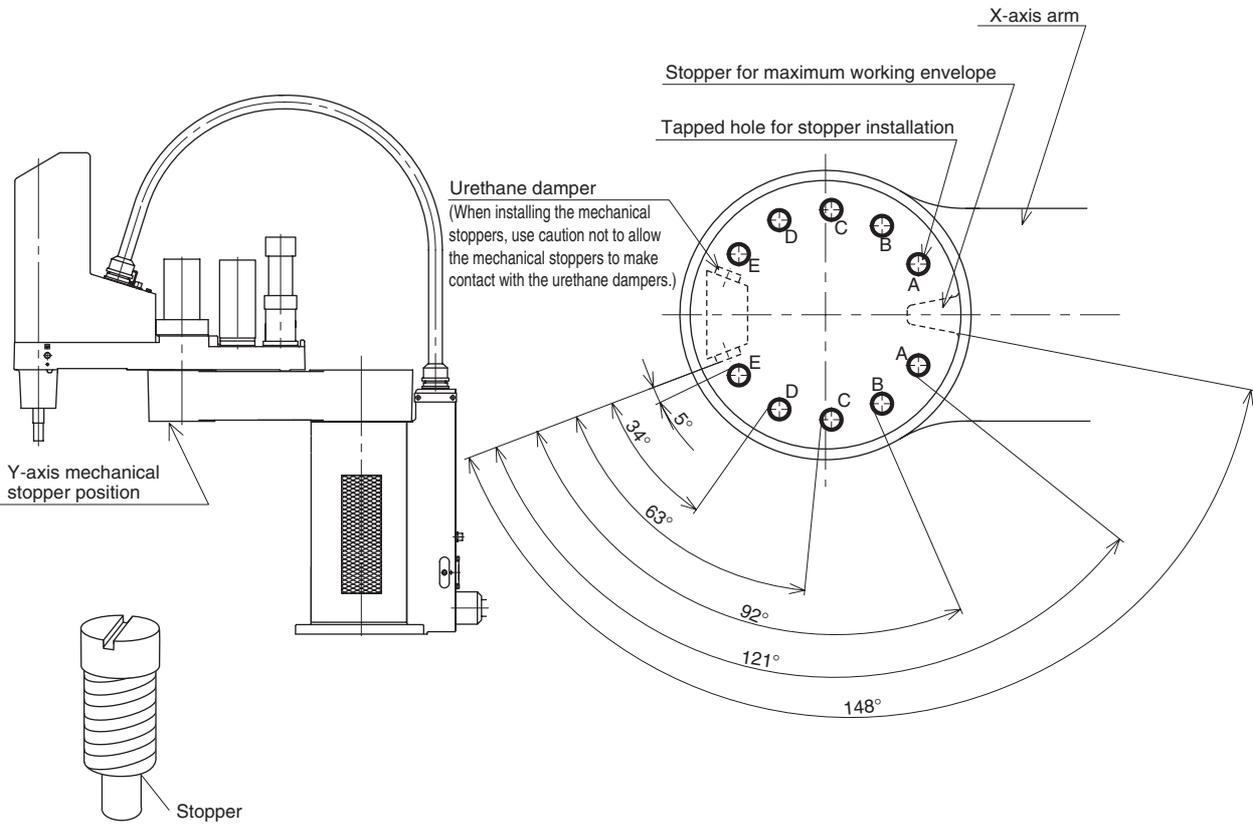
## 8-1 YK550X

To change the Y-axis mechanical stopper positions, use the procedure below while referring to Fig. 3-98.

- 1) Turn the robot X and Y-axis arms so that they are nearly straight.
- 2) The mechanical stoppers are not installed at the time of shipment, but the robot has fixed stoppers cast integrally with the arm. These are used for the maximum working envelope. To narrow the movement range, install the mechanical stoppers (supplied with the robot) securely in the desired positions A to E. Use a slotted screwdriver to tighten the stopper all the way into the tapped holes.

For example, when the mechanical stoppers are installed in position A in Fig. 3-98, the Y-axis arm is allowed to turn though an angle of 121 degrees from the front of the arm to the mechanical stopper.

- 3) Check that the movement range is limited by the mechanical stoppers as desired.



**Fig. 3-98 Y-axis mechanical stopper positions and movement range**

8-2 YK1200X

To limit the movement range of the Y-axis of the YK1200X, the user must prepare and assemble the shock absorber shown below and the shock absorber clamp parts shown in Fig. 3-99.

Use of these parts makes it possible to limit the movement range of the Y-axis from  $\pm 150$  degrees (standard) to  $\pm 110$  degrees .

(The movement range limited with the mechanical stopper is  $\pm 125$  degrees.)

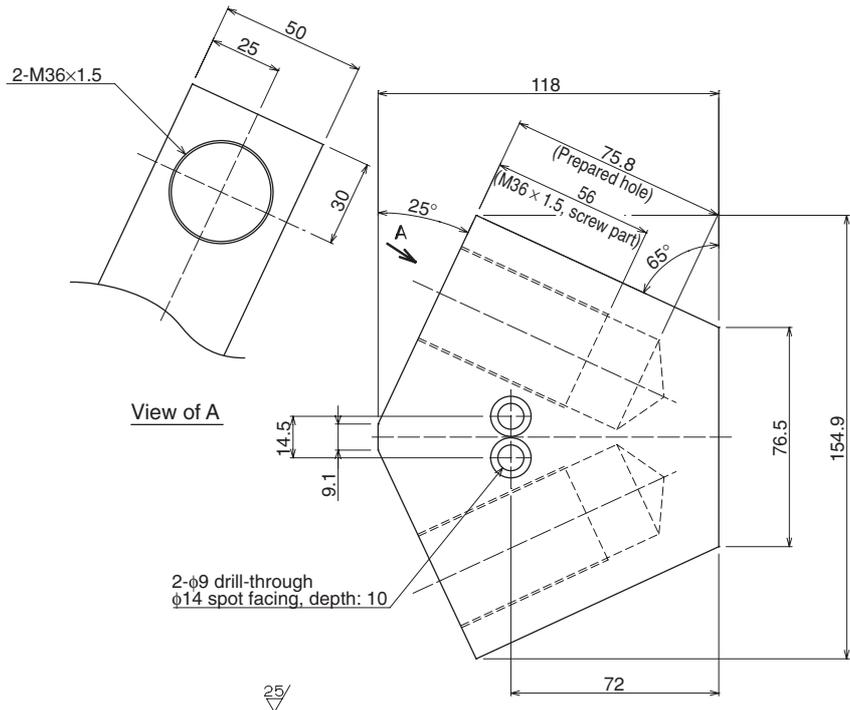
**⚠ WARNING**

Always turn off the controller before changing the movement range with mechanical stoppers.

**⚠ CAUTION**

When the mechanical stoppers are installed, the soft limits must be set to a point inside the mechanical stopper positions.

Recommended shock absorber model: Adjustable shock absorber  
OEM1.25M1 (ENIDINE Co., Ltd.)



\* Unless otherwise specified particularly, the edges should be C0.5 or less and the corners should be R0.2 or less.

Material : SS400  
Surface treatment : Galvanization

**Fig. 3-99 Shock absorber clamp parts**

- 1) Prepare a hex wrench set.
- 2) Turn off the robot controller.
- 3) Place a sign indicating the robot is being adjusted, to keep others from touching the controller switch.
- 4) Enter the safeguard enclosure.
- 5) Remove the Y-axis mechanical stopper clamp bolts and then remove the mechanical stopper. (Fig. 3-100)
- 6) Install the shock absorber clamp parts using the mechanical stopper clamp bolt holes in the Y-axis arm. (Fig. 3-101, Clamp bolt: M8 × 60)
- 7) Assemble the shock absorber into the shock absorber clamp parts and adjust the absorber projection length as shown in Fig. 3-102.
- 8) Secure the shock absorber to the clamp parts with the supplied nuts (M36×1.5). (Recommended tightening torque: 100N•m)
- 9) Go out of the safeguard enclosure.
- 10) Check that no one is inside the safeguard enclosure, and then turn on the controller.
- 11) Set the soft limits to a point inside the mechanical stopper positions.

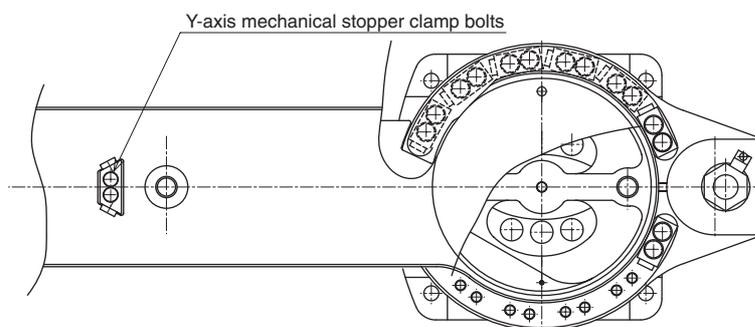


Fig. 3-100

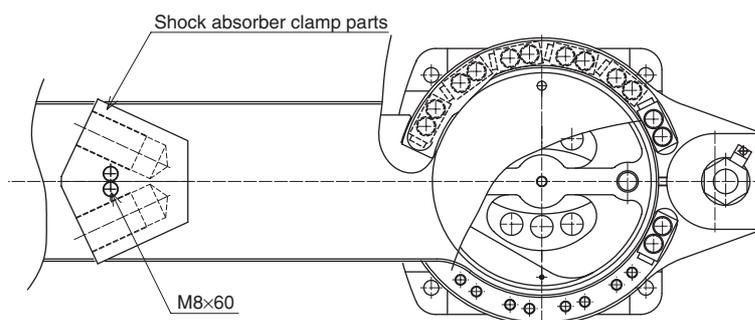


Fig. 3-101

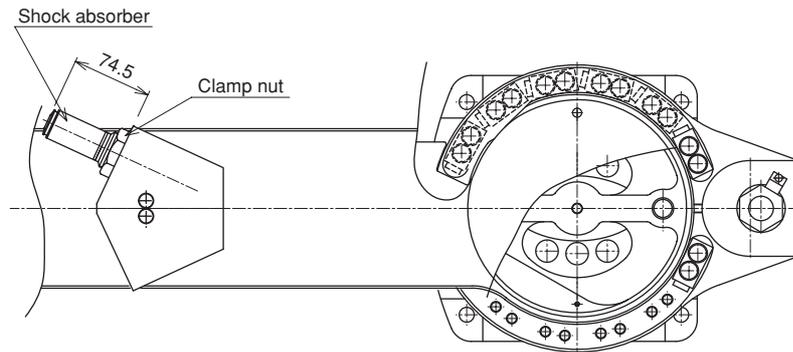


Fig. 3-102

● **Overrun amounts during impacts with Y-axis mechanical stopper**

The robot overruns the mechanical stopper position when it strikes the mechanical stopper. Use caution and take overrun into account since the end effector may interfere with the robot body and peripheral equipment or the robot body may interfere with the peripheral equipment. The maximum overrun amount is 3 degrees (overrun angle at the Y-axis joint) when the movement range is limited with the additional mechanical stopper (for normal operation, maximum payload, maximum speed).

- \* If the Y-axis mechanical stopper is deformed or damaged by impacts, please contact our sales office or dealer. Using the deformed or damaged mechanical stopper is dangerous, so it must be replaced.

# 9 Limiting the Movement Range with Z-Axis Mechanical Stoppers (YK1200X)

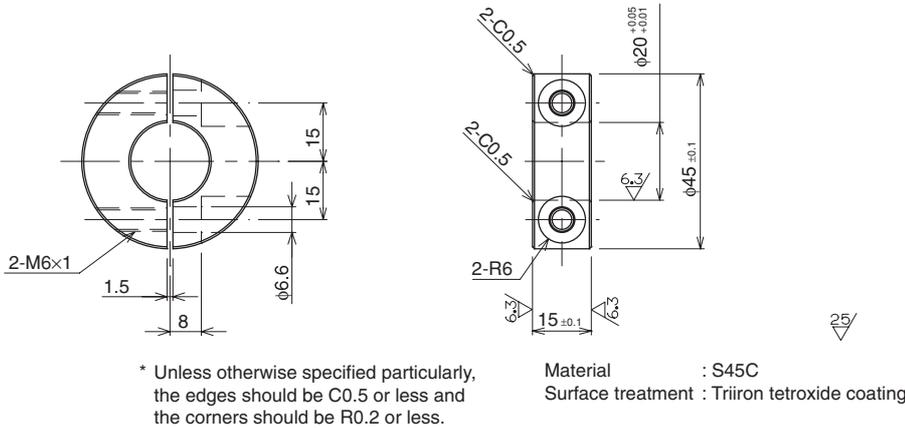
To limit the movement range of the Z-axis of the YK1200X, the user must prepare and assemble the mechanical stopper parts shown in Fig. 3-103. Use of these parts makes it possible to narrow the movement range of the Z-axis.

**⚠ WARNING**

Always turn off the controller before changing the movement range with mechanical stoppers.

**⚠ CAUTION**

When the mechanical stoppers are installed, the soft limits must be set to a point inside the mechanical stopper positions.



**Fig. 3-103 Drawing of mechanical stopper parts for Z-axis**

## 9-1 Installing the minus direction stopper

Install the additional mechanical stopper in the Z-axis minus direction by following the instructions shown in Fig. 3-104.

- 1) Prepare a hex wrench set.
- 2) Turn off the robot controller.
- 3) Place a sign indicating the robot is being adjusted, to keep others from touching the controller switch.
- 4) Enter the safeguard enclosure.
- 5) Remove the Y-axis arm cover.  
For details on how to remove the cover, refer to "7 Removing the Robot Covers" in Chapter 4.
- 6) Degrease the bore cylindrical surface of the additional mechanical stopper. Install the additional mechanical stopper on the ball screw with the additional mechanical stopper clamp bolts (M6×1, L=20). At this time, gradually tighten the bolts alternately to the specified torque. (Specified torque: 15.2N•m)
- 7) Go out of the safeguard enclosure.
- 8) Check that no one is inside the safeguard enclosure, and then turn on the controller.
- 9) Place a sign indicating the robot is being adjusted, to keep others from operating the controller or operation panel.
- 10) Perform the Z-axis absolute reset.  
To perform the Z-axis absolute reset, see "3-3 Absolute reset procedures" in Chapter 4. After that, check the machine reference value and make the adjustment when necessary.

### CAUTION

Use the following procedure to display the **adjustment machine reference value**.

When adjusting the machine reference value, always check the **adjustment machine reference value** with this procedure.

- (1) Press the MODE key.
- (2) Press the F3 key to enter MANUAL mode.
- (3) Press the F13 key (LOWER+F3) to select "ABS Reset".
- (4) After the Z-axis absolute reset is complete, press the F10 (UPPER+F5) key to display the **adjustment machine reference value (%)**.

When the machine reference is within the allowable range (between 26 and 74%), proceed to step 16). If the machine reference is outside the allowable range, adjust it as described in step 11) onward.

- 11) Turn off the controller and enter the safeguard enclosure.
- 12) Put a mark at the added stopper position and loosen the bolt for the added stopper.  
To adjust the machine reference value, move the added stopper as follows:  
Machine reference value < 26% : Move the added stopper in the plus direction.  
Machine reference value > 74% : Move the added stopper in the minus direction.  
As an approximate guide, a 2.5mm movement equals 100%.
- 13) Repeat the same procedure from step 6) until the machine reference is within the allowable range.
- 14) When the machine reference is set within the allowable range, go out of the safeguard enclosure.
- 15) Check that no one is inside the safeguard enclosure and then turn on the controller.
- 16) Set the soft limit in the minus direction.
- 17) Make sure that the movement range is limited securely.
- 18) Turn off the controller and enter the safeguard enclosure.
- 19) Place a sign indicating the robot is being adjusted, to keep others from operating the controller power.
- 20) Reattach the Y-axis arm cover.

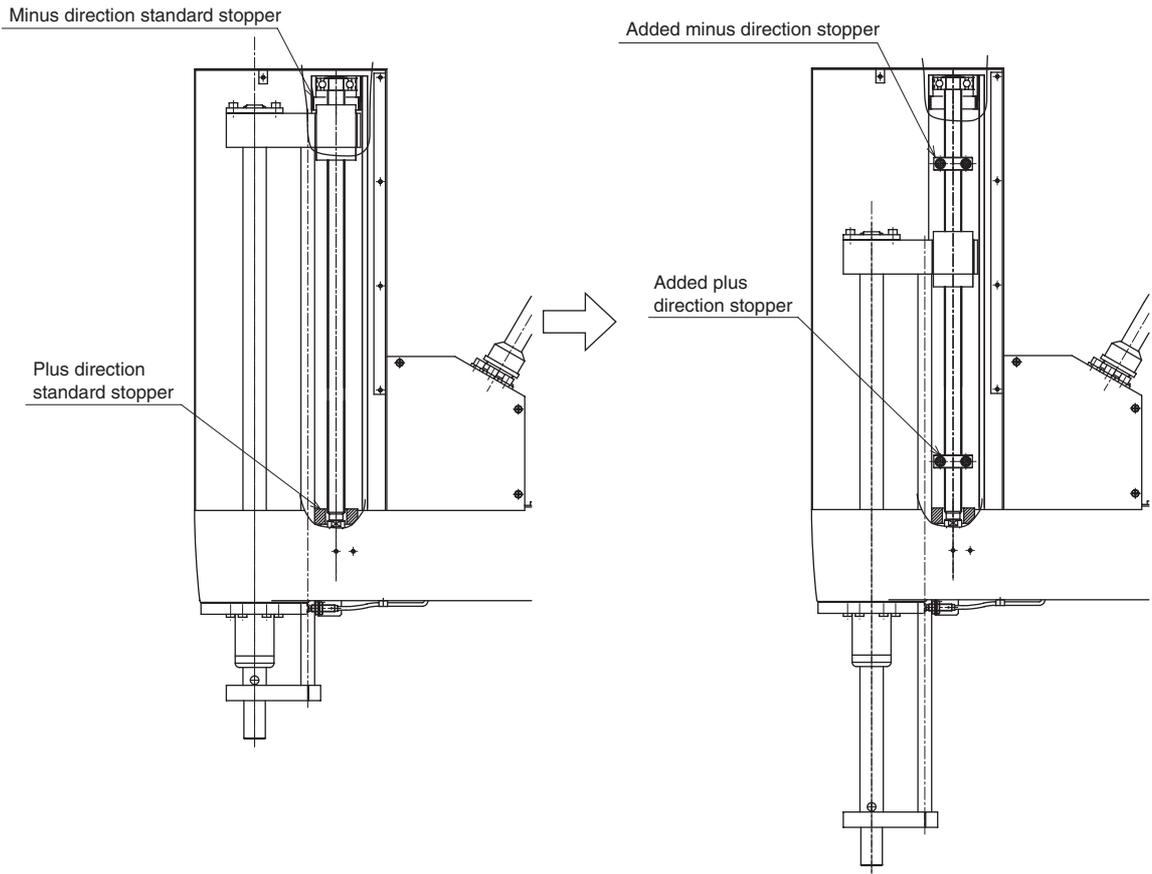


Fig. 3-104

## 9-2 Installing the plus direction stopper

Install the additional mechanical stopper in the Z-axis plus direction by following the instructions shown in Fig. 3-104.

- 1) Prepare a hex wrench set.
- 2) Turn off the robot controller.
- 3) Place a sign indicating the robot is being adjusted, to keep others from touching the controller switch.
- 4) Enter the safeguard enclosure.
- 5) Remove the Y-axis arm cover.  
For details on how to remove the cover, refer to "7 Removing the Robot Covers" in Chapter 4.
- 6) Degrease the bore cylindrical surface of the additional mechanical stopper. Install the additional mechanical stopper on the ball screw with the additional mechanical stopper clamp bolts (M6×1, L=20). At this time, gradually tighten the bolts alternately to the specified torque. (Specified torque: 15.2N•m)
- 7) Go out of the safeguard enclosure.
- 8) Check that no one is inside the safeguard enclosure, and then turn on the controller.
- 9) Set the soft limit in the plus direction.
- 10) Make sure that the movement range is limited securely.
- 11) Turn off the controller and enter the safeguard enclosure.
- 12) Place a sign indicating the robot is being adjusted, to keep others from operating the controller power.
- 13) Reattach the Y-axis arm cover.

### 9-3 Overrun amounts during impacts with Z-axis mechanical stopper

The robot overruns the mechanical stopper position when it strikes the mechanical stopper. Use caution and take overrun into account since the end effector may interfere with the robot body and peripheral equipment or the robot body may interfere with the peripheral equipment. The maximum overrun amounts when the movement range is limited with the additional mechanical stopper are listed below (for normal operation, maximum payload, maximum speed).

Stopper position	Upper end	Lower end
Overrun amounts	7mm	7mm

- (1) If the Z-axis mechanical stopper is deformed or damaged by impacts, please contact our sales office or dealer. Using the deformed or damaged mechanical stopper is dangerous, so it must be replaced.
- (2) After the robot strikes the Z-axis mechanical stopper, the stopper position may shift, and so check the stopper position. If shifted, move the stopper to the correct position and refasten it securely by following the assembly procedure.

## 10 Limiting the Movement Range with X-, Y- and Z-Axis Mechanical Stoppers (YK250X, YK350X, YK400X, YK250XH, YK350XH, YK400XH)

### 10-1 Installing the X-, Y- and Z-axis additional mechanical stoppers

The X-, Y- and Z-axis movement ranges can be narrowed as shown in Table 3-6 by ordering and installing additional optional parts listed in Table 3-5.

The mechanical stopper positions may slightly differ depending on machining precision of the parts and the installation position.

#### **⚠ WARNING**

- Always turn off the controller before changing the movement range with mechanical stoppers.
- When the plus direction stopper is installed, the Z-axis acceleration must be reduced. Refer to "9-3-2 Installing the plus direction stopper".

#### **⚠ CAUTION**

When the mechanical stoppers are installed, the soft limits must be set to a point inside the mechanical stopper positions.

**Table 3-5**

YK250X(H), YK350X(H), YK400X(H)

	No.	Part No.	Qty	Remarks
Additional mechanical stopper parts in either direction of X-axis plus or minus direction, or in both directions (*1)	①	KN3-M2197-001	1	Stopper damper
	②	90112-10J045	1	Bolt
	③	99712-10600	1	Nut
Additional mechanical stopper parts in Y-axis plus direction	④	KN3-M2197-001	1	Stopper damper
	⑤	90112-10J045	1	Bolt
	⑥	99712-10600	1	Nut
Additional mechanical stopper parts in Y-axis minus direction	④	KN3-M2197-001	1	Stopper damper
	⑤	90112-10J045	1	Bolt
	⑥	99712-10600	1	Nut

\*1: To add the stopper in the plus or minus direction or even in both directions, use one each of the above stopper parts. (When changing the movement range in both directions, move the existing stopper position.)

YK250X(H), YK350X(H), YK400X(H)

	No.	Part No.	Qty	Remarks
Additional mechanical stopper parts in Z-axis plus direction	①	KBE-M1780-000	1	Stopper block
	②	KN3-M1789-000	1	Damper
	③	91312-04012	2	Bolt

YK250X, YK350X, YK400X

	No.	Part No.	Qty	Remarks
Additional mechanical stopper parts in Z-axis minus direction	④	KN3-M183A-000	1	Stopper block (supplied with bolt)

YK250XH, YK350XH, YK400XH

	No.	Part No.	Qty	Remarks
Additional mechanical stopper parts in Z-axis minus direction	④	KN3-M183A-100	1	Stopper block (supplied with bolt)

**Table 3-6**

YK250X(H), YK350X(H), YK400X(H)

	Standard stopper	Additional stopper
Stopper position in X-axis plus/minus directions	132°	105°
Maximum movement position in X-axis plus/minus directions	115°	102°

YK250X, YK350X

	Standard stopper	Additional stopper
Stopper position in Y-axis plus/minus directions	145°	88°
Maximum movement position in Y-axis plus/minus directions	140°	85°

YK400X

	Standard stopper	Additional stopper
Stopper position in Y-axis plus/minus directions	156°	88°
Maximum movement position in Y-axis plus/minus directions	140°	85°

YK250XH, YK350XH

	Standard stopper	Additional stopper
Stopper position in Y-axis plus/minus directions	142°	88°
Maximum movement position in Y-axis plus/minus directions	140°	85°

YK400XH

	Standard stopper	Additional stopper
Stopper position in Y-axis plus/minus directions	154°	88°
Maximum movement position in Y-axis plus/minus directions	140°	85°

YK250X(H), YK350X(H), YK400X(H)

	Standard stopper	Additional stopper
Stopper position in Z-axis plus direction (*1)	158 mm	158-L <sub>1</sub> mm
Maximum movement position in Z-axis plus direction (*1)	150 mm	150-L <sub>1</sub> mm
Stopper position in Z-axis minus direction (*1)	-5 mm	L <sub>2</sub> -5 mm
Maximum movement position (origin position) in Z-axis minus direction (*1)	0 mm	L <sub>2</sub> mm (*2)

\*1: The Z-axis movement range and working envelope indicate the positions when the downward direction relative to the initial Z-axis origin position is set as the plus direction.

The actual origin position is lowered by L<sub>2</sub> and the movement range and stroke are reduced by L<sub>1</sub>+L<sub>2</sub>.

\*2: Depending on the relation to the Z-axis machine reference adjustment, L<sub>2</sub> will be a position at 3 mm intervals, such as approximately 12mm, 15mm, etc.

**Soft limits after installing additional stoppers**

YK250X(H), YK350X(H), YK400X(H)

	Soft limit (pulses)	Working envelope
X-axis working envelope in plus direction	232107	102°
X-axis working envelope in minus direction	-232107	-102°

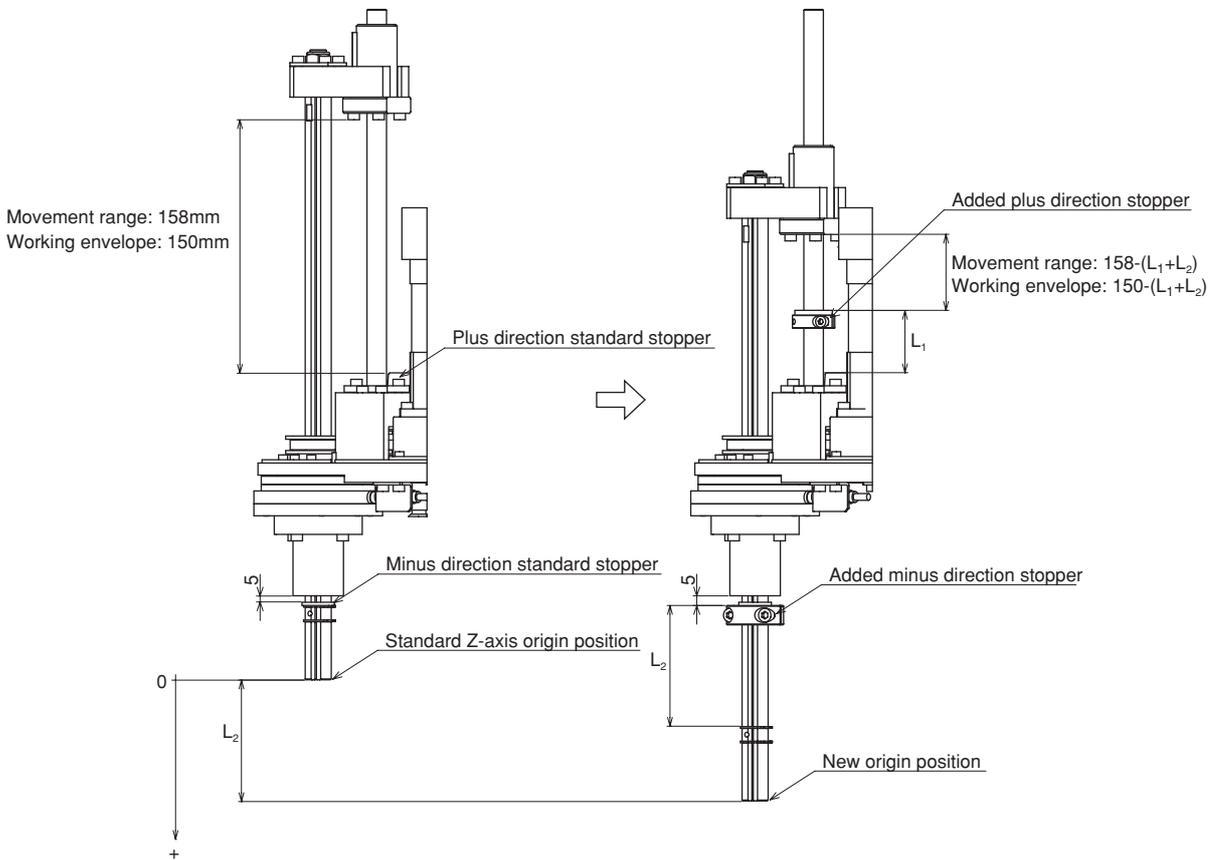
YK250X(H), YK350X(H), YK400X(H)

	Soft limit (pulses)	Working envelope
Y-axis working envelope in plus direction	193422	85°
Y-axis working envelope in minus direction	-193422	-85°

YK250X(H), YK350X(H), YK400X(H)

	Soft limit (pulses)	Working envelope
Z-axis working envelope in plus direction	$16384 (150 - (L_1 + L_2)) / 12$	$150 - (L_1 + L_2)$ mm
Z-axis working envelope in minus direction	-683	-0.5 mm

$L_1$  minimum value = 11,  $L_2$  minimum value = 12



**Fig. 3-105**

## 10-2 Installing the X- and Y-axis additional mechanical stoppers

Install the X- and Y-axis additional mechanical stoppers by following the instructions shown in Fig. 3-106.

The X- and Y-axis mechanical stoppers can be installed separately in the plus and minus directions.

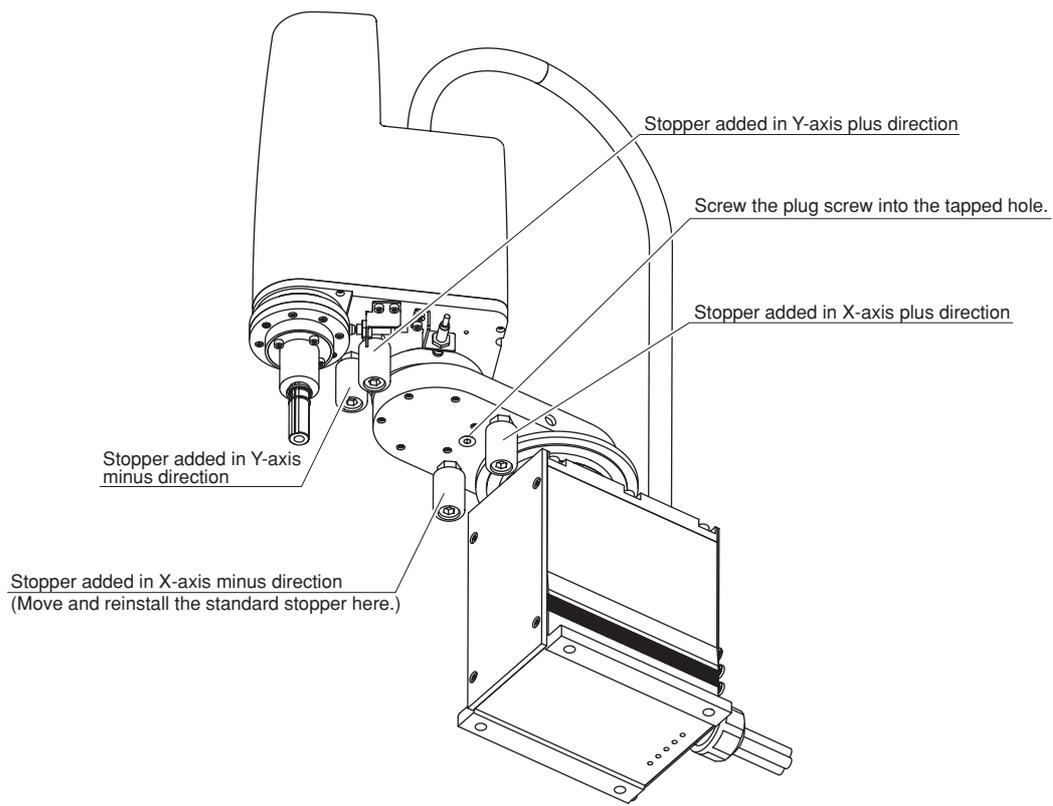
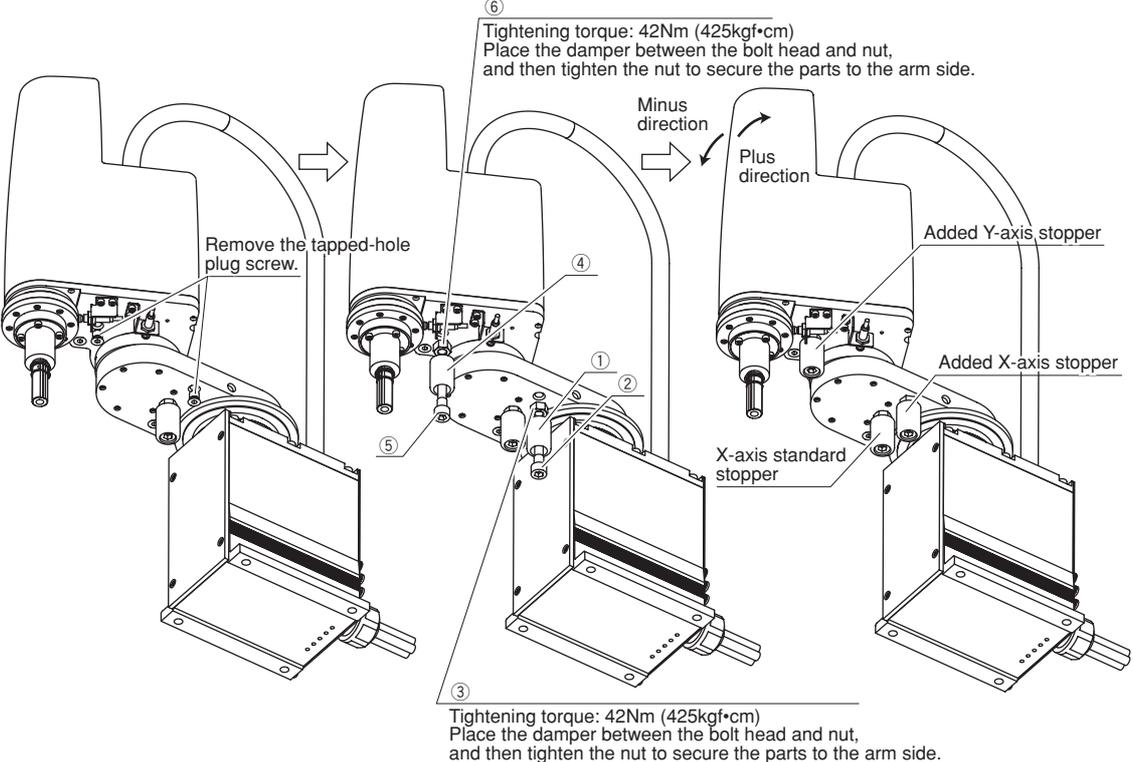
Fig. 3-107 shows an example for installing the additional stopper as the plus direction stopper, but the stopper can also be installed in the minus direction.

The following procedure is described using the X-axis plus direction stopper as an example.

### **⚠ WARNING**

When adding the stopper in only one direction, do not remove the standard stopper. If it is removed, there will be no stopper on the opposite side. (The X-axis standard stopper works as the stopper in both plus and minus directions.)

- 1) Prepare a hex wrench set.
- 2) Turn off the robot controller.
- 3) Place a sign indicating the robot is being adjusted, to keep others from touching the controller switch.
- 4) Enter the safeguard enclosure.
- 5) Remove the tapped-hole plug screw from the X-axis arm.
- 6) Place the damper ① between the bolt head ② and nut ③, and then tighten the nut to the specified torque to secure the nut to the arm. Use the bolt and nut shown in Table 3-5. When adding the stopper in only one direction of the X-axis, do not remove the standard stopper. If it is removed, there will be no stopper on the opposite side. Only when changing the stopper position in both directions, remove the standard stopper to move its position. Screw the plug screw into the tapped hole where the standard stopper was installed.
- 7) Check that the movement range is limited by the stoppers as desired.
- 8) Go out of the safeguard enclosure.
- 9) Check that no one is inside the safeguard enclosure and then turn on the controller.
- 10) Set the soft limit in the X-axis plus direction as shown in Table 3-6. (When the stopper was installed in the minus direction, set the soft limit in the minus direction.)
- 11) Stay outside the safeguard enclosure and check that the maximum soft limits work to stop the X-axis arm at a point before the stopper position. Depending on the accuracy and position of the stopper parts, the X-axis arm may not stop until it reaches the stopper. In this case, set the soft limits smaller than the values shown in Table 3-6.



When installing the additional stoppers in both plus and minus directions

**Fig. 3-106 XY axes of YK250X(H), YK350X(H), and YK400X(H)**

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## 10-3 Installing the Z-axis additional mechanical stopper

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### 10-3-1 Installing the minus direction stopper

Install the additional mechanical stopper in the Z-axis minus direction by following the instructions shown in Fig. 3-107.

- 1) Prepare the hex wrench set and torque wrench.
- 2) Turn off the robot controller.
- 3) Place a sign indicating the robot is being adjusted, to keep others from touching the controller switch.
- 4) Enter the safeguard enclosure.
- 5) Remove the Y-axis arm cover by referring to section 7 in Chapter 4, and move up the urethane damper.
- 6) Install the additional stopper ④ to the spline shaft by tightening the supplied bolts to the specified torque.  
Alternately tighten the bolts a little at a time. Depending on the relation to the Z-axis machine reference adjustment,  $L_2$  in the Z-axis minus direction stopper in Table 3-6 will be a position at 3mm intervals, such as approximately 12mm, 15mm, etc.
- 7) Go out of the safeguard enclosure.
- 8) Check that no one is inside the safeguard enclosure, and then turn on the controller.
- 9) Place a sign indicating the robot is being adjusted, to keep others from operating the controller or operation panel.
- 10) Perform the Z-axis absolute reset.  
To perform the Z-axis absolute reset, see "3-3 Absolute reset procedures" in Chapter 4. Make a note of the Z-axis machine reference value.

**CAUTION**

Use the following procedure to display the **adjustment machine reference value**.

When adjusting the machine reference value, always check the **adjustment machine reference value** with this procedure.

---

- (1) Press the MODE key.
  - (2) Press the F3 key to enter MANUAL mode.
  - (3) Press the F13 key (LOWER+F3) to select "ABS Reset".
  - (4) After the Z-axis absolute reset is complete, press the F10 (UPPER+F5) key to display the **adjustment machine reference value (%)**.
-

When the machine reference is within the allowable range (between 26 and 74%), proceed to step 16). If the machine reference is outside the allowable range, adjust it as described in step 11) onward.

- 11) Turn off the controller and enter the safeguard enclosure.
- 12) Put a mark at the added stopper position and loosen the bolt for the added stopper.  
To adjust the machine reference value, move the added stopper as follows:  
Machine reference value < 26% : Move the added stopper in the plus direction.  
Machine reference value > 74% : Move the added stopper in the minus direction.  
As an approximate guide, a 3mm movement equals 100%.
- 13) Repeat the same procedure from step 6) until the machine reference is within the allowable range.
- 14) When the machine reference is set within the allowable range, go out of the safeguard enclosure.
- 15) Check that no one is inside the safeguard enclosure and then turn on the controller.
- 16) Set the soft limits as shown in Table 3-6.  
The soft limit in the minus direction is already set by default to the value shown in Table 3-6.
- 17) Stay outside the safeguard enclosure and check that the soft limits work to stop the Z-axis unit at a point before the stopper position. Depending on the accuracy and position of the stopper parts, the Z-axis unit may not stop until it reaches the stopper. In this case, set the soft limits larger than the values shown in Table 3-6.
- 18) Check that the movement range is limited by the stoppers as desired.
- 19) Turn off the controller and enter the safeguard enclosure.
- 20) Reattach the Y-axis arm cover.

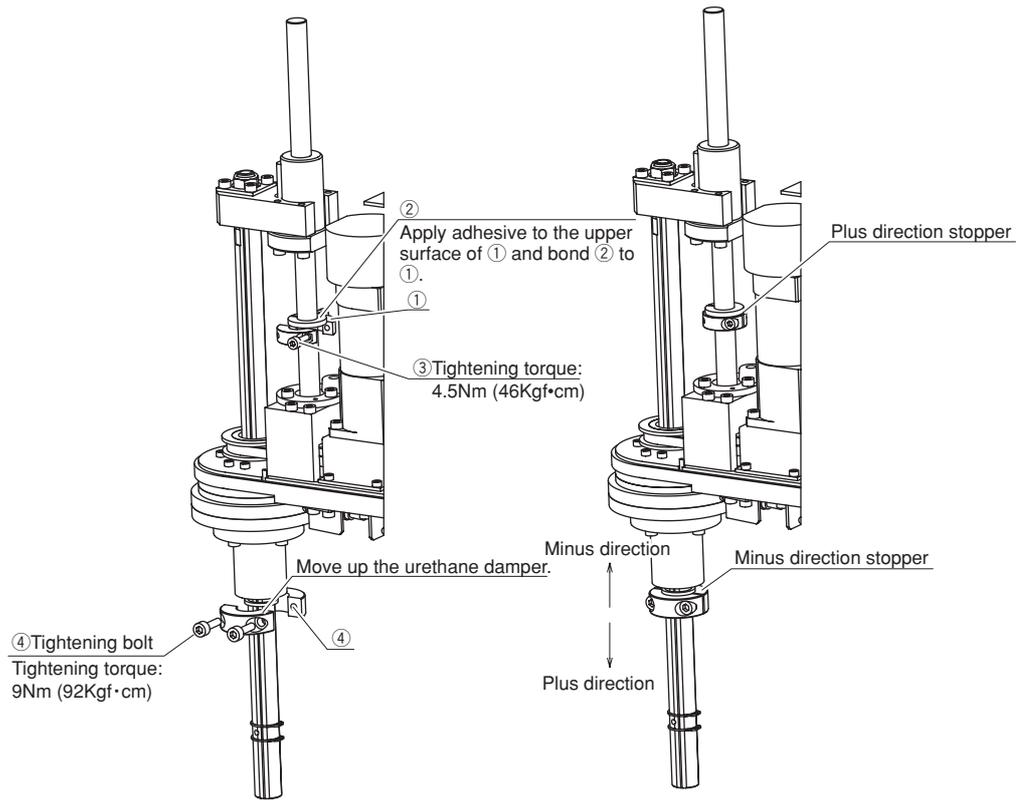


Fig. 3-107

## 10-3-2 Installing the plus direction stopper

Install the additional mechanical stopper in the Z-axis plus direction by following the instructions shown in Fig. 3-107.

- 1) Prepare the hex wrench set and torque wrench.
- 2) Turn off the robot controller.
- 3) Place a sign indicating the robot is being adjusted, to keep others from touching the controller switch.
- 4) Enter the safeguard enclosure.
- 5) Remove the Y-axis arm cover by referring to section 7 in Chapter 4.
- 6) Install the additional stopper ① to the ball screw by tightening the bolts ③ to the specified torque.  
Alternately tighten the bolts a little at a time. There is no restriction on the stopper position in the plus direction.
- 7) Open the urethane damper ②, fit it onto the ball screw, and bond it to the upper surface of ① using adhesive. Use ThreeBond 1739 instant adhesive as the adhesive. Fully degrease the bonding surfaces before applying the adhesive.
- 8) Go out of the safeguard enclosure.
- 9) Check that no one is inside the safeguard enclosure, and then turn on the controller.
- 10) Place a sign indicating the robot is being adjusted, to keep others from operating the controller or operation panel.
- 11) Set the soft limit in the plus direction as shown in Table 3-6.
- 12) Stay outside the safeguard enclosure and check that the soft limits work to stop the Z-axis unit at a point before the stopper position.  
Depending on the accuracy and position of the stopper parts, the Z-axis unit may not stop until it reaches the stopper. In this case, set the soft limits smaller than the values shown in Table 3-6.
- 13) Check that the movement range is limited by the stoppers as desired.
- 14) Turn off the controller and enter the safeguard enclosure.
- 15) Reattach the Y-axis arm cover.

**⚠ WARNING**

The plus direction stopper will become a load, and so the Z-axis acceleration must be reduced as shown below. If not reduced, the service life of the Z-axis drive unit will decrease.

Tip load	0kg	1kg	2kg	3kg
Z-axis acceleration	90%	90%	90%	85%

**10-4      Overrun amounts during impacts with X, Y and Z-axis additional mechanical stoppers**

A urethane damper is installed to absorb the shock when an impact occurs with the mechanical stopper, so a certain amount of overrun occurs when the robot strikes the mechanical stopper. Use caution and take overrun into account since the end effector may interfere with the robot body and peripheral equipment or the robot body may interfere with the peripheral equipment. Maximum overrun amounts are listed below (for normal operation, maximum payload, maximum speed).

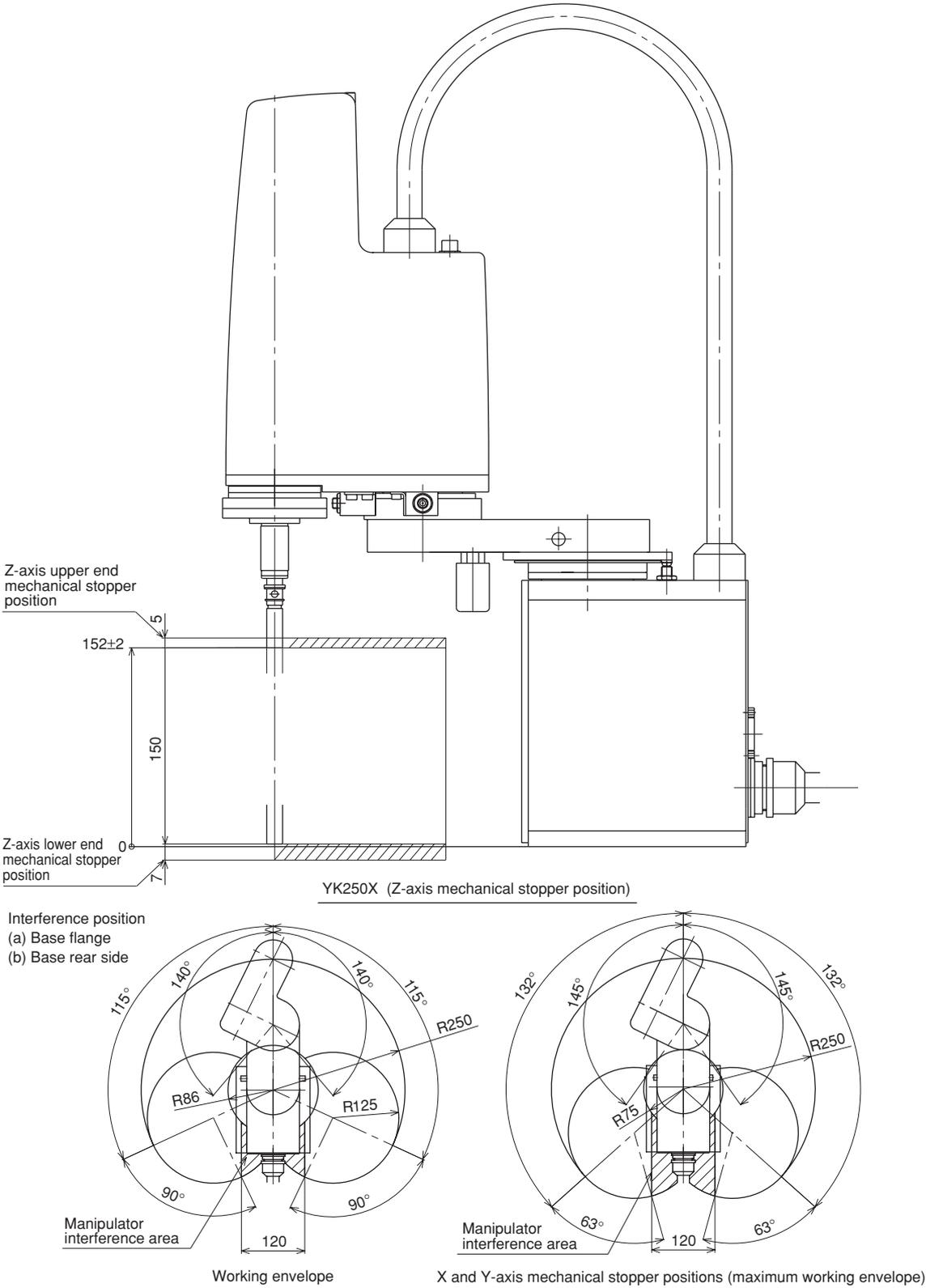
X-axis	Y-axis	Z-axis	
		Upper end	Lower end
10°	16°	2mm	5mm

Note: Here, ° (deg.) is the overrun angle at the X-axis and Y-axis joints.

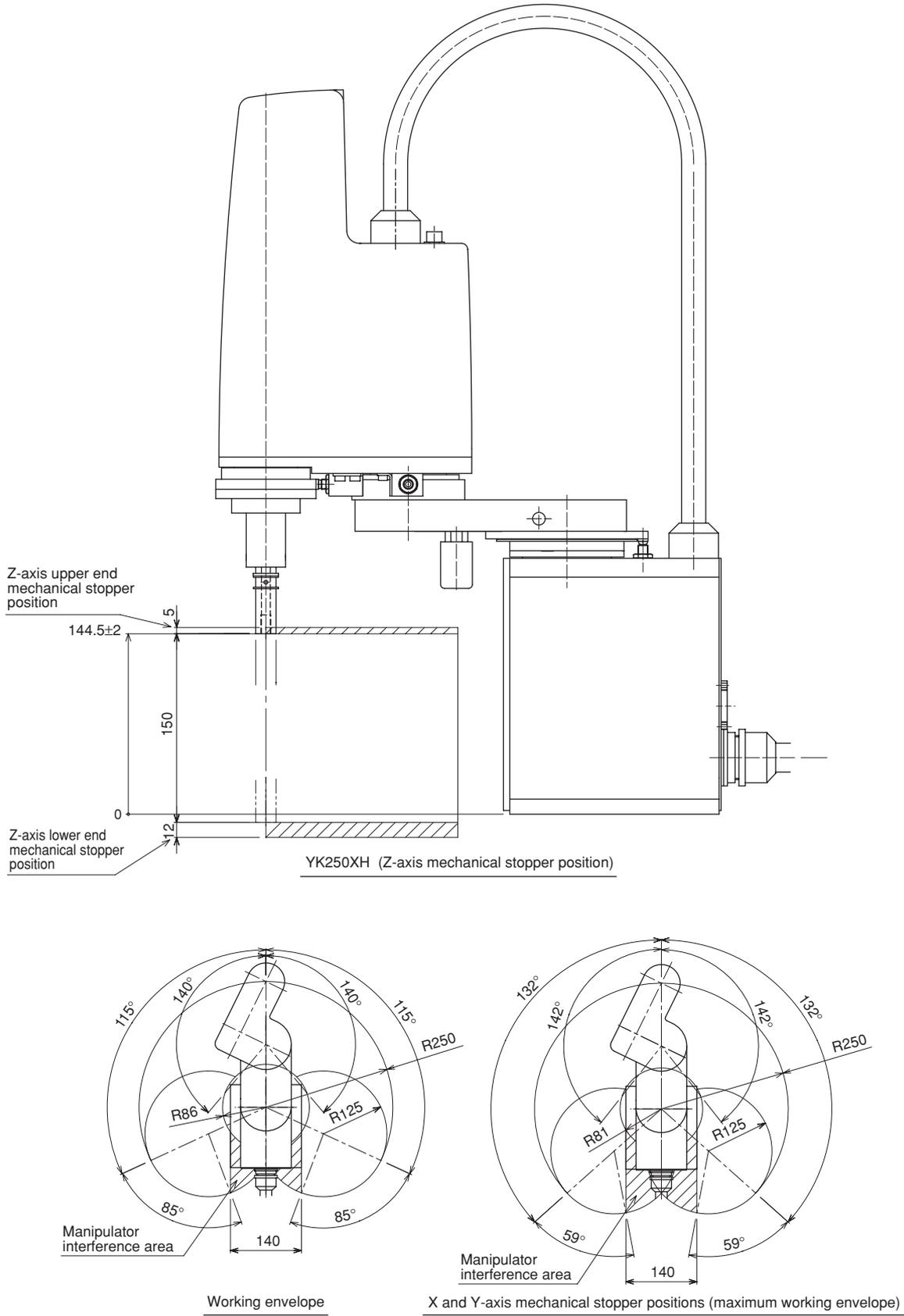
- (1) When the robot strikes the X-axis or Y-axis mechanical stopper or another object, or when the R-axis collides with an object, speed reduction gears are locked while being meshed if the collision impact is large. If this happens, please contact our sales office or dealer.
- (2) If the X-axis, Y-axis or Z-axis mechanical stopper is deformed or damaged by impacts, please contact our sales office or dealer. Using the deformed or damaged mechanical stopper is dangerous, so it must be replaced.
- (3) After the robot strikes the Z-axis mechanical stopper, the stopper position may shift, and so check the stopper position. If shifted, move the stopper to the correct position and refasten it securely by following the assembly procedure.

# 11 Working Envelope and Mechanical Stopper Positions for Maximum Working Envelope

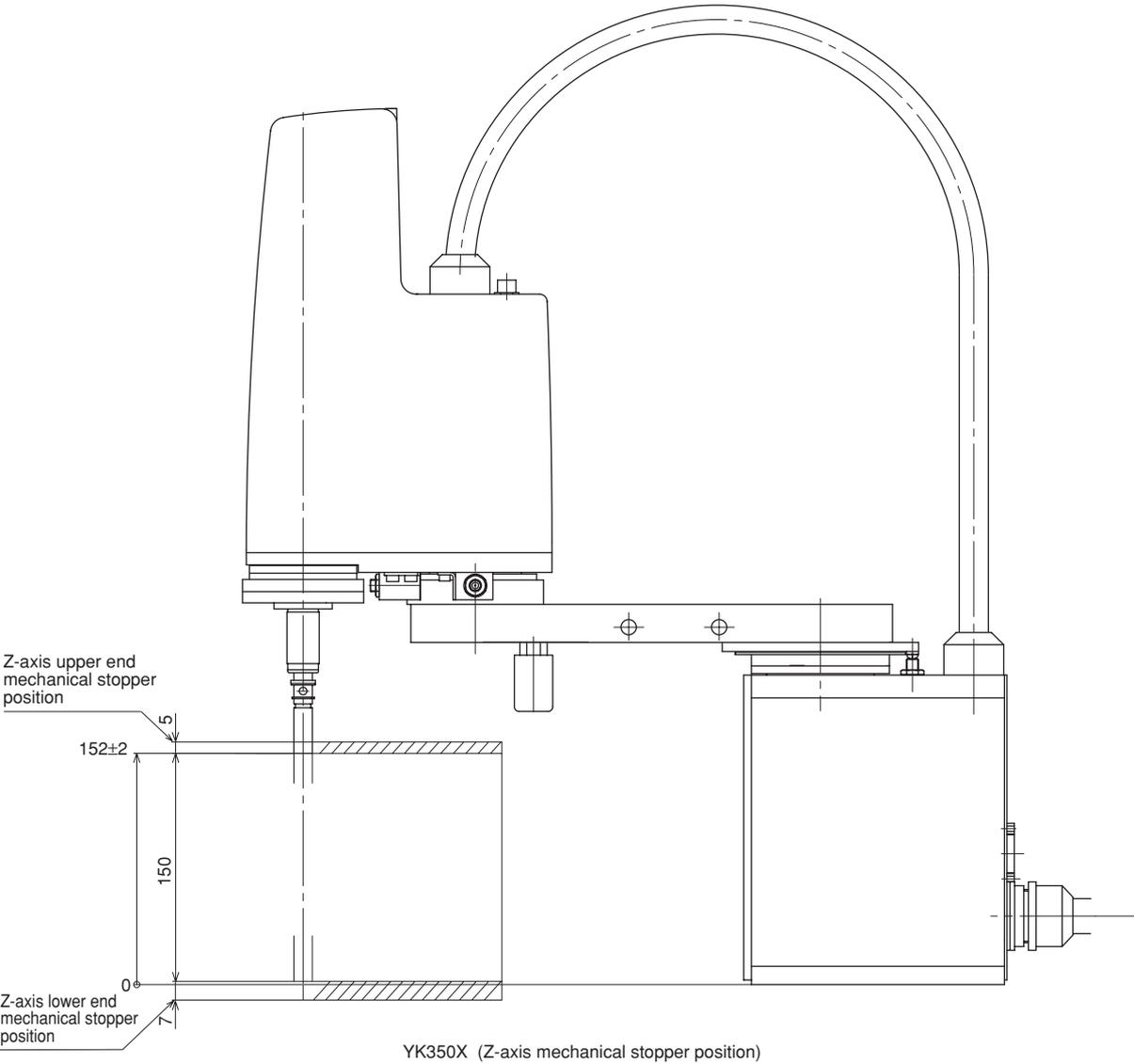
Working envelope of each robot and mechanical stopper positions for the maximum working envelope are shown in Fig. 3-108 to Fig. 3-120.



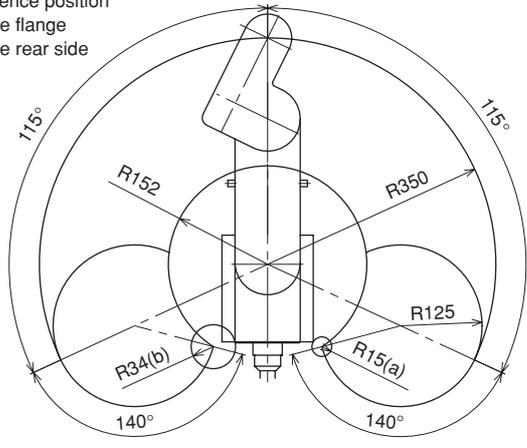
**Fig. 3-108 YK250X**



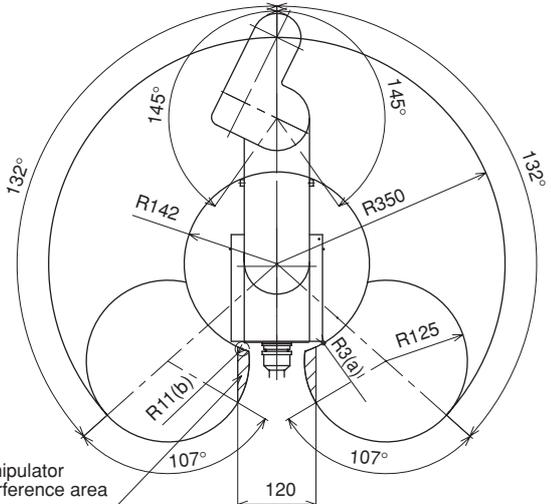
**Fig. 3-109 YK250XH**



Interference position  
 (a) Base flange  
 (b) Base rear side

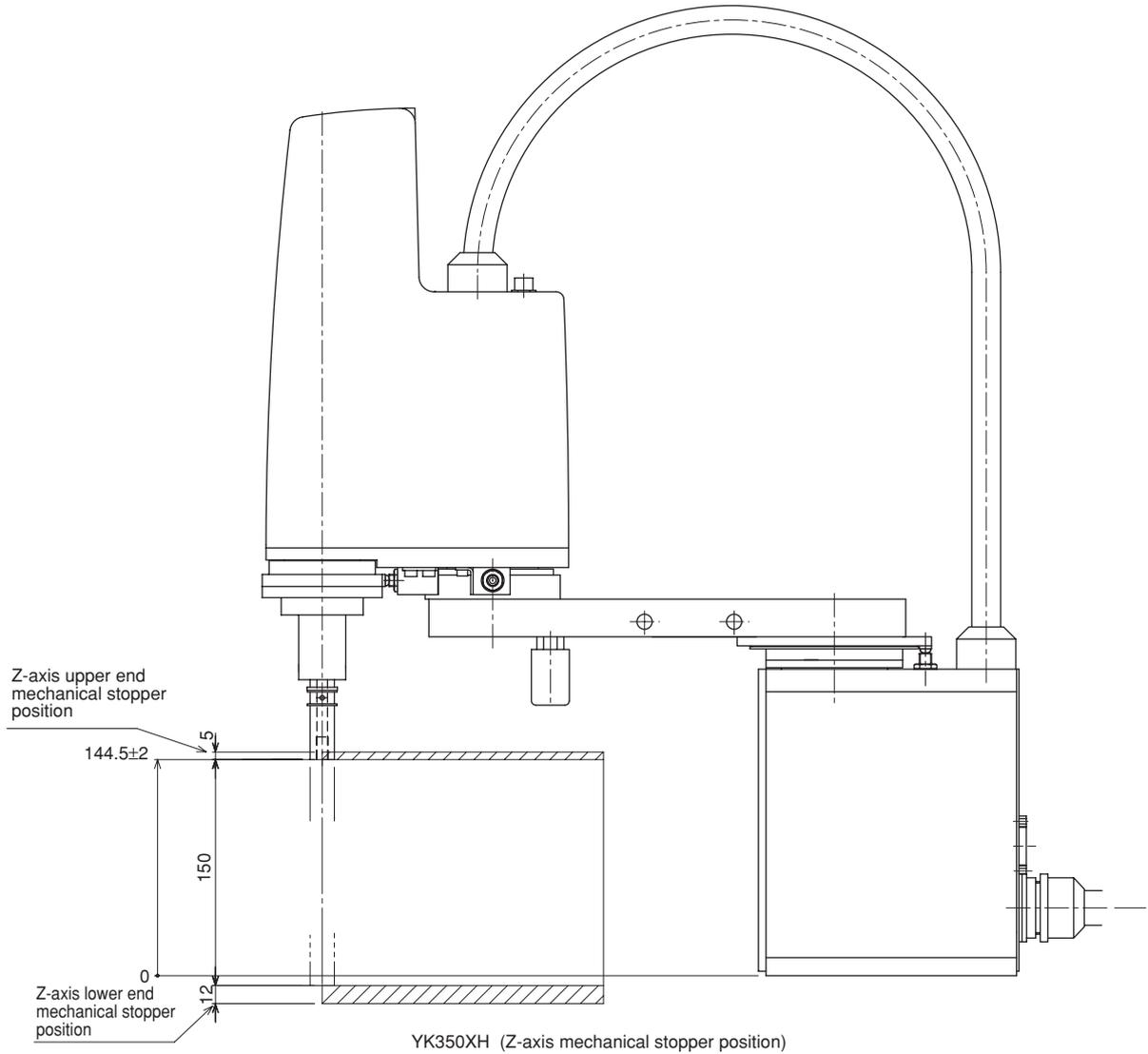


Working envelope

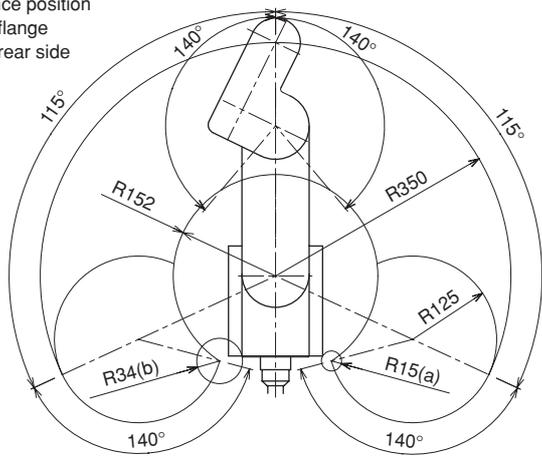


X and Y-axis mechanical stopper positions (maximum working envelope)

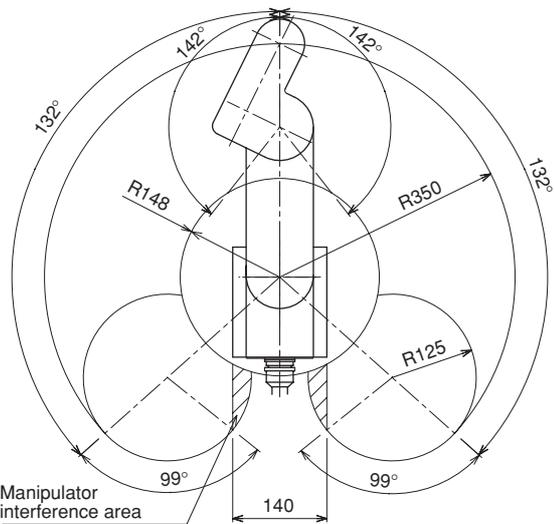
Fig. 3-110 YK350X



Interference position  
 (a) Base flange  
 (b) Base rear side

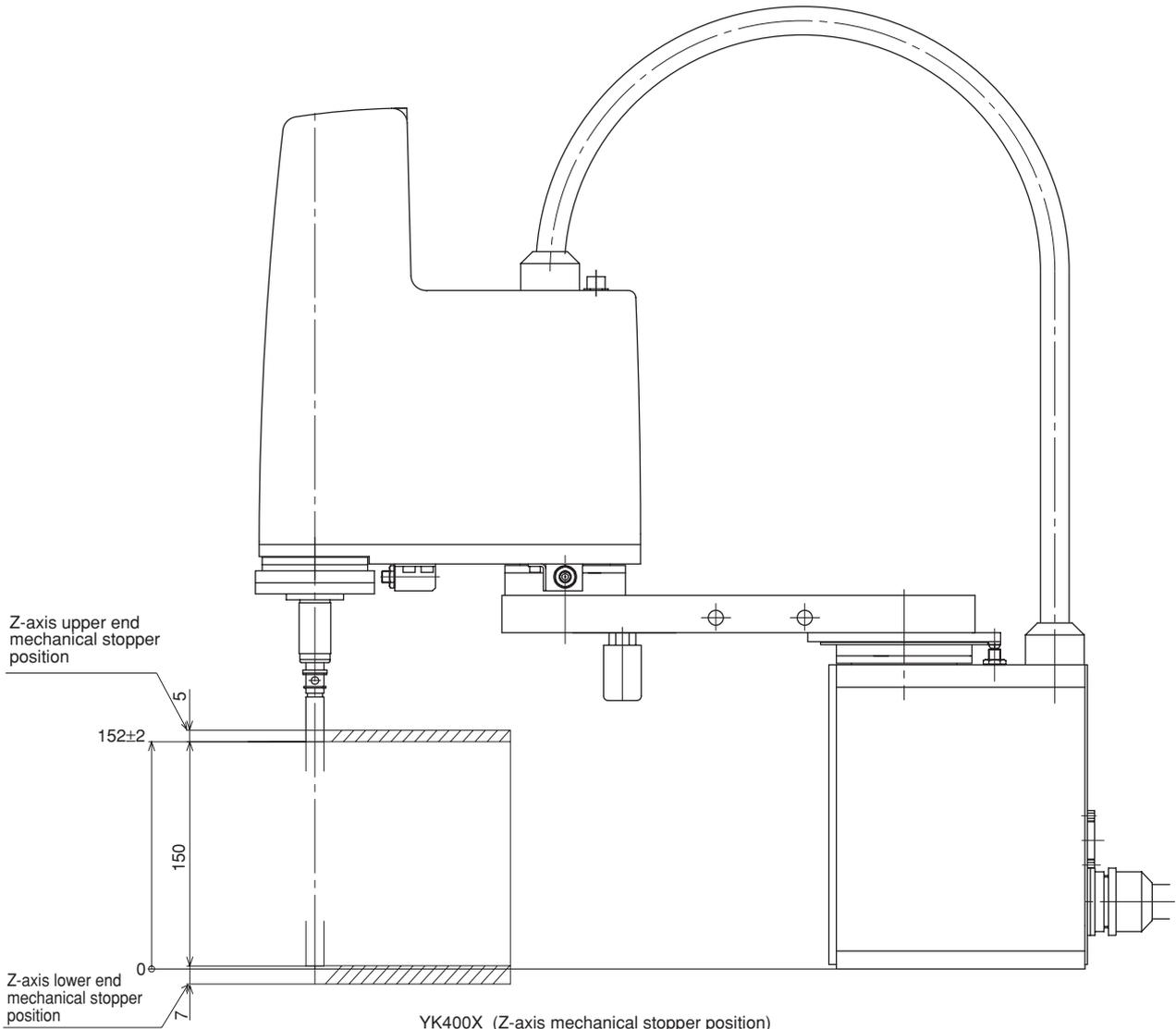


Working envelope



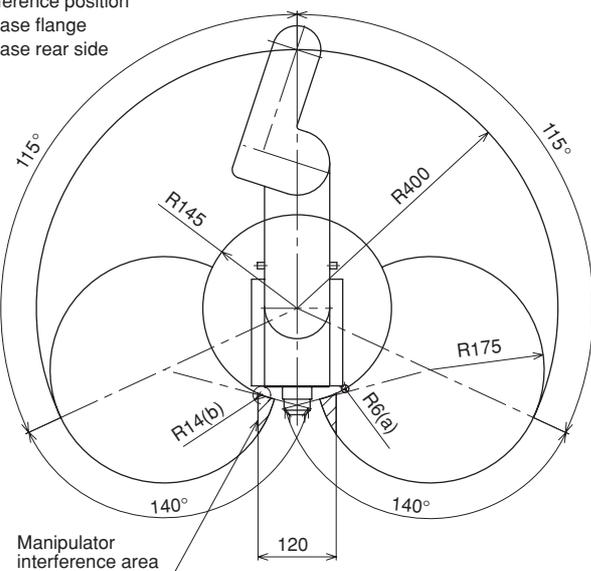
X and Y-axis mechanical stopper positions (maximum working envelope)

**Fig. 3-111 YK350XH**

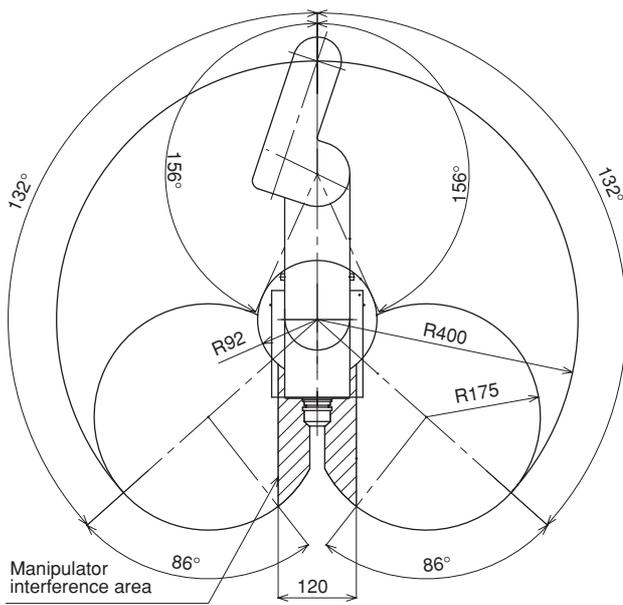


YK400X (Z-axis mechanical stopper position)

Interference position  
 (a) Base flange  
 (b) Base rear side



Working envelope



X and Y-axis mechanical stopper positions (maximum working envelope)

Fig. 3-112 YK400X

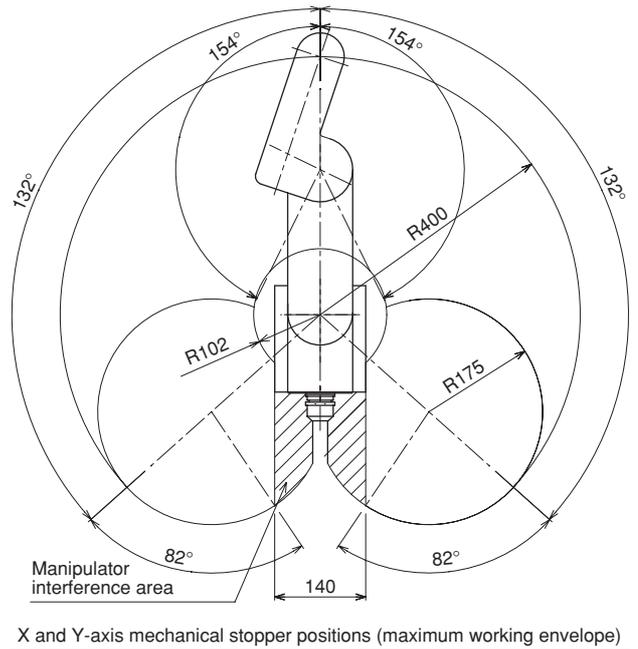
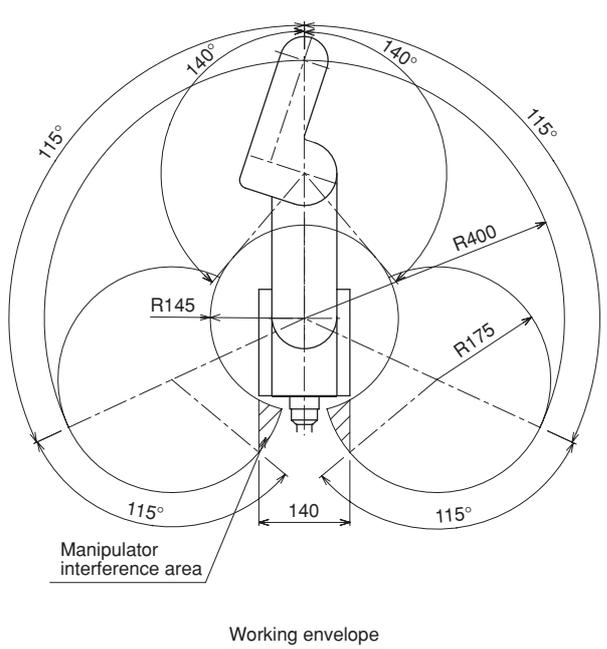
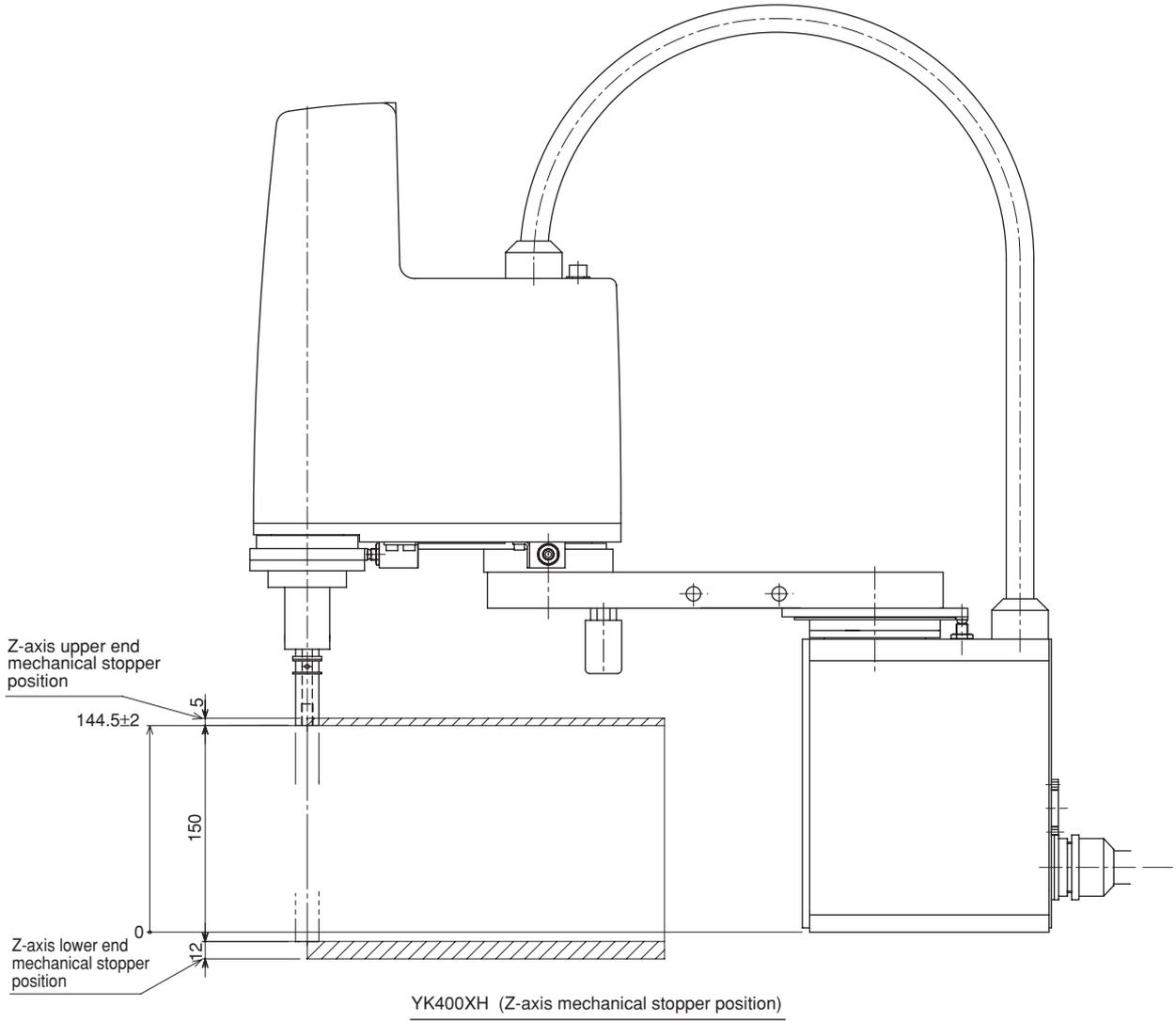
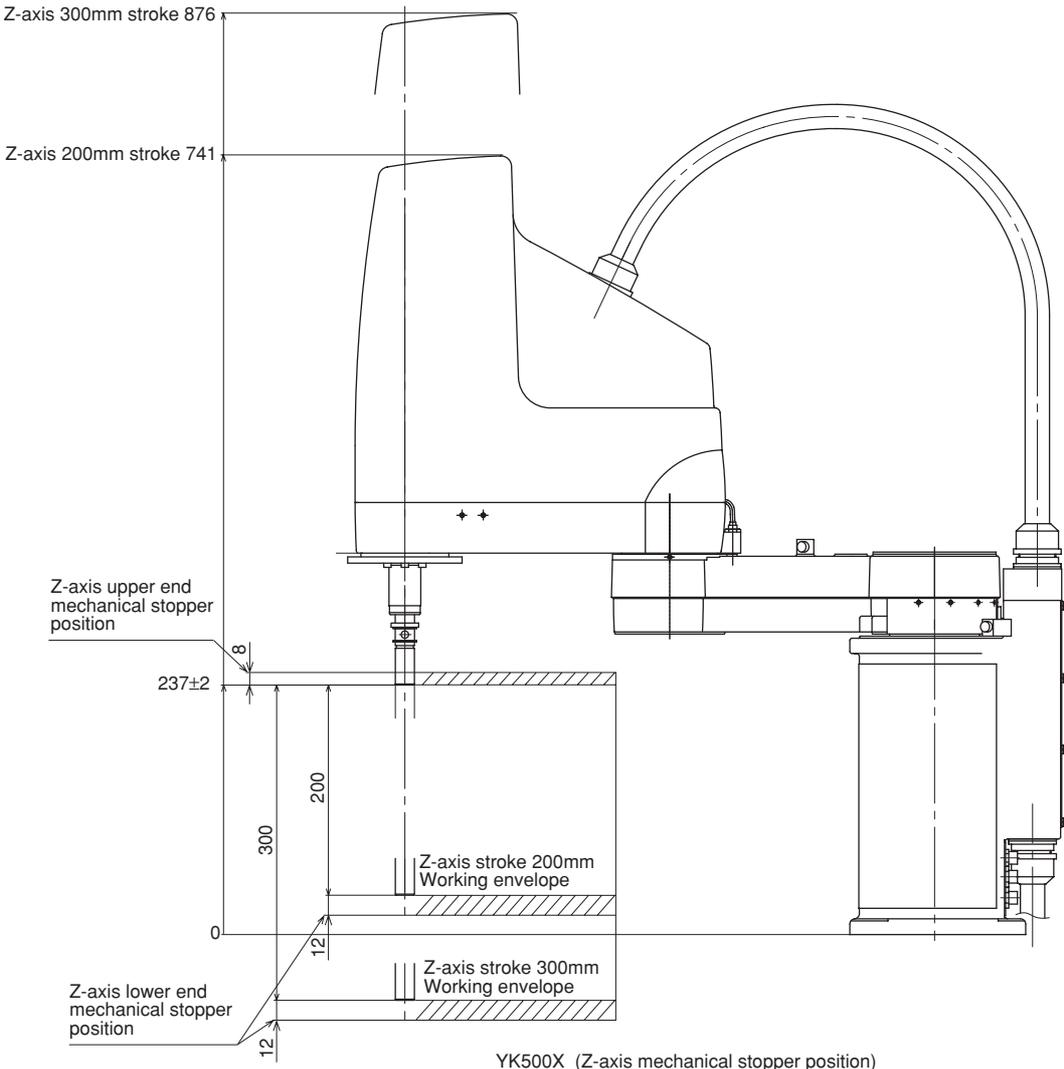


Fig. 3-113 YK400XH



Interference position  
 (a) Base flange  
 (b) Base rear side  
 (c) Base

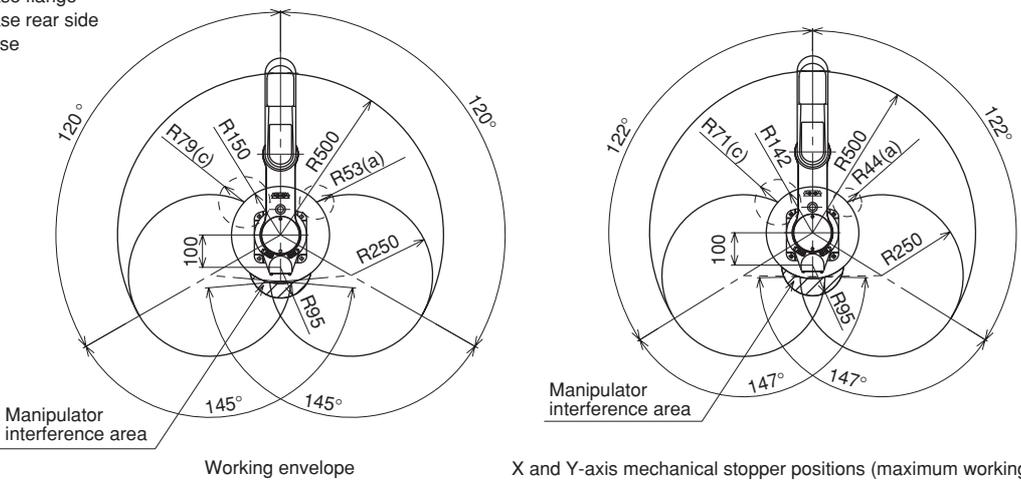
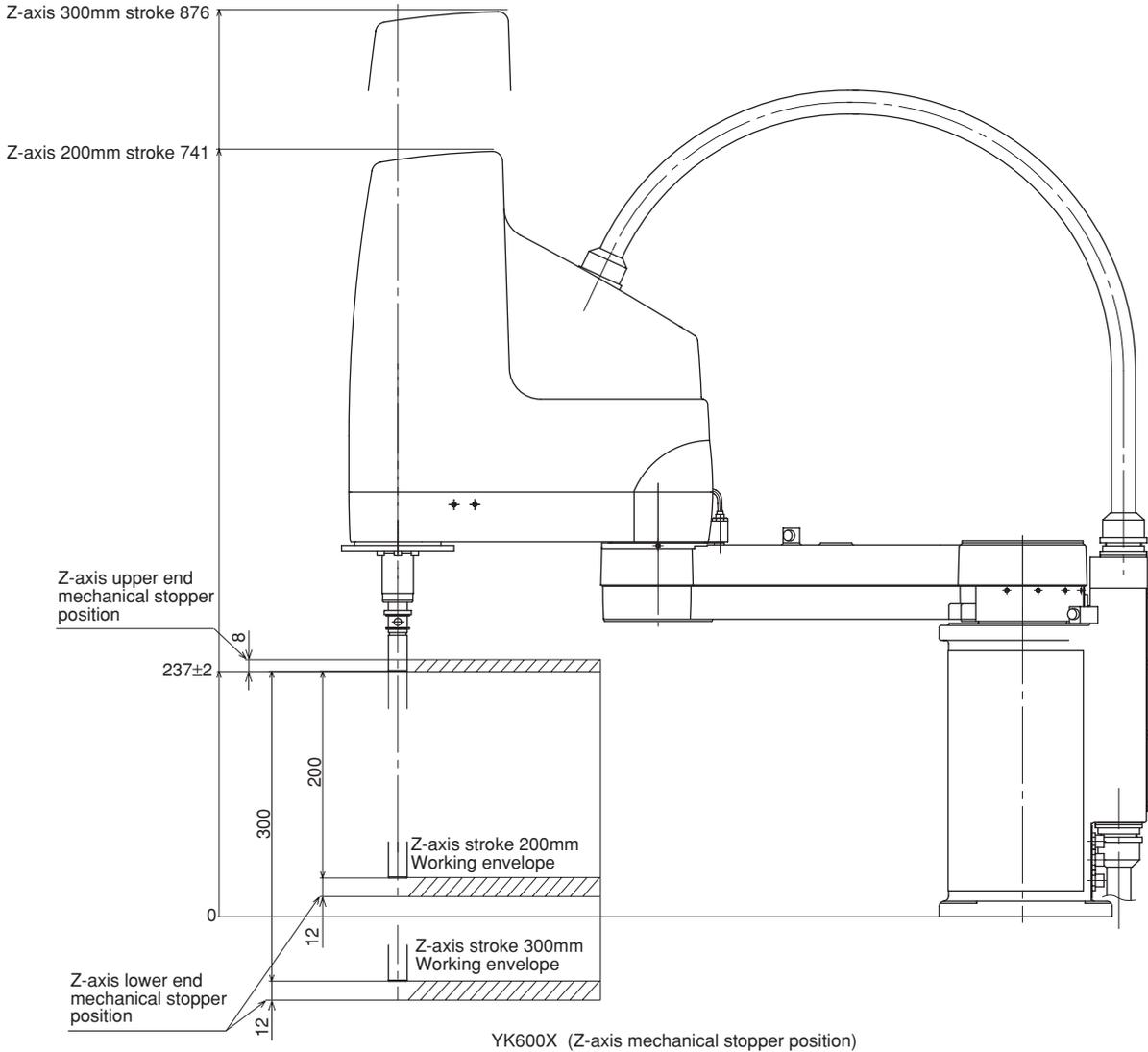


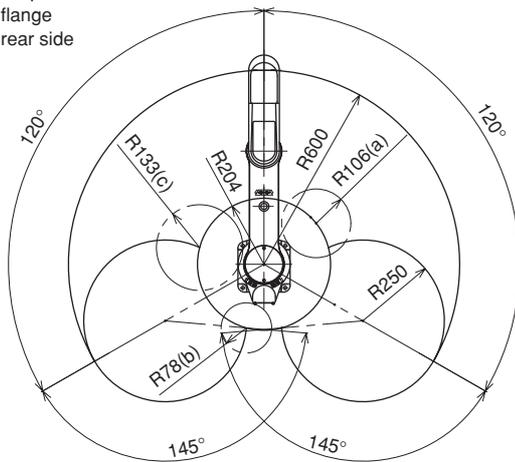
Fig. 3-114 YK500X

**CHAPTER 3 Installation**

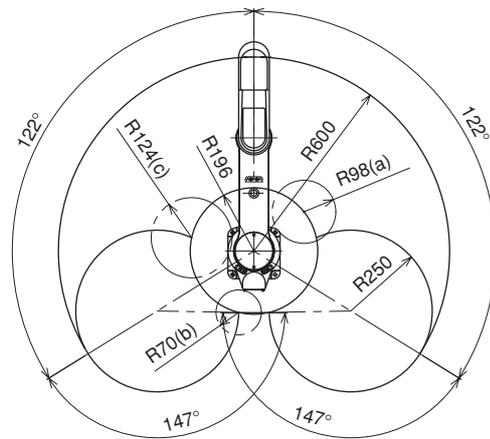


**YK600X (Z-axis mechanical stopper position)**

Interference position  
 (a) Base flange  
 (b) Base rear side  
 (c) Base

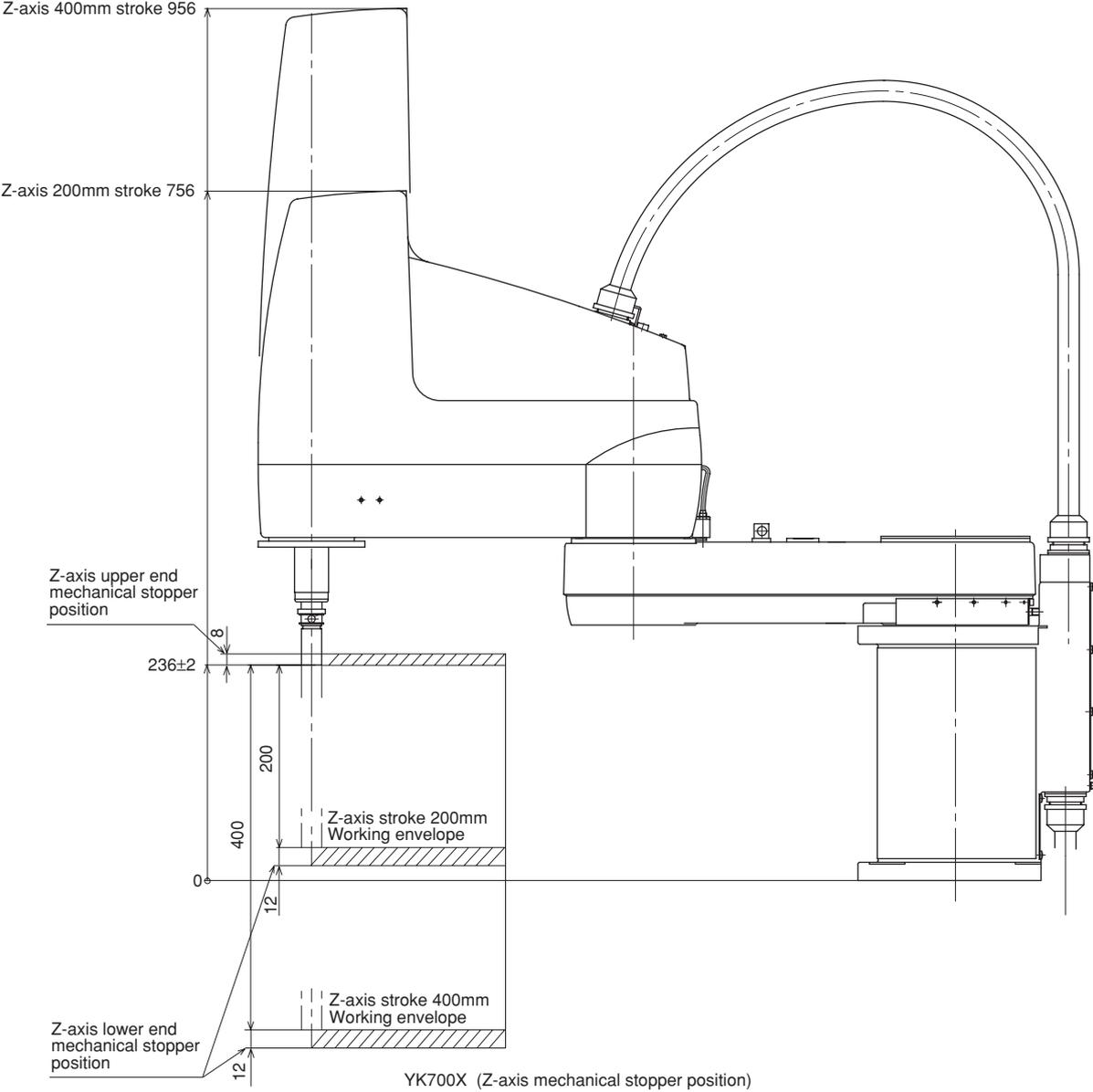


**Working envelope**



**X and Y-axis mechanical stopper positions (maximum working envelope)**

**Fig. 3-115 YK600X**



Interference position  
 (a) Base flange  
 (b) Base rear side  
 (c) Base

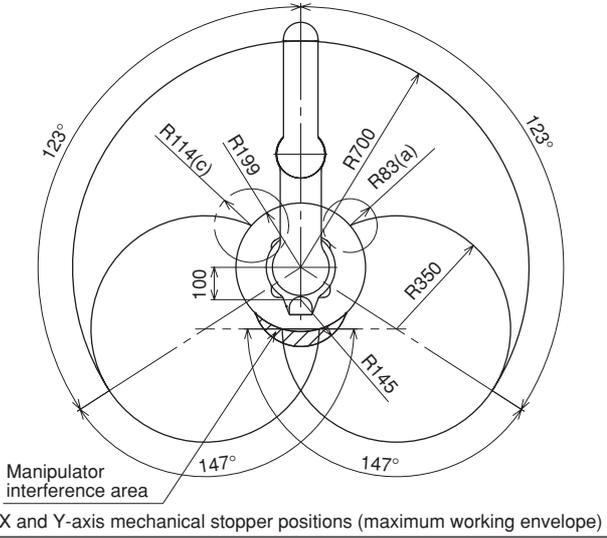
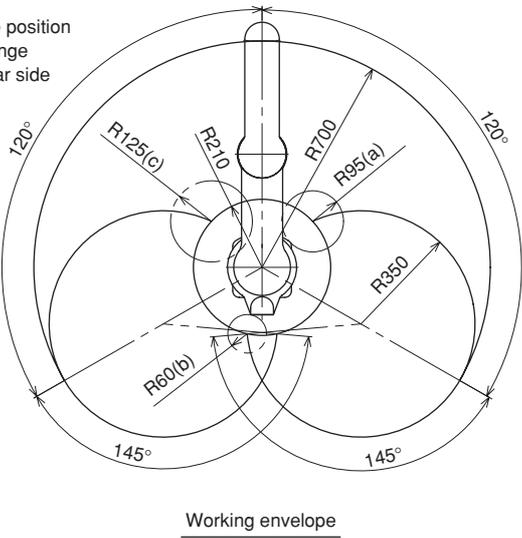
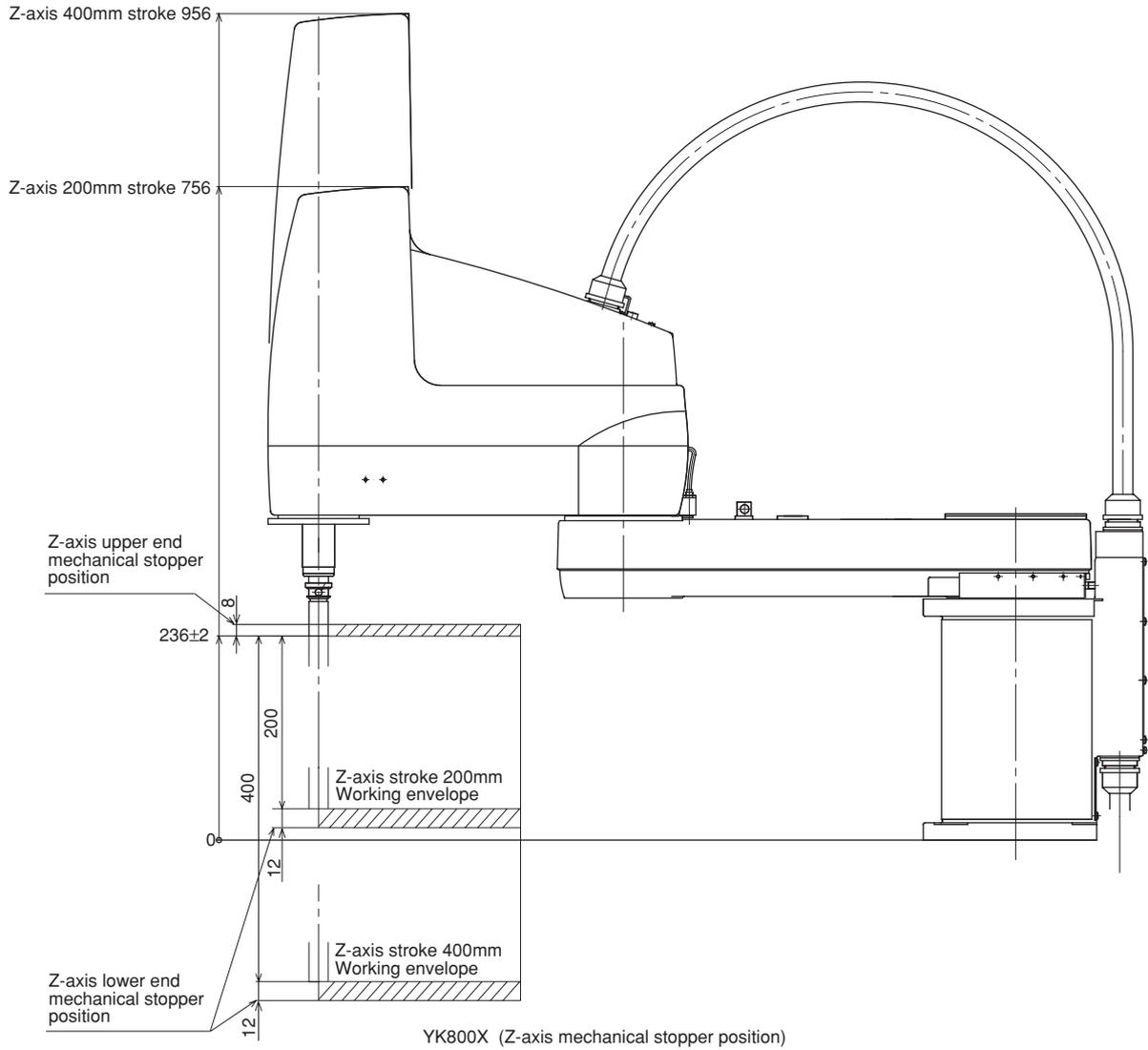


Fig. 3-116 YK700X



Interference position  
 (a) Base flange  
 (b) Base rear side  
 (c) Base

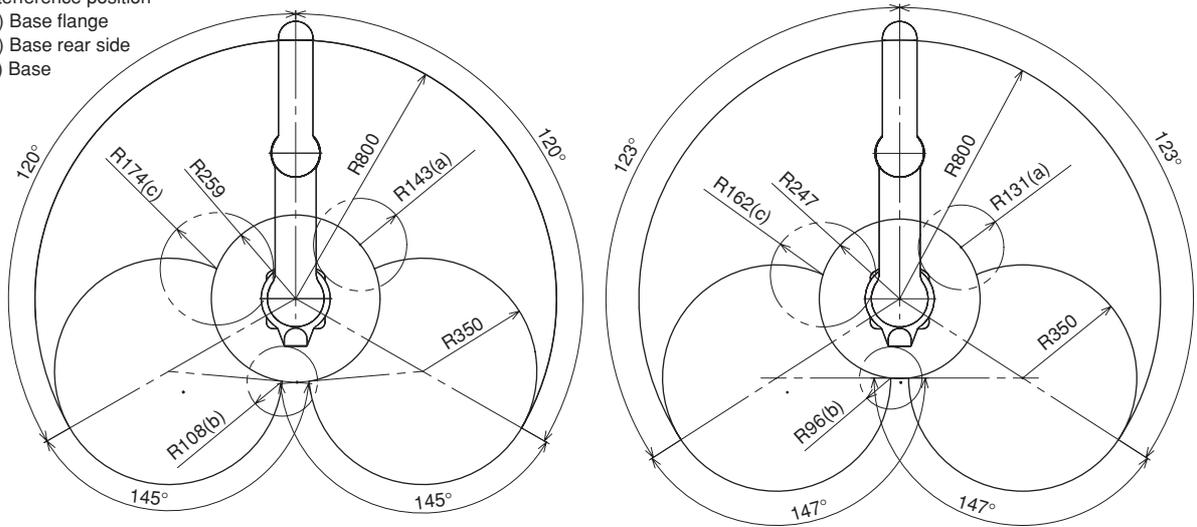
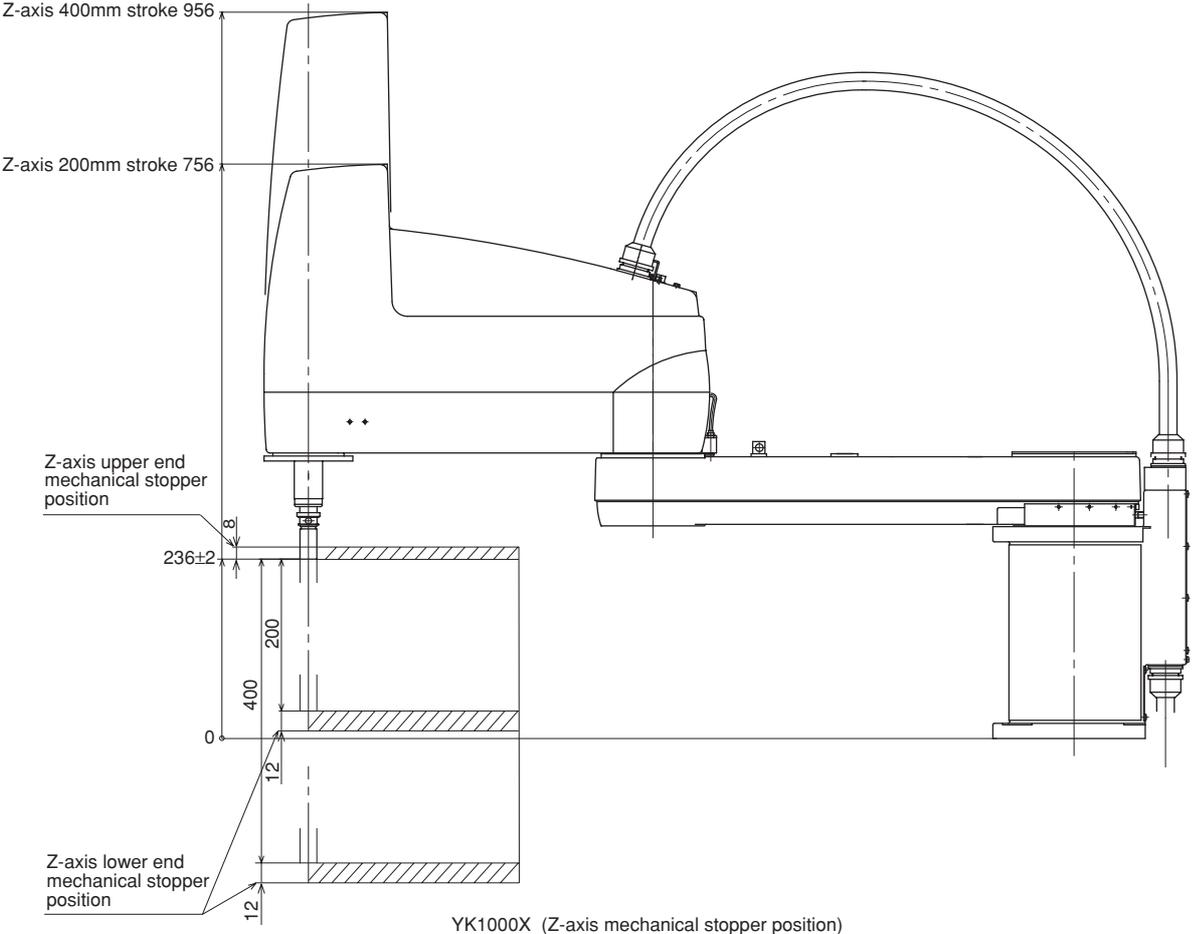
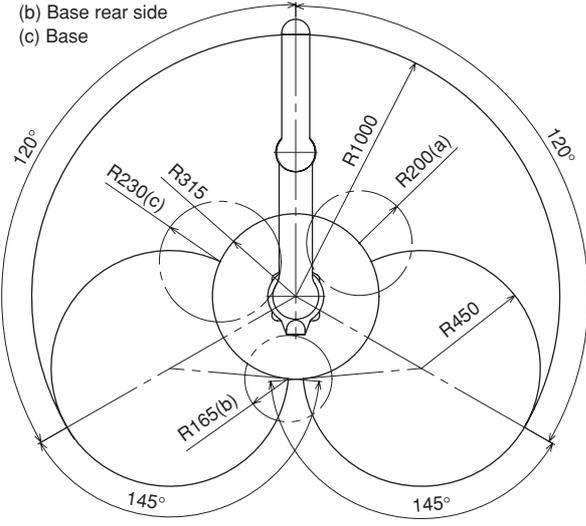


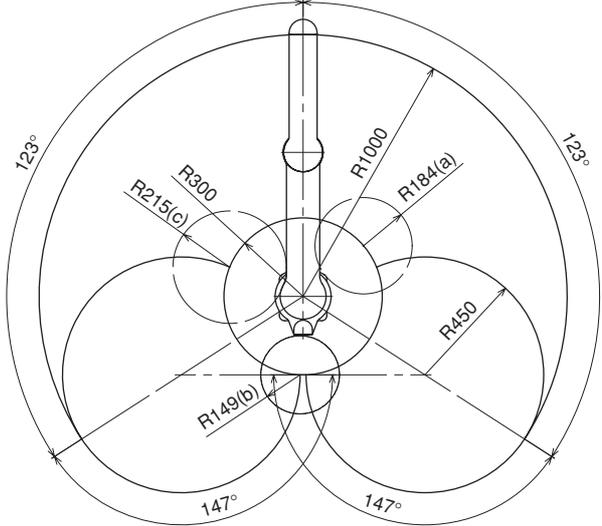
Fig. 3-117 YK800X



Interference position  
 (a) Base flange  
 (b) Base rear side  
 (c) Base

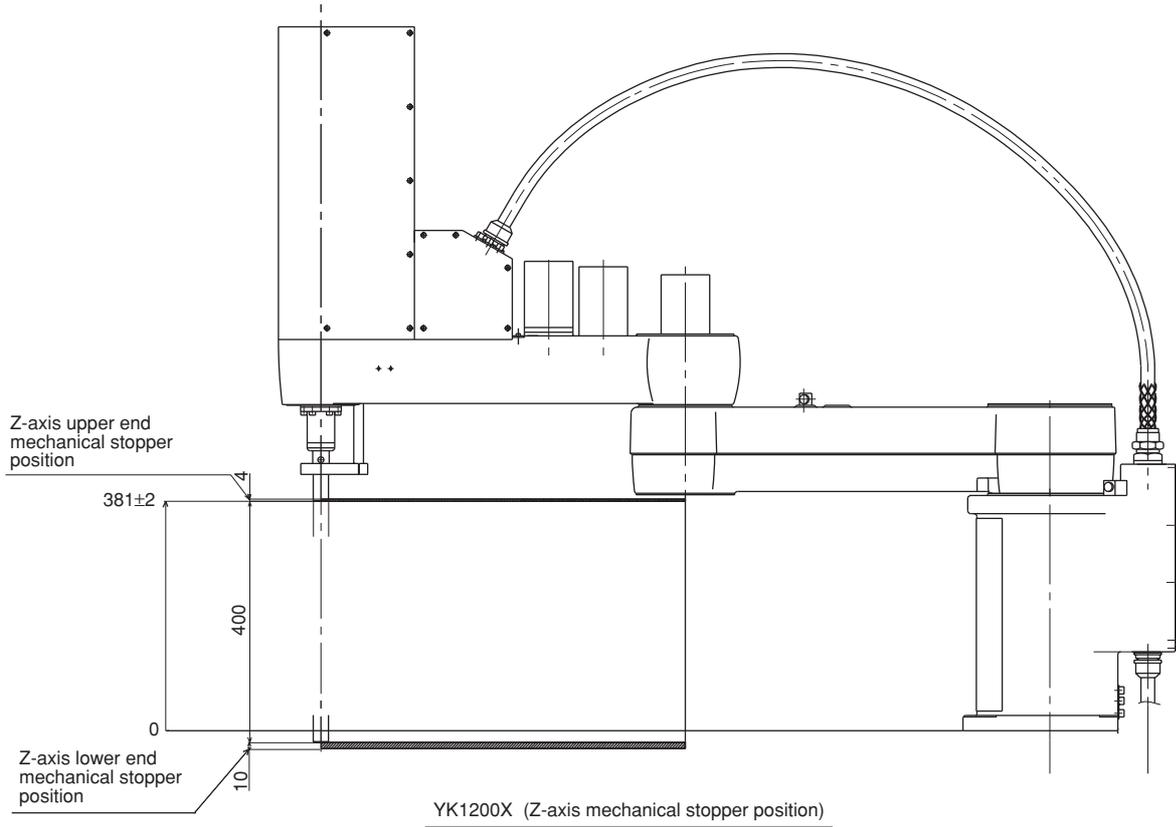


Working envelope

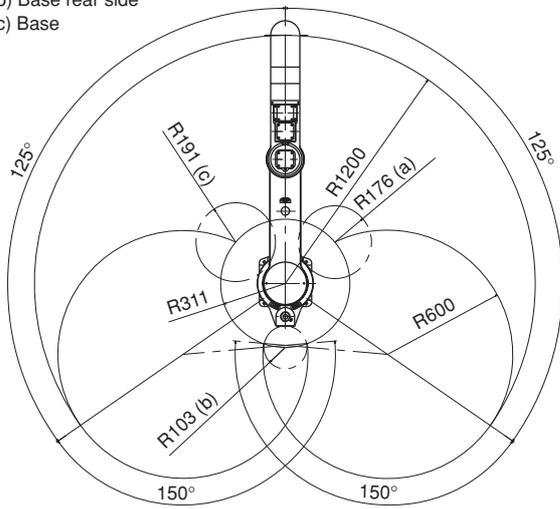


X and Y-axis mechanical stopper positions (maximum working envelope)

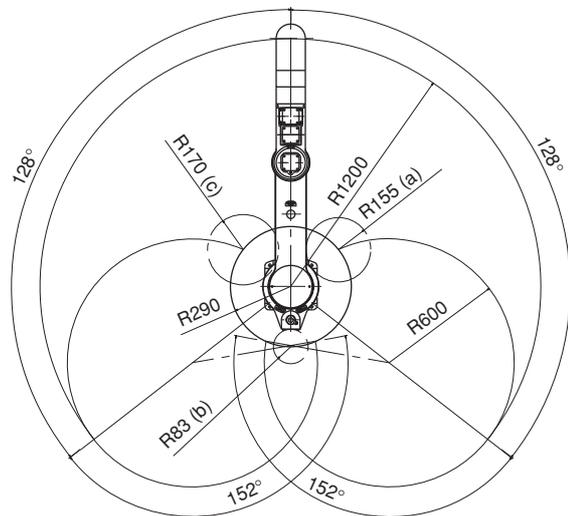
Fig. 3-118 YK1000X



Interference position  
 (a) Base flange  
 (b) Base rear side  
 (c) Base

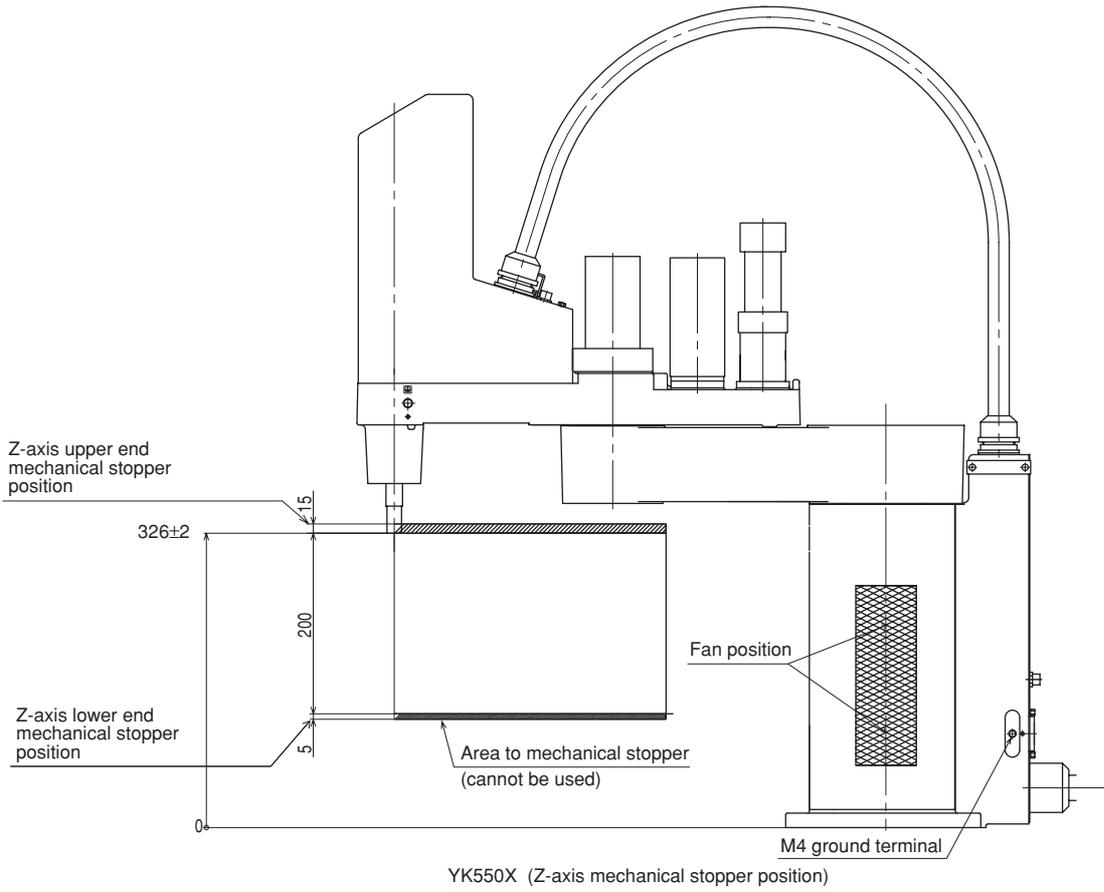


Working envelope



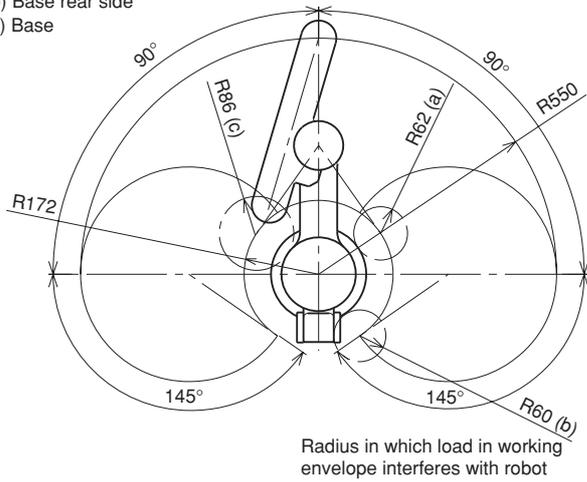
X and Y-axis mechanical stopper positions (maximum working envelope)

**Fig. 3-119 YK1200X**

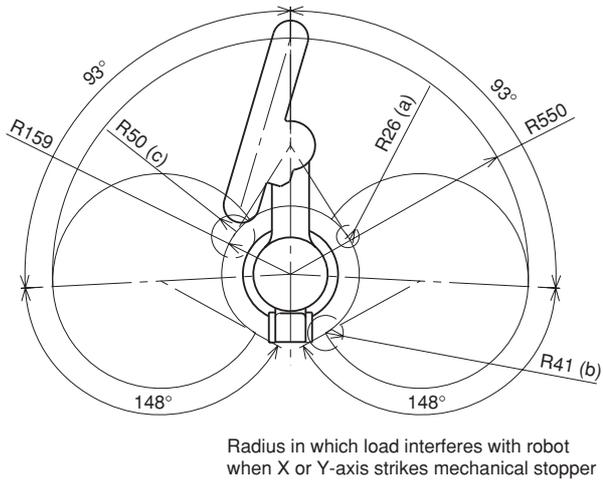


Interference position

- (a) Base flange
- (b) Base rear side
- (c) Base



Working envelope



X and Y-axis mechanical stopper positions (maximum working envelope)

\*The area between working envelope and X or Y-axis mechanical stopper position cannot be used.

Fig. 3-120 YK550X

Here, working envelope and mechanical stopper positions for the maximum working envelope of a robot are described using the YK500X as an example. Refer to Fig. 3-114 YK500X. Other robot models are the same.

1) X and Y axes

1. Do not attempt operation outside the working envelope. On the YK-X series, the origin can be set at any position. The working envelope described in this manual is an area with the robot frontal reference.
2. Interference positions where a load may touch the robot within the working envelope and their radii are shown in the figure. Here, "a", "b" and "c" are the respective interference positions with the base flange, base rear panel, and base. Use caution not to allow the robot load to interfere with any part of the robot.
3. Interference positions where a load might touch the robot when the robot strikes the X-axis or Y-axis mechanical stoppers set for the maximum working envelope and their radii are shown at the mechanical stopper positions. Here, "a", "b" and "c" are the respective interference positions with the base flange, base rear panel, and base.

2) Z-axis

Do not attempt work outside the working envelope. In particular, do not attempt work in the area between the working envelope and mechanical stopper position. Mechanical stoppers are installed at both the upper and lower ends of the movement range.

**⚠ WARNING**

---

The robot cable, user wiring or tubing may be damaged if the robot load interferes with them resulting in hazardous robot malfunctions. Do not operate at points where the load may interfere with the robot cable, user wiring or tubing.

---

3) R-axis

The R-axis has no mechanical stoppers.

**⚠ CAUTION**

---

Since the R-axis has no mechanical stoppers, make certain that the end effector wiring and tubing do not become entangled during operation.

---

## 4) Robot overrun during impacts with mechanical stopper

A urethane damper is installed to absorb the shock when an impact occurs with the mechanical stopper, so a certain amount of overrun occurs when the robot strikes the mechanical stopper. Use caution and take overrun into account since the end effector may interfere with the robot body and peripheral equipment or the robot body may interfere with the peripheral equipment. Maximum overrun amounts are listed below (for normal operation, maximum payload, maximum speed).

Robot model	X-axis	Y-axis	Z-axis	
			Upper end	Lower end
YK250X(H), YK350X(H), YK400X(H)	10°	2°	2mm	2mm
YK500X, YK600X	6°	2°	5mm	2mm
YK700X, YK800X, YK1000X	6°	2°	5mm	2mm
YK550X	10°	10°	1mm	4mm
YK1200X	4°	5.5°	4.5mm	4.5mm

Note: Here, ° (deg.) is the overrun angle at the X-axis and Y-axis joints.

1. If the X-axis, Y-axis or Z-axis mechanical stopper is deformed or damaged by impacts, please contact our sales office or dealer. Using the deformed or damaged mechanical stopper is dangerous, so it must be replaced.
2. When the robot strikes the X-axis or Y-axis mechanical stopper or another object, or when the R-axis collides with an object, speed reduction gears are locked while being meshed if the collision impact is large. If this happens, please contact our sales office or dealer.
3. When the robot strikes the Z-axis upper mechanical stopper excessively, the urethane damper may be splayed beyond the retaining ring. In this case, return the urethane damper to its original state. (All models except for YK550X)
4. After the robot strikes the Z-axis mechanical stopper, the stopper position may shift, and so check the stopper position. If shifted, move the stopper to the correct position and refasten it securely by following the assembly procedure.

# 12 Stopping Time and Stopping Distance at Emergency Stop

When the emergency stop button is pressed during robot operation or the power supply to the controller is turned off, the stopping time and stopping distance or angle of the main 3 axes change depending on the operation speed as shown below. The following figures show typical time and distance needed for each axis to come to a stop after a stop signal is initiated when the robot arms are fully extended while 3 types of tip mass (33%, 66% and 100% of maximum payload) are loaded.

## 12-1 YK250X(H), YK350X(H), YK400X(H)

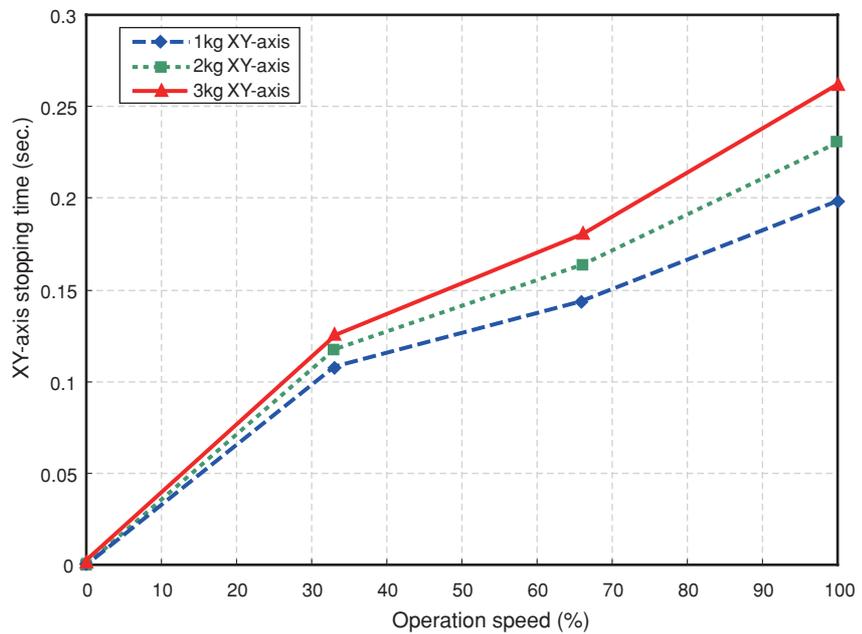


Fig. 3-121 XY-axis plus direction stopping time for YK250X(H)

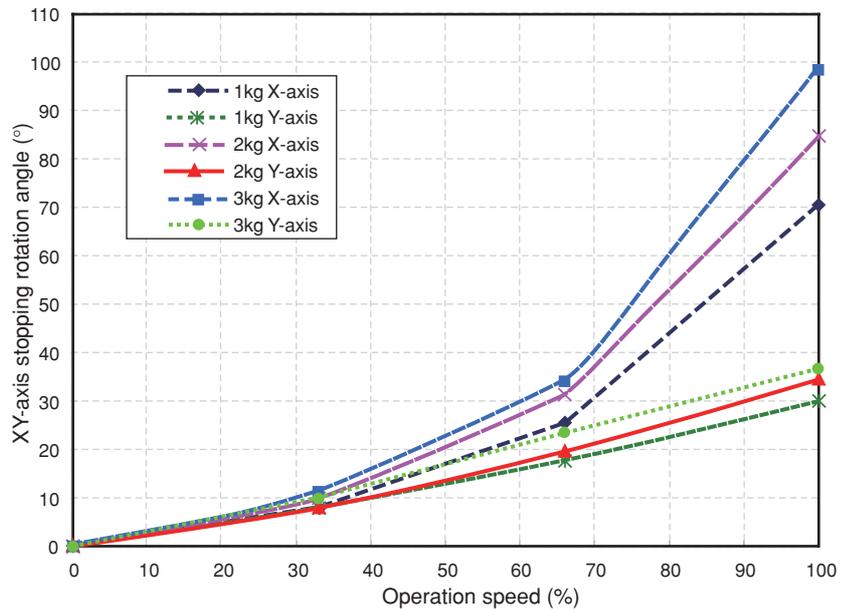


Fig. 3-122 XY-arm plus direction stopping rotation angle for YK250X(H)

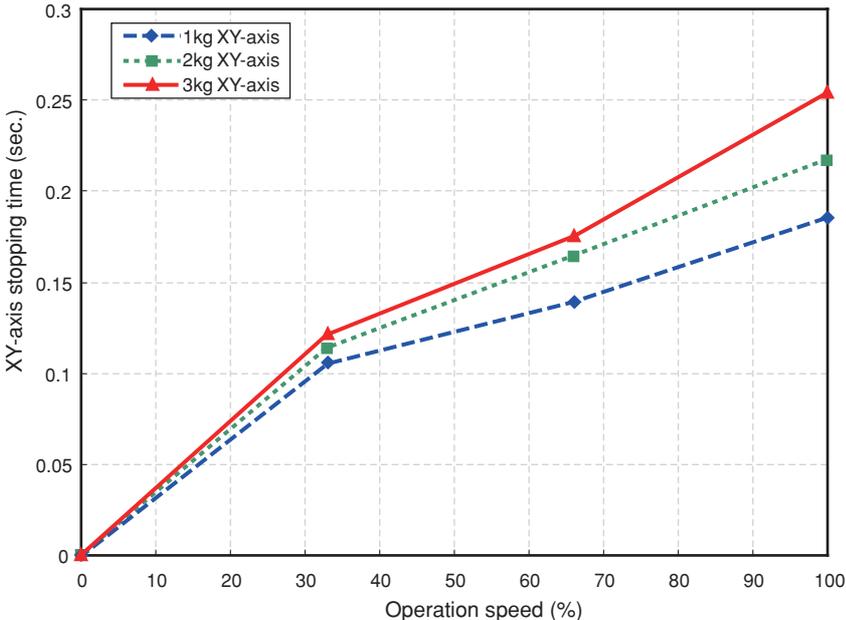


Fig. 3-123 XY-axis minus direction stopping time for YK250X(H)

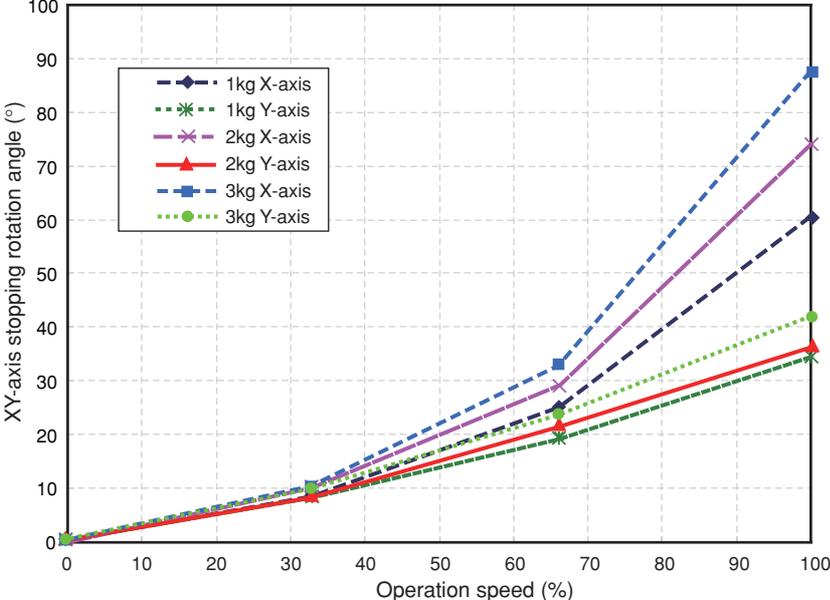


Fig. 3-124 XY-arm minus direction stopping rotation angle for YK250X(H)

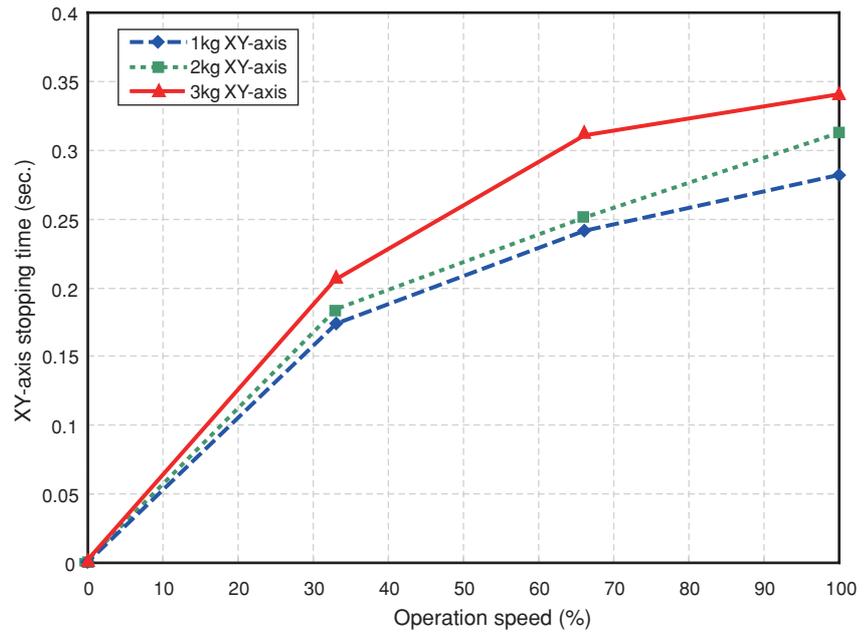


Fig. 3-125 XY-axis plus direction stopping time for YK350X(H)

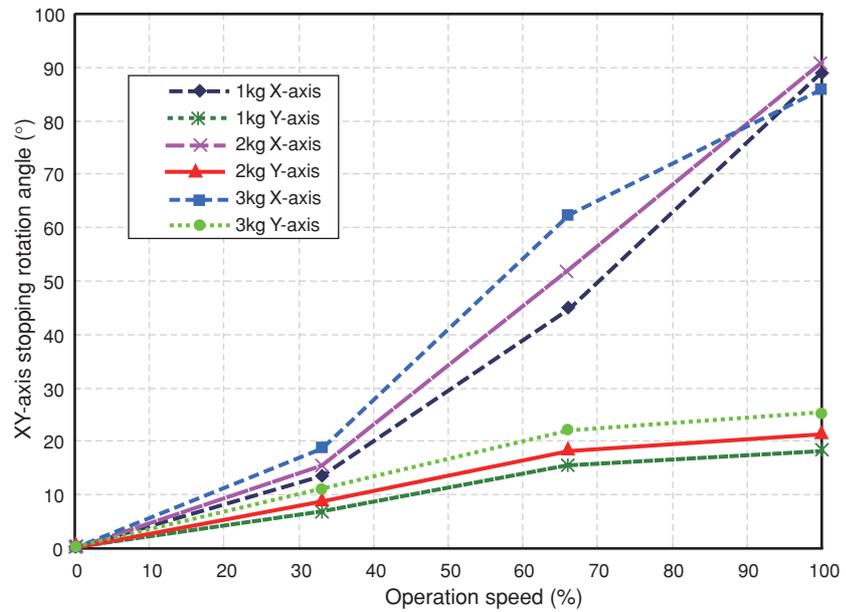


Fig. 3-126 XY-arm plus direction stopping rotation angle for YK350X(H)

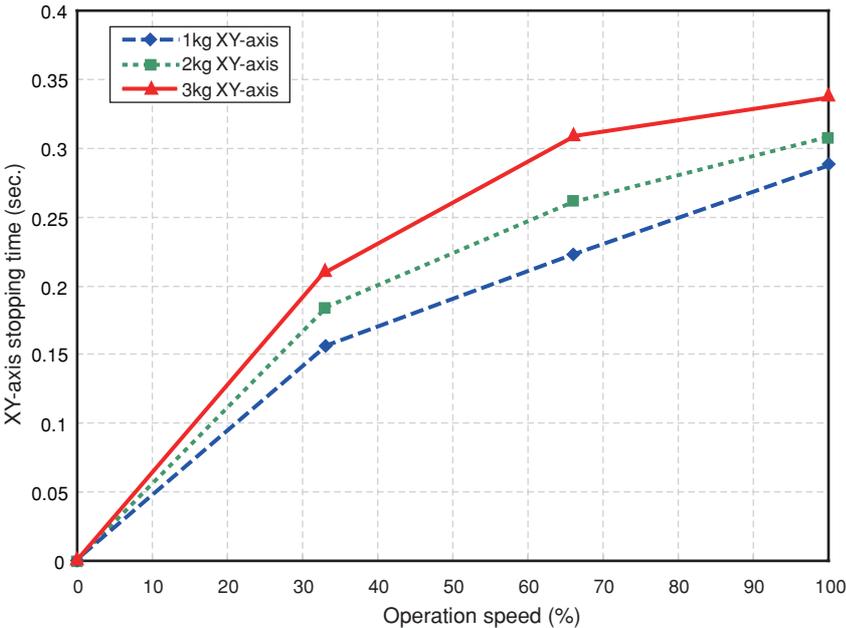


Fig. 3-127 XY-axis minus direction stopping time for YK350X(H)

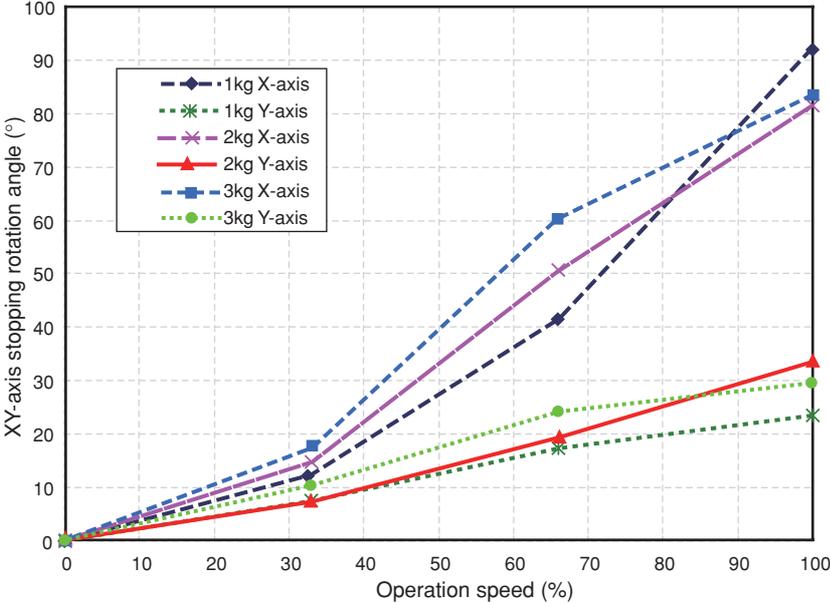


Fig. 3-128 XY-arm minus direction stopping rotation angle for YK350X(H)

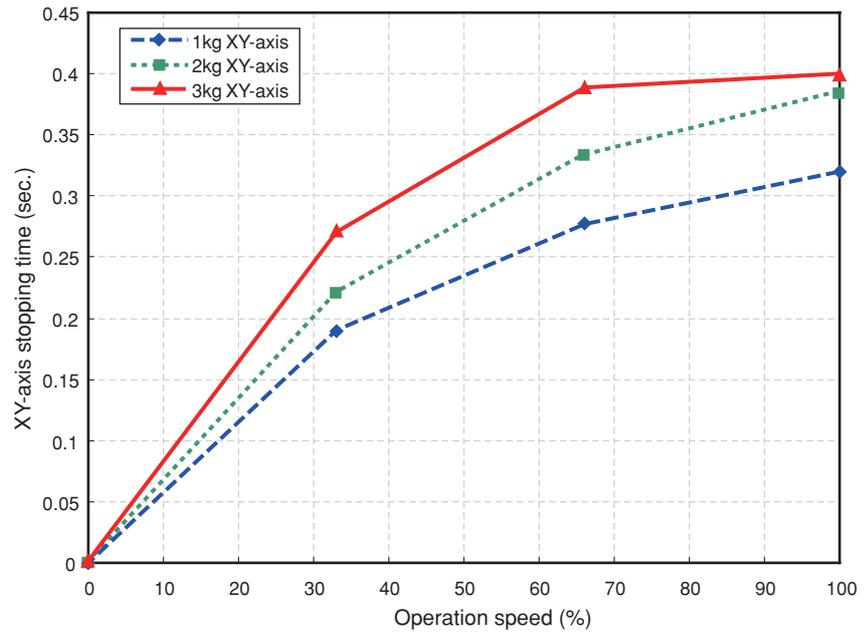


Fig. 3-129 XY-axis plus direction stopping time for YK400X(H)

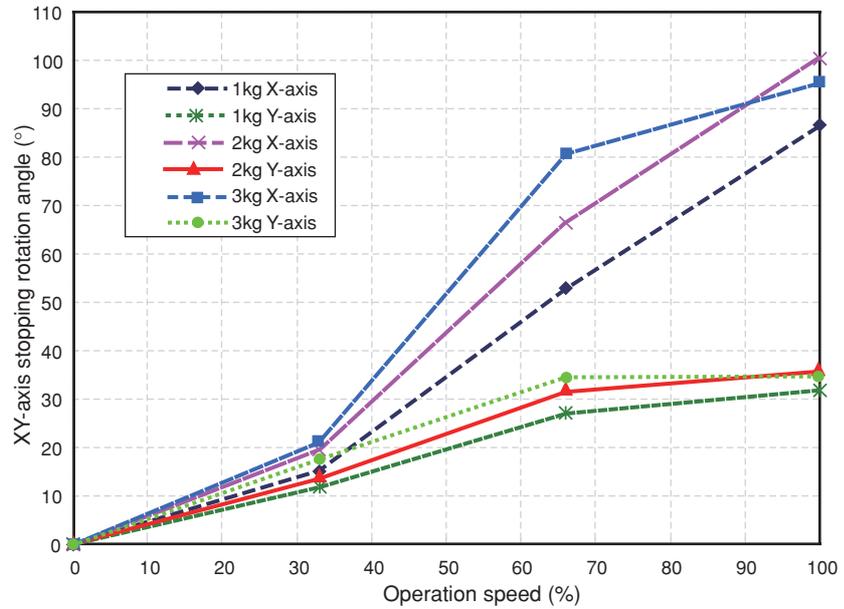


Fig. 3-130 XY-arm plus direction stopping rotation angle for YK400X(H)

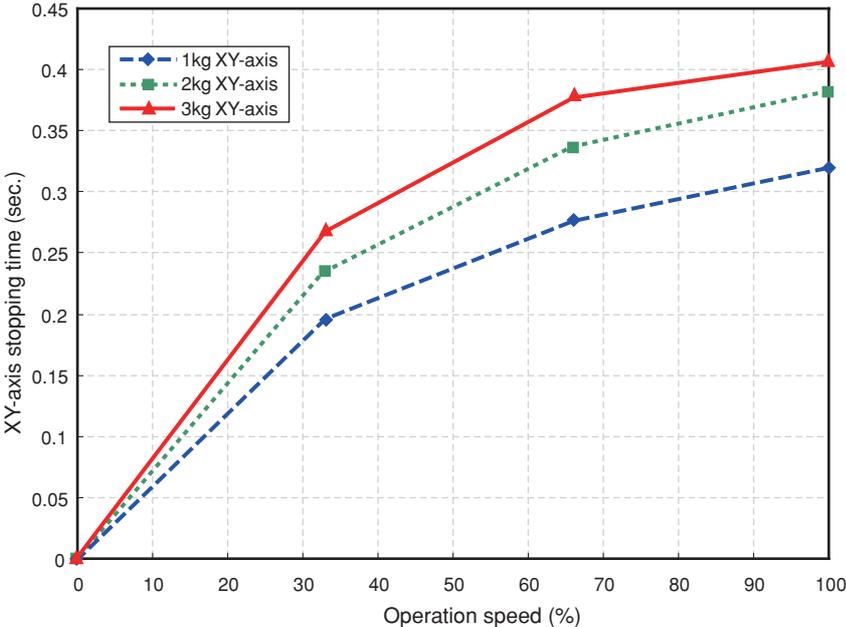


Fig. 3-131 XY-axis minus direction stopping time for YK400X(H)

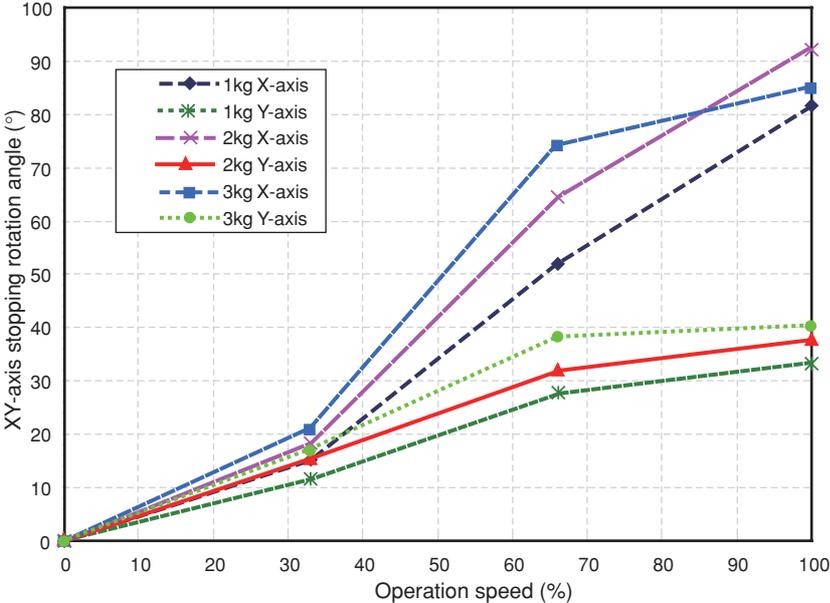


Fig. 3-132 XY-arm minus direction stopping rotation angle for YK400X(H)

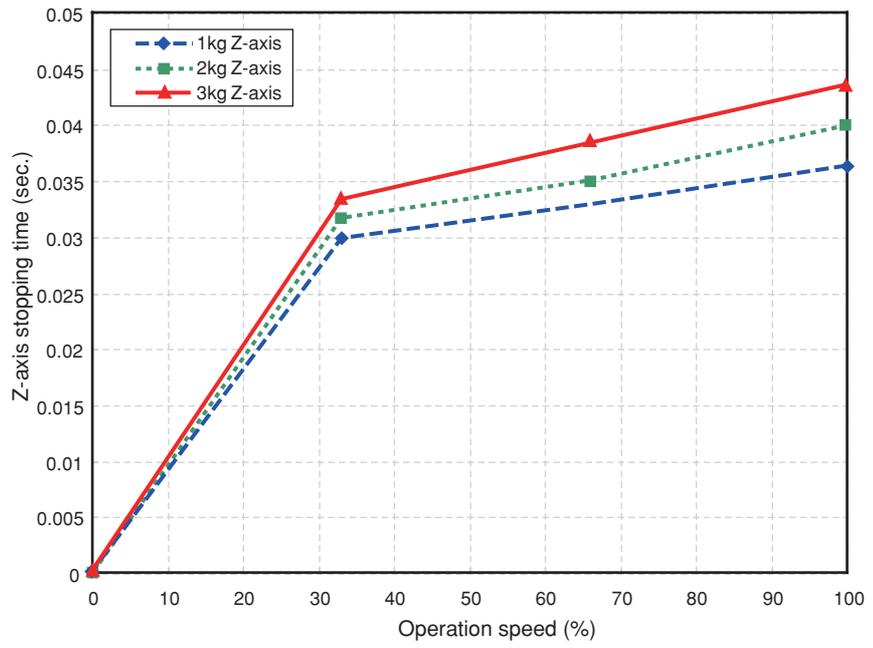


Fig. 3-133 Z-axis stopping time for YK250X(H) and YK350X(H)

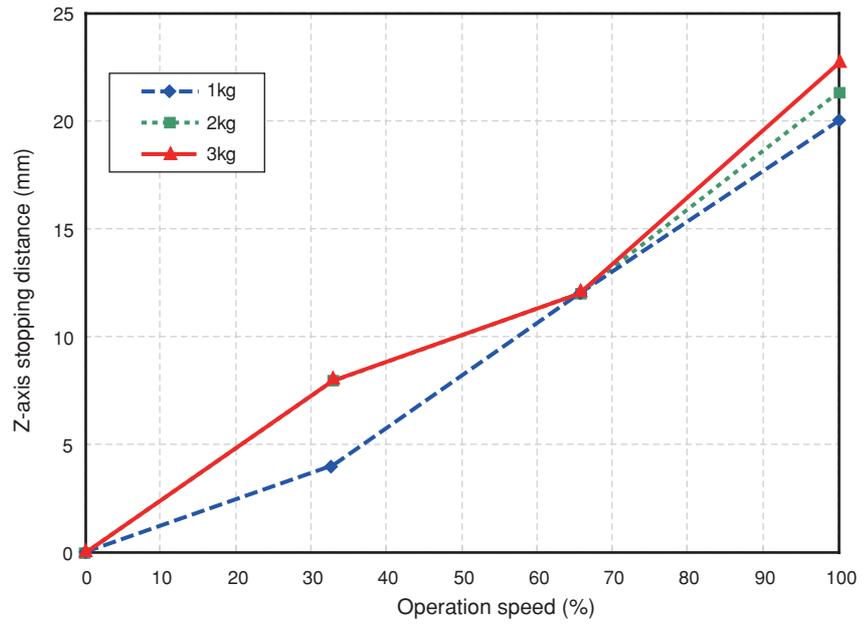


Fig. 3-134 Z-axis stopping distance for YK250X(H) and YK350X(H)

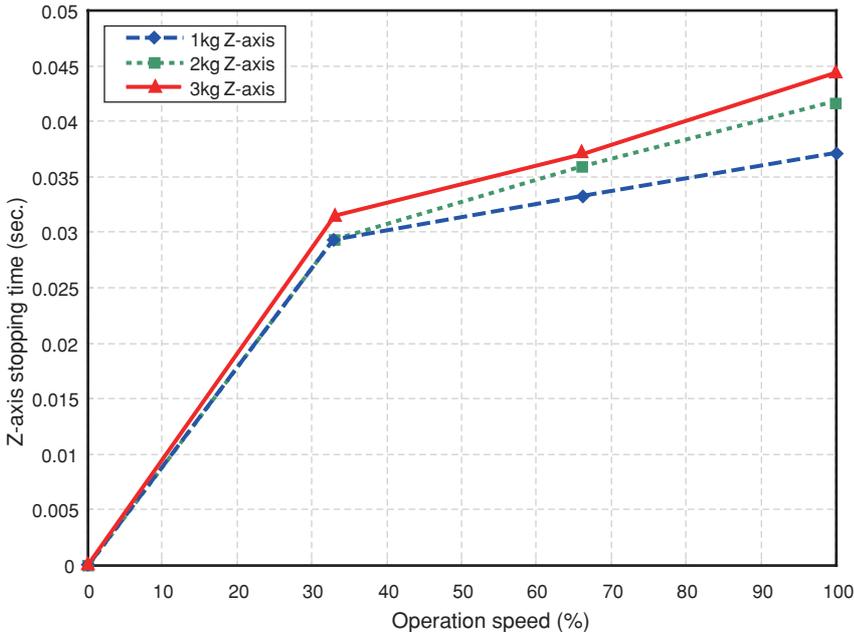


Fig. 3-135 Z-axis stopping time for YK400X(H)

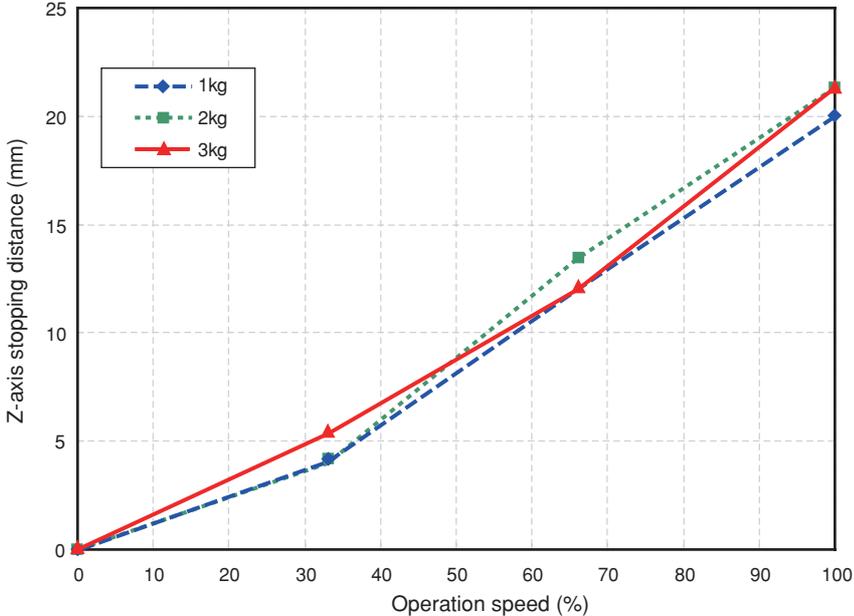


Fig. 3-136 Z-axis stopping distance for YK400X(H)

12-2 YK1200X

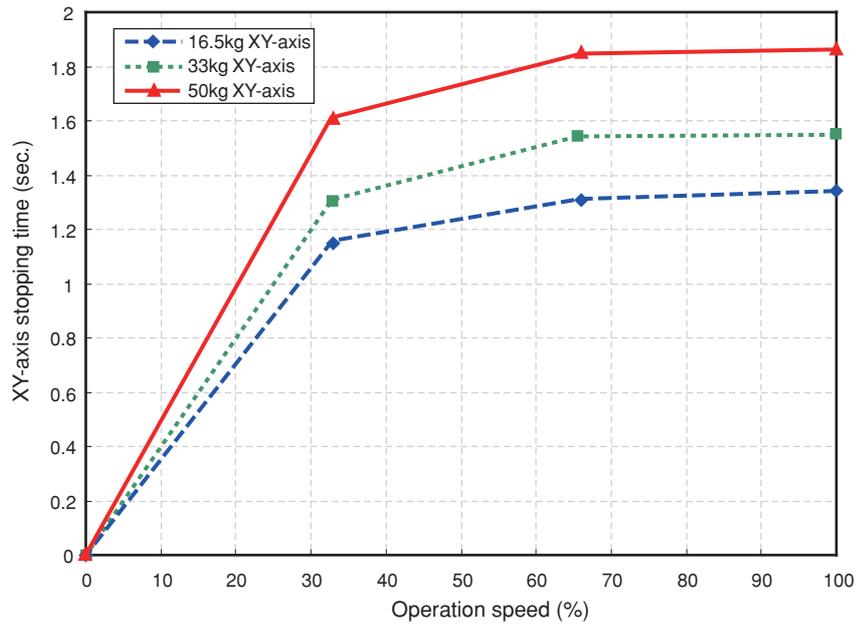


Fig. 3-137 XY-axis stopping time for YK1200X

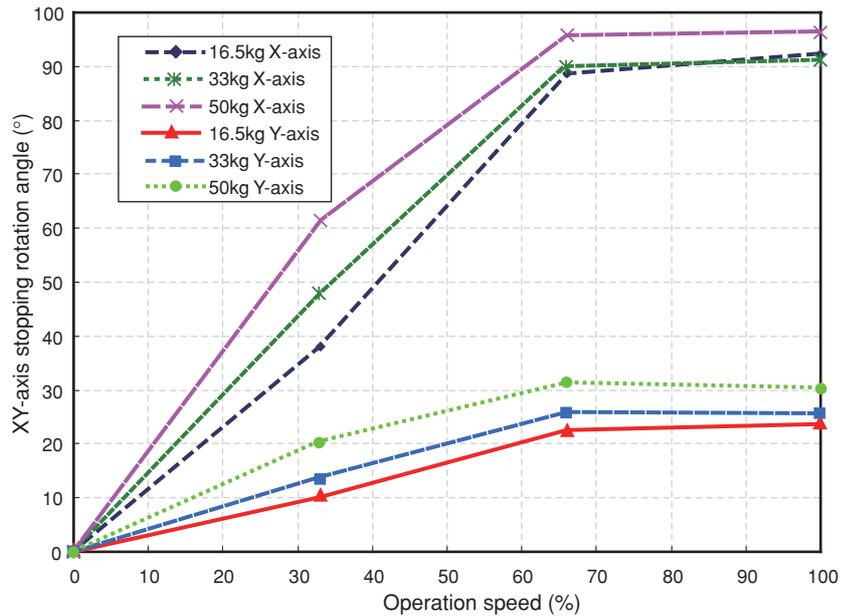


Fig. 3-138 XY-arm stopping rotation angle for YK1200X

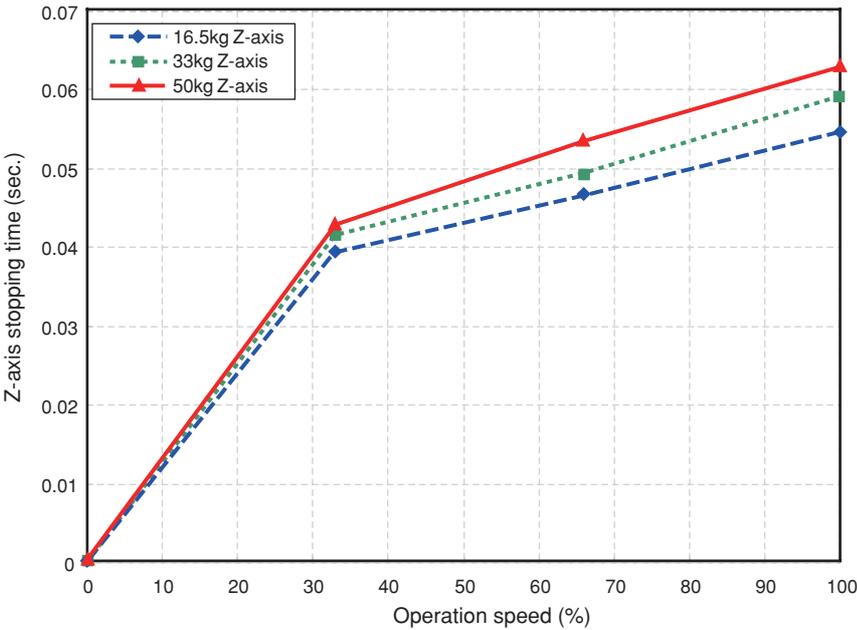


Fig. 3-139 Z-axis stopping time for YK1200X

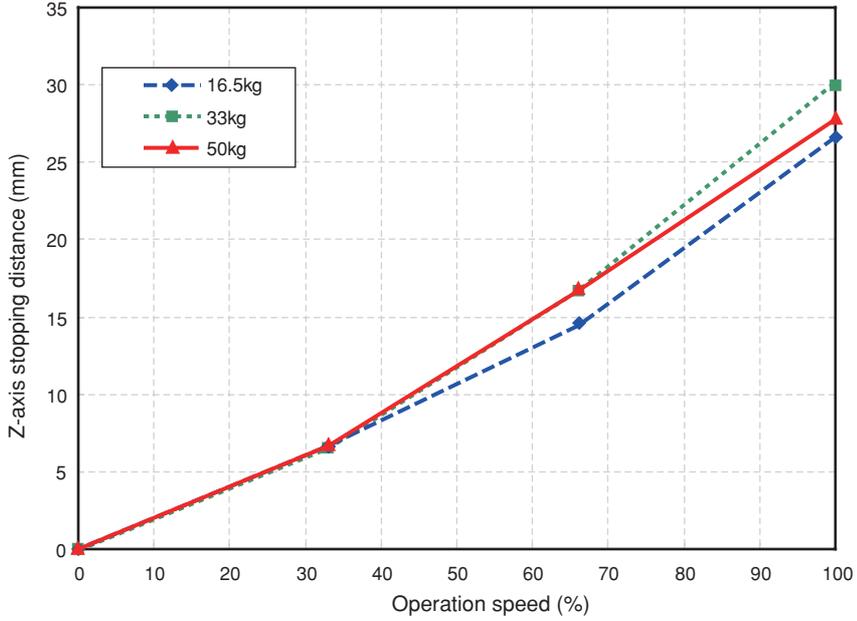


Fig. 3-140 Z-axis stopping distance for YK1200X

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# MEMO

# CHAPTER 4

## Adjustment

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## 1 Overview

YAMAHA robots have been completely adjusted at the factory or by the sales representative before shipment, including the origin position adjustment. If the operating conditions are changed and the robot must be adjusted, then follow the procedures described in this chapter.

---

## 2 Safety Precautions

- (1) Read and understand the contents of this chapter completely before attempting to adjust the robot.
- (2) Place a conspicuous sign indicating the robot is being adjusted, to prevent others from touching the controller switch, programming box or operation panel.
- (3) If a safeguard enclosure has not yet been provided right after installation of the robot, rope off or chain off the movement area around the manipulator in place of a safeguard enclosure, and observe the following points.
  - ① Use stable posts which will not fall over easily.
  - ② The rope or chain should be easily visible by everyone around the robot.
  - ③ Place a conspicuous sign prohibiting the operator or other personnel from entering the movement area of the manipulator.
- (4) To check operation after adjustment, refer to "6. Trial Operation" in Chapter 1.

### 3 Adjusting the origin

All models of the YK-X series robots use an absolute type position detector. The origin position (zero pulse point) can be determined by absolute reset. Once absolute reset is performed, you do not have to repeat absolute reset when turning the power on next time.

However, absolute reset is required if any of the following cases occur. The robot is shipped from the factory in condition "c" (below), so please perform absolute reset after installing the robot. For more details on absolute reset, refer to "Absolute Reset" in Chapter 4 of the "YAMAHA Robot Controller User's Manual".

- a. Absolute-related error occurred on the axis.
- b. Power drop was detected in the absolute battery for the driver installed inside the robot controller.
- c. Cable connecting the robot unit to the controller was disconnected.  
(This is the status when shipped from the factory.)
- d. Robot generation was changed.
- e. Parameters were initialized.
- f. Axis parameters "Origin shift", "Origin method", "Origin direction" or "Motor direction" were changed.
- g. Motor was replaced. (Motor wiring connector was removed.)
- h. Data in the ALL data file (extension: ALL) or parameter file (extension: PRM) was written into the controller by way of the RS-232C.

The following sections explain how to perform absolute reset.

#### **CAUTION**

If any of the above cases occur after installing the robot, absolute reset must be performed again. To perform absolute reset, move the robot arms back to their origin positions where the robot does not interfere with peripheral equipment after the setup is complete.

#### **CAUTION**

After performing absolute reset, move the robot to a known point to check whether the origin position is correctly set. When doing this check, move the robot at the slowest possible speed.

#### **CAUTION**

The standard coordinate and point data must be reset when the origin position is changed.

#### **CAUTION**

Make point data setting after changing the origin position.  
After changing the origin position, do not use the previous point data.

There are three absolute reset methods for the YK-X series: the sensor method, mark method, and stroke end method.

The X-axis, Y-axis, and R-axis use the sensor method as the initial setting, while the Z-axis uses the stroke end method.

---

## 3-1 Absolute reset method

---

### 3-1-1 Sensor method (X-axis, Y-axis, and R-axis)

In the sensor method, the target axis is automatically operated for the absolute reset, and the absolute reset is performed at the position where the proximity sensor provided on the target axis detects the detection area (dog).

The absolute reset in the sensor method can be executed with the programming box (MPB/RPB), RS-232C communication, and dedicated input.

#### **⚠ WARNING**

Serious injury might occur from physical contact with the robot during operation.

Never enter within the robot movement range during absolute reset.

#### **⚠ CAUTION**

The origin cannot be detected in any axis which is not positioned on the plus side from the origin (See Fig. 4-2.) before starting the return-to-origin operation. (Factory setting at shipment.)

In this case, press the STOP key to interrupt the return-to-origin operation, move the target axis to the plus side of the origin, and reperform the origin return operation.

If the return-to-origin operation is not interrupted, the robot will continue the operation and may collide with the mechanical stopper or a peripheral device. Since a mechanical stopper is not provided in the R-axis, the wiring and piping installed on the end effector may be wound up by the operation.

### 3-1-2 Mark method (X-axis, Y-axis, and R-axis)

In the mark method, you move the robot beforehand, to the position where you want to perform absolute reset and then perform absolute reset there.

Use either of the following 2 methods to move the robot to the position where you want to perform absolute reset. (See Fig. 4-3.)

- (1) Move the robot in step jog while the servo is on.
  - Select this method when the mark (sticker) indicating the origin position can be seen from outside the robot movement range.
- (2) Move the robot manually while the servo is off.
  - Select this method when the mark (sticker) indicating the origin position cannot be seen from outside the robot movement range.

---

**⚠ CAUTION**

Use the programming box (MPB/RPB) or the RS-232C port when using the mark method for absolute reset. You cannot use dedicated inputs to perform absolute reset.

---

**⚠ CAUTION**

The deviation between the origin position marks must be within a specified range (repeatability tolerance) when performing absolute reset at the same positions as the previous absolute reset. (See Fig. 4-4.)

A position deviation (positional shift) will occur if absolute reset is performed at a position outside the repeatability tolerance or at a position different from the previous absolute reset position.

Use the supplied origin position stickers to put a mark on the origin positions of the X-axis, Y-axis and R-axis, so that you can perform absolute reset at the origin positions within the tolerance range.

Origin position repeatability (tolerance) values for each robot axis are shown in Table 4-1.

---

---

### 3-1-3 Stroke end method (Z-axis)

In the stroke end method, absolute reset is performed at a position slightly backed off from the stroke end, after the Z-axis contacts the mechanical stopper and stroke end is detected.

**⚠ WARNING**

Serious injury might occur from physical contact with the robot during operation.

Never enter within the robot movement range during absolute reset.

---

### 3-2 Machine reference

The YK-X series position detectors are resolvers that have four positions where absolute reset can be performed per motor revolution. If the sensor method is used for the absolute reset, the origin position will be set at the positions where absolute reset can be performed soon after the origin sensor reacts to the dog (the origin signal is detected). The machine reference means the position relationship of the position where the robot detects the origin signal to the position where the absolute reset can be performed soon after detection. (See Fig. 4-1.) The machine reference is expressed with the ratio of interval A to interval B shown in Fig. 4-1. Interval A is the minimum distance between the positions where absolute reset can be performed and interval B is the distance between the position where the origin signal is detected and the position where absolute reset can be performed soon after the origin signal detection. The machine reference value is displayed on the optional MPB/RPB screen. (Unit: %)

$$\text{Machine reference value} = B/A \times 100(\%)$$

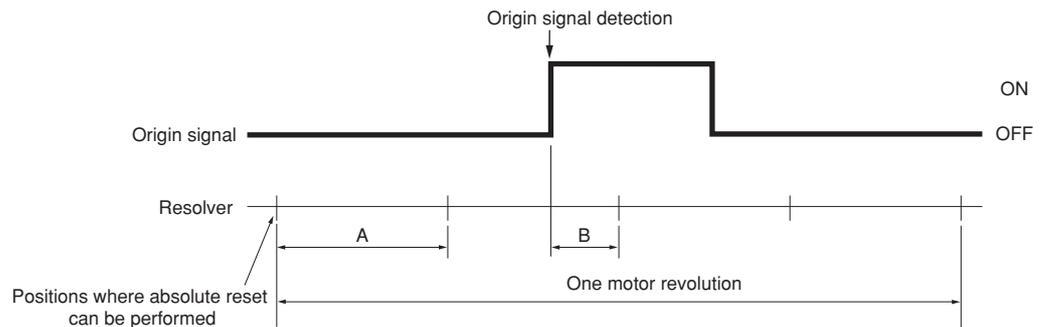
**CAUTION**

The machine reference must be adjusted within a specified range to keep the repeatability precision of the absolute reset position. (The machine reference is factory-adjusted prior to shipping.) If the origin position is changed, the machine reference must be readjusted. For information on how to adjust the machine reference, refer to "3-4 Changing the origin position and adjusting the machine reference" in Chapter 4.

When the temperature of the robot joint sections is high immediately after the robot has been operated, the machine reference value might be outside the specified range (40 to 60%). When checking or adjusting the machine reference value, always make sure that the temperature of the robot joint sections has returned to room temperature.

Recommended machine reference value: 40 to 60%

### Machine reference



### Machine reference display

\* In the screen illustration below, a section of the screen shown by the ≈ marks is omitted.

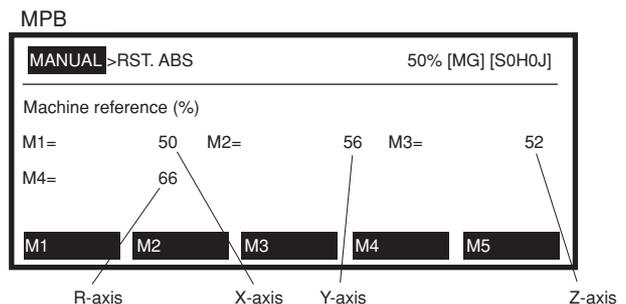
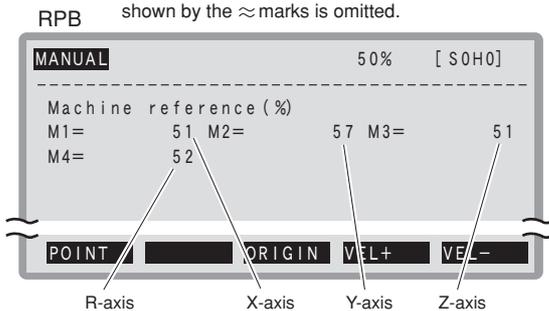


Fig. 4-1

### 3-3 Absolute reset procedures

---

#### 3-3-1 Sensor method (X-axis, Y-axis, and R-axis)

**⚠ WARNING**

Serious injury might occur from physical contact with the robot during operation.

Never enter within the robot movement range during absolute reset.

---

The operation procedure using the MPB/RPB is described next. (Press the ESC key on the MPB/RPB if you want to return to the preceding step.)

See the "YAMAHA Robot Controller User's Manual" for information on operating the robot controller.

- 1) Check that no one is inside the safeguard enclosure and then turn on the controller.
- 2) Place a sign indicating the robot is being adjusted, to keep others from touching the controller switch or operation panel.
- 3) Set the controller to MANUAL mode, if not in MANUAL mode.
- 4) Press the F13 (LOWER+F3) key to select "RST. ABS".
- 5) Select the axis for absolute reset. (X-axis: M1, Y-axis: M2, Z-axis: M3, R-axis: M4)  
To perform absolute reset on all axes, select "ALL" with the F11 (LOWER+F1) key.

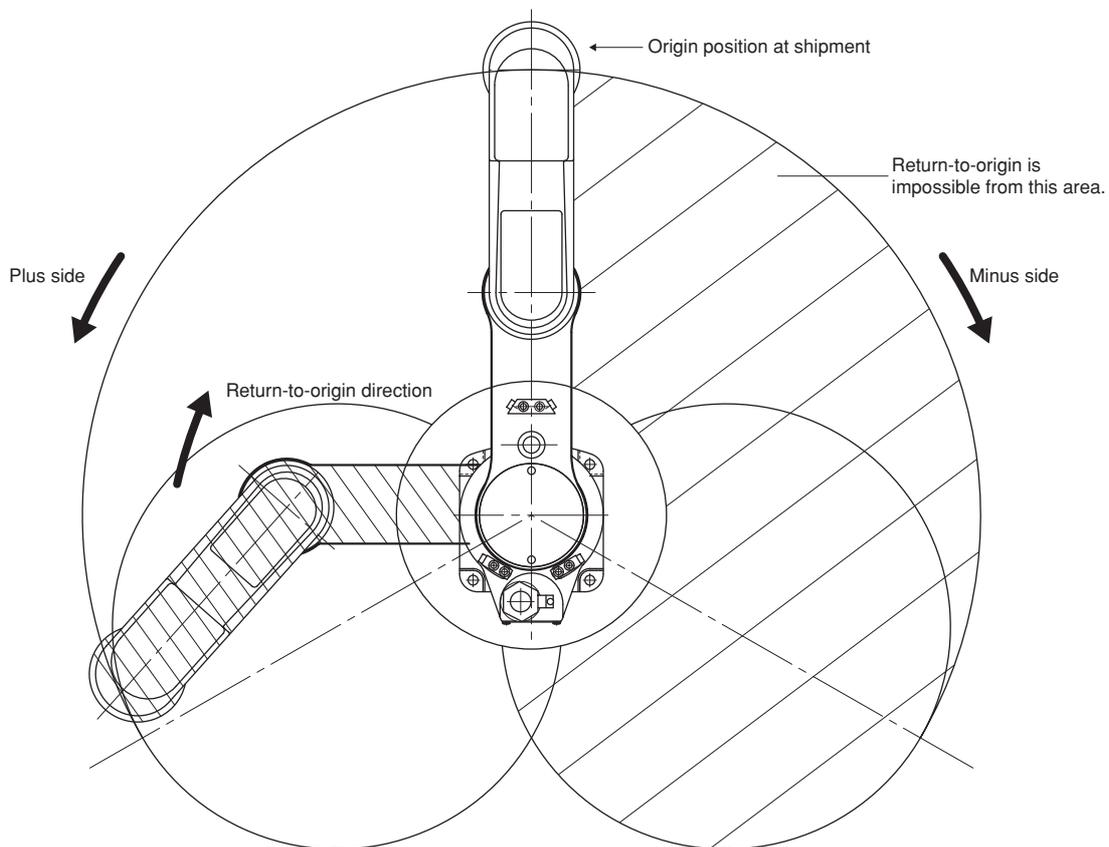
**⚠ CAUTION**

The Z-axis of the stroke end method first rises during the absolute reset of all axes (default setting). Be careful that your fingers do not get pinched or crushed by any sudden movement.

---

- 6) Check that the absolute reset axis must be positioned at the plus side of the origin. (See Fig. 4-2.)  
If it is not at the plus side, then press the jog key to move the target axis to the plus side.
- 7) Since the message "Reset ABS encoder OK?" is displayed, check that there are not any obstacles in the robot movement range, and press the F4 key (YES).

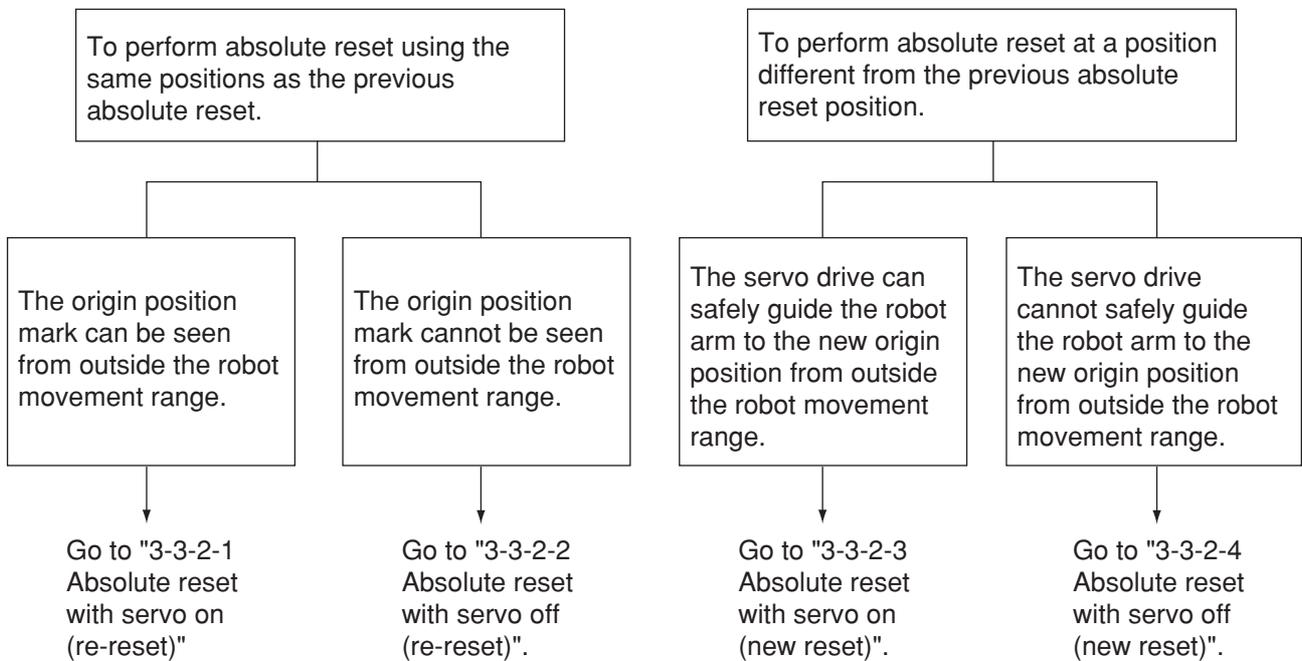
- 8) After the absolute reset is completed, check that the machine reference value displayed on the MPB/RPB is between 40 and 60 (recommended range). If the machine reference value is outside the recommended range, then the next absolute reset may not be properly performed. In this case, refer to "3-4 Changing the origin position and adjusting the machine reference", and make the necessary adjustments.

**Fig. 4-2**

### 3-3-2 Mark method (X-axis, Y-axis, and R-axis)

The absolute reset in the mark method is divided into four types according to the conditions as shown in Fig. 4-3.

Since each operating procedure is different, refer to the corresponding section in this manual.



**Fig. 4-3 Absolute reset flow chart**

### 3-3-2-1 Absolute reset with servo on (re-reset)

**⚠ WARNING**

Serious injury might occur from physical contact with the robot during operation.

Never enter within the robot movement range during absolute reset.

The operation procedure using the MPB/RPB is described next. (Press the ESC key on the MPB/RPB if you want to return to the preceding step.)

See the "YAMAHA Robot Controller User's Manual" for information on operating the robot controller.

- 1) Check that no one is inside the safeguard enclosure and then turn on the controller.
- 2) Place a sign indicating the robot is being adjusted, to keep others from touching the controller switch or operation panel.
- 3) While holding the MPB/RPB, move to a position where the origin position sticker can be seen. Never enter within the robot movement range at this time.
- 4) Set the controller to MANUAL mode, if not in MANUAL mode.
- 5) Press the F13 (LOWER+F3) key to select "RST. ABS".
- 6) Select the axis for absolute reset. (X-axis: M1, Y-axis: M2, Z-axis: M3, R-axis: M4)  
To perform absolute reset on all axes, select "ALL" with the F11 (LOWER+F1) key.

**⚠ CAUTION**

The Z-axis of the stroke end method first rises during the absolute reset of all axes (default setting). Be careful that your fingers do not get pinched or crushed by any sudden movement.

- 7) Do as follows according to the axis that was selected.
  - (1) X, Y and R axes
    1. Jog the robot in steps using the F1 or F2 key so the origin position marks align with each other. (Robot movement speed can be adjusted with the F4 or F5 key.)

### **▲ CAUTION**

---

There are several dispersed positions where absolute reset can be performed. All robot stop positions can be used for absolute reset when the robot was moved with the F1 or F2 key.

Press the F1 or F2 key again before performing the absolute reset, move the axis left or right, and check that the origin position marks align with each other. (See Fig. 4-4.)

A position deviation (position shift) occurs if absolute reset is performed at a position different from the previous absolute reset position.

---

2. When the robot has been moved to a position for absolute reset, check that the figure of the selected axis displayed on the MPB/RPB screen is within 26 from 74 (usually 50) and press the ENTER key.
3. A message "Reset ABS encoder OK?" appears so press the F4 (YES) key if this position is okay for reset.

If "ALL" was selected in 6), then the message "Reset ABS encoder OK?" appears once again before the Z-axis rises.

Check that there are no hazards even if the Z-axis rises and press the F4 (YES) key.

- (2) Z axis
  1. The message "Reset ABS encoder OK?" appears so check that there are no obstacles in the robot movement area and press the F4 (YES) key.
  2. After absolute reset is complete, check that the machine reference value shown on the MPB/RPB is between 26 and 74.

If the machine reference value is outside these limits, then the absolute reset may not have been performed correctly. If the absolute reset is incorrect, adjust the Z-axis setting while referring to "Chapter 4, 3-4 Changing the origin position and adjusting the machine reference".

### 3-3-2-2 Absolute reset with servo off (re-reset)

The operation procedure using the MPB/RPB is described next. (Press the ESC key on the MPB/RPB if you want to return to the preceding step.)

See the "YAMAHA Robot Controller User's Manual" for information on operating the robot controller.

- 1) Check that no one is inside the safeguard enclosure and then press the emergency stop button. Next turn on the controller while in servo-off.
- 2) Place a sign indicating the robot is being adjusted, to keep others from touching the controller switch.
- 3) While holding the MPB/RPB, enter the safeguard enclosure.
- 4) Set the controller to MANUAL mode, if not in MANUAL mode.
- 5) Press the F13 (LOWER+F3) key to select "RST.ABS".
- 6) Select the axis for absolute reset. (X-axis: M1, Y-axis: M2, Z-axis: M3, R axis: M4)  
To perform absolute reset on all axes, select "ALL" with the F11 (LOWER+F1) key.

#### **CAUTION**

The Z-axis (M3) uses the stroke end method to detect the origin position by having the axis making contact with a mechanical stopper at the end of the stroke. (default setting)

This means that the servo must be turned on to perform Z-axis absolute reset. See "3-3-2-1 Absolute reset with servo on (re-reset)" for information on performing absolute reset on the Z-axis.

- 7) Move the robot manually to a position where the origin position marks are aligned with each other.

#### **CAUTION**

The deviation between the origin position marks must be within a specified range (repeatability tolerance) when performing an absolute reset at the same position as the previous absolute reset. (See Fig. 4-4)

A position deviation (positional shift) will occur if the absolute reset is performed at a position outside the repeatability tolerance or at a position different from the previous absolute reset position.

When performing the absolute reset make sure that the deviation (positional shift) between the origin position marks is within the allowed tolerance for origin position repeatability.

Origin position repeatability (tolerance) values for each robot axis are shown in Table 4-1.

- 8) After moving the robot to a position for absolute reset, check that the figure of the selected axis displayed on the MPB/RPB screen is within 26 to 74 and press the ENTER key.

**⚠ CAUTION**

---

There are several dispersed positions where absolute reset can be performed. Move the robot a little bit at a time while viewing the MPB/RPB screen so that the origin position marks match each other. Then press the ENTER key at a position where the selected axis figure is between 26 and 74 on the MPB/RPB screen.

---

**⚠ CAUTION**

---

If the selected axis does not show a figure between 26 and 74, then an error message, "ABS.reset position error" appears during the next step and absolute reset is disabled.

---

- 9) A message "Reset ABS encoder OK?" appears, so press the F4 (YES) key if okay to reset at that position.

**⚠ CAUTION**

---

If "ALL" was selected in 6) then the X-axis, Y-axis or R-axis can be reset in servo-off. However the servo must be on when performing absolute reset of the Z-axis. See "3-3-2-1 Absolute reset with servo on (re-reset)" for information on how to perform Z-axis absolute reset.

---

- 10) Go outside the safeguard enclosure.
- 11) Check that no one is inside the safeguard enclosure and then release the emergency stop button on the controller.

### 3-3-2-3 Absolute reset with servo on (new reset)

**⚠ WARNING**

Serious injury might occur from physical contact with the robot during operation.

Never enter within the robot movement range during absolute reset.

The operation procedure using the MPB/RPB is described next. (Press the ESC key on the MPB/RPB if you want to return to the preceding step.)

See the "YAMAHA Robot Controller User's Manual" for information on operating the robot controller.

- 1) Check that no one is inside the safeguard enclosure and then turn on the controller.
- 2) Place a sign indicating the robot is being adjusted, to keep others from touching the controller switch or operation panel.
- 3) Move the robot to the arm position where the absolute reset will be newly performed, and shift your own position while holding the MPB/RPB so you can see the joint area. Do not enter within the robot movement range.
- 4) Set the controller to MANUAL mode, if not in MANUAL mode.
- 5) Press the F13 (LOWER+F3) key to select "RST.ABS".
- 6) Select the axis for absolute reset. (X-axis: M1, Y-axis: M2, Z-axis: M3, R-axis: M4)  
To perform absolute reset on all axes, select "ALL" with the F11 (LOWER+F1) key.

**⚠ CAUTION**

The Z-axis rises during absolute reset of all axes (default setting) so don't let fingers get pinched or crushed by sudden movement.

- 7) Do as follows according to the axis that was selected.
  - (1) X, Y and R axes
    1. Press the F1 or F2 key to jog the robot in steps to the position where absolute reset is to be performed. (Robot movement speed is adjustable with F4 or F5 key.)

**⚠ CAUTION**

---

There are several dispersed positions where absolute reset can be performed. All robot stop positions can be used for absolute reset when the robot was moved with the F1 or F2 key.

---

2. When the robot has been moved to a position for absolute reset, check that the figure of the selected axis displayed on the MPB/RPB screen is within 26 to 74 (usually 50) and press the ENTER key.
3. A message "Reset ABS encoder OK?" appears so press the F4 (YES) key if this position is okay for reset.

If "ALL" was selected in 6), then the message "Reset ABS encoder OK?" appears once again before the Z-axis rises.

Check that there are no hazards even if the Z-axis rises and press the F4 (YES) key.

- (2) Z-axis
  1. The message "Reset ABS encoder OK?" appears so check that there are no obstacles in the robot movement area and press the F4 (YES) key.
  2. After absolute reset is complete, check that the machine reference value shown on the MPB/RPB is between 26 and 74.

If the machine reference value is outside these limits, then the absolute reset may not have been performed correctly. If the absolute reset is incorrect, adjust the Z-axis setting while referring to "Chapter 4, 3-4 Changing the origin position and adjusting the machine reference".
- 8) After absolute reset is complete, move all robot axes to their "0" pulse positions. To move axes to their "0" pulse positions, see Chapter 4, "Point trace function" in the "YAMAHA Robot Controller User's Manual".

**⚠ CAUTION**

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Before affixing the origin position stickers, be sure to move all robot axes back to their "0" pulse positions. Omitting this step may mean that the next absolute reset might be incorrect.

---

- 9) After moving all the axes back to their "0" pulse positions, press the emergency stop button and affix the supplied origin position stickers to the upper and lower areas of the X-axis, Y-axis, and R-axis. Use these marked positions to perform an absolute reset if it is needed in the future. (See Fig. 4-5 to Fig. 4-8.)

Use alcohol, etc. to remove any grease or oil from the surface where you will affix the stickers. After the surface dries attach the stickers securely.

The YK550X does not have a relatively rotating part where the R-axis origin position sticker is attached. We recommend using the sensor method for detection the R-axis origin.

**⚠ CAUTION**

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The deviation between the origin position marks must be within a specified range (repeatability tolerance) when performing the absolute reset at the same position as the previous absolute reset. (See Fig. 4-4)

When affixing an origin position sticker, align it precisely with the upper and lower stickers of the joint area so that the absolute reset position can be easily checked the next time an absolute reset is performed.

---

**⚠ CAUTION**

---

Be careful not to let the robot joints move while attaching the origin stickers. When the servo is off, the robot joints may sometimes move due to tension in the harness from the arm position. If this is the case, the origin should be set to another position where the joints will not move.

---

- 10) Go outside the safeguard enclosure.
- 11) Check that no one is inside the safeguard enclosure and then release the emergency stop button on the controller.

### 3-3-2-4 Absolute reset with servo off (new reset)

The operation procedure using the MPB/RPB is described next. (Press the ESC key on the MPB/RPB if you want to return to the preceding step.)

See the "YAMAHA Robot Controller User's Manual" for information on operating the robot controller.

- 1) Check that no one is inside the safeguard enclosure and then press the emergency stop button. Next turn on the controller while in servo-off.
- 2) Place a sign indicating the robot is being adjusted, to keep others from touching the controller switch or operation panel.
- 3) While holding the MPB/RPB, enter the safeguard enclosure.
- 4) Set the controller to MANUAL mode, if not in MANUAL mode.
- 5) Press the F13 (LOWER+F3) key to select "RST.ABS".
- 6) Select the axis for absolute reset. (X-axis: M1, Y-axis: M2, Z-axis: M3, R-axis: M4)  
To perform absolute reset on all axes, select "ALL" with the F11 (LOWER+F1) key.

---

**⚠ CAUTION**

The Z-axis (M3) uses the stroke end method to detect the origin position by having the axis making contact with a mechanical stopper at the end of the stroke. (default setting)

This means that the servo must be turned on to perform Z-axis absolute reset. See "3-3-2-3 Absolute reset with servo on (new reset)" for information on performing absolute reset on the Z-axis.

---

- 7) Move the robot manually to the position for performing absolute reset.
- 8) After moving the robot to a position for absolute reset, check that the figure of the selected axis displayed on the MPB/RPB screen is within 26 to 74 and press the ENTER key.

---

**⚠ CAUTION**

There are several dispersed positions where absolute reset can be performed. Move the robot a little bit at a time while viewing the MPB/RPB screen, and press the ENTER key at a position where the figure of the selected axis is between 26 to 74 on the MPB/RPB screen.

---

**⚠ CAUTION**

If the selected axis does not show a figure between 26 and 74, then an error message, "ABS.reset position error" appears during the next step and absolute reset is disabled.

- 9) A message "Reset ABS encoder OK?" appears, so press the F4 (YES) key if okay to reset at that position.

**⚠ CAUTION**

If "ALL" was selected in 6) then the X-axis, Y-axis or R-axis can be reset in servo-off. However the servo must be on when performing absolute reset of the Z-axis. See "3-3-2-3 Absolute reset with servo on (new reset)" for information on performing Z-axis absolute reset.

- 10) After absolute reset is complete, set the robot to servo-on and move all robot axes to their "0" pulse positions. To move axes to their "0" pulse positions, see Chapter 4, "Point trace function" in the "YAMAHA Robot Controller User's Manual".

**⚠ CAUTION**

Before affixing the origin position stickers, be sure to move all robot axes back to their "0" pulse positions. Omitting this step may mean that the next absolute reset might be incorrect.

- 11) After moving all the axes back to their "0" pulse positions, press the emergency stop button and affix the supplied origin position stickers to the upper and lower areas of the X-axis, Y-axis, and R-axis. Use these marked positions to perform an absolute reset if it is needed in the future. (See Fig. 4-5 to Fig. 4-8.)  
Use alcohol, etc. to remove any grease or oil from the surface where you will affix the stickers. After the surface dries attach the stickers securely.

**⚠ CAUTION**

The deviation between the origin position marks must be within a specified range (repeatability tolerance) when performing the absolute reset at the same position as the previous absolute reset. (See Fig. 4-4)

When affixing an origin position sticker, align it precisely with the upper and lower stickers of the joint area so that the absolute reset position can be easily checked the next time an absolute reset is performed.

**⚠ CAUTION**

Be careful not to let the robot joints move while attaching the origin stickers. When the servo is off, the robot joints may sometimes move due to tension in the harness from the arm position. If this is the case, the origin should be set to another position where the joints will not move.

---

- 12) Go outside the safeguard enclosure.
- 13) Check that no one is inside the safeguard enclosure and then release the emergency stop button on the controller.

**Table 4-1 Origin position repeatability tolerance**

YK250X(H), YK350X(H), YK400X(H)		
Axis	Origin position repeatability tolerance (°)	Origin position repeatability tolerance (mm)
X-axis	±0.90	±0.78
Y-axis	±0.90	±0.78
R-axis	±0.90	±0.58

YK500X, YK600X		
Axis	Origin position repeatability tolerance (°)	Origin position repeatability tolerance (mm)
X-axis	±0.56	±0.58
Y-axis	±0.56	±0.47
R-axis	±0.90	±0.65

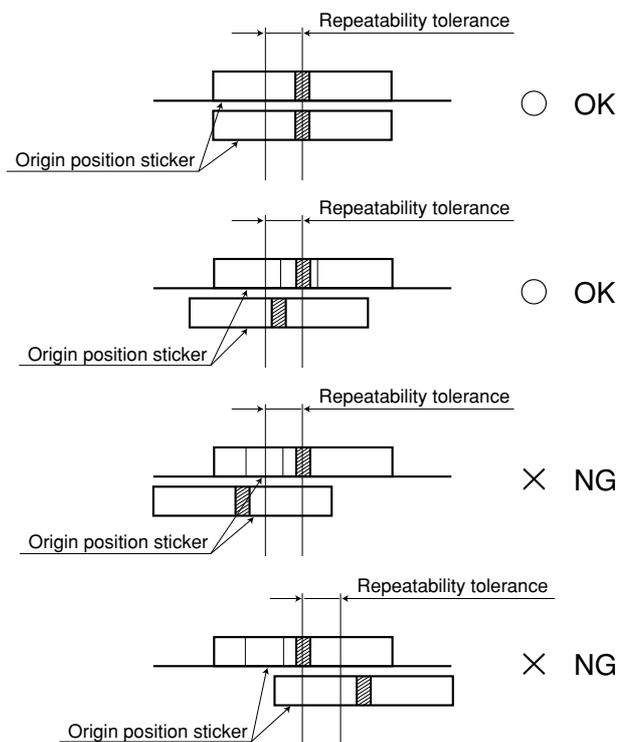
YK700X, YK800X		
Axis	Origin position repeatability tolerance (°)	Origin position repeatability tolerance (mm)
X-axis	±0.56	±0.76
Y-axis	±0.56	±0.62
R-axis	±0.90	±0.73

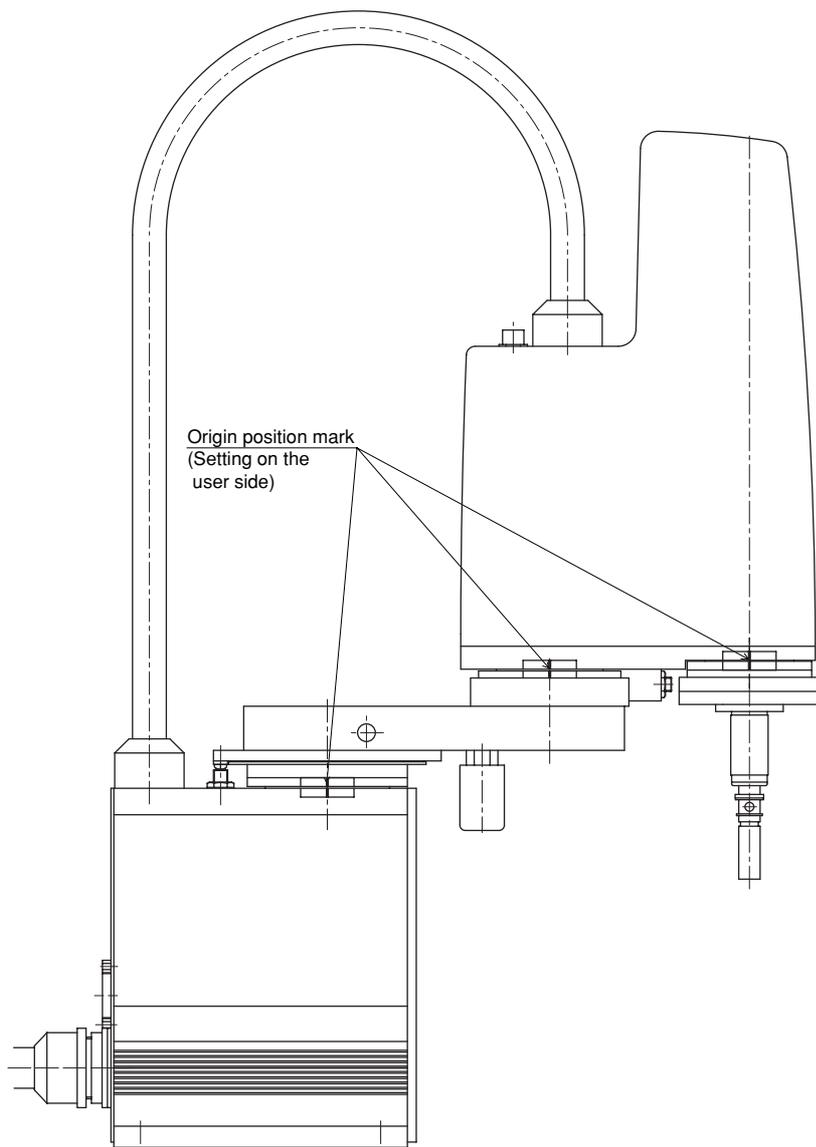
YK1000X		
Axis	Origin position repeatability tolerance (°)	Origin position repeatability tolerance (mm)
X-axis	±0.45	±0.62
Y-axis	±0.56	±0.62
R-axis	±0.90	±0.73

YK1200X		
Axis	Origin position repeatability tolerance (°)	Origin position repeatability tolerance (mm)
X-axis	±0.37	±0.64
Y-axis	±0.43	±0.58
R-axis	±0.90	±0.89



**Fig. 4-4 Positional relation between origin position stickers**



**Fig. 4-5 Origin position mark setting example YK250X(H), YK350X(H), YK400X(H)**

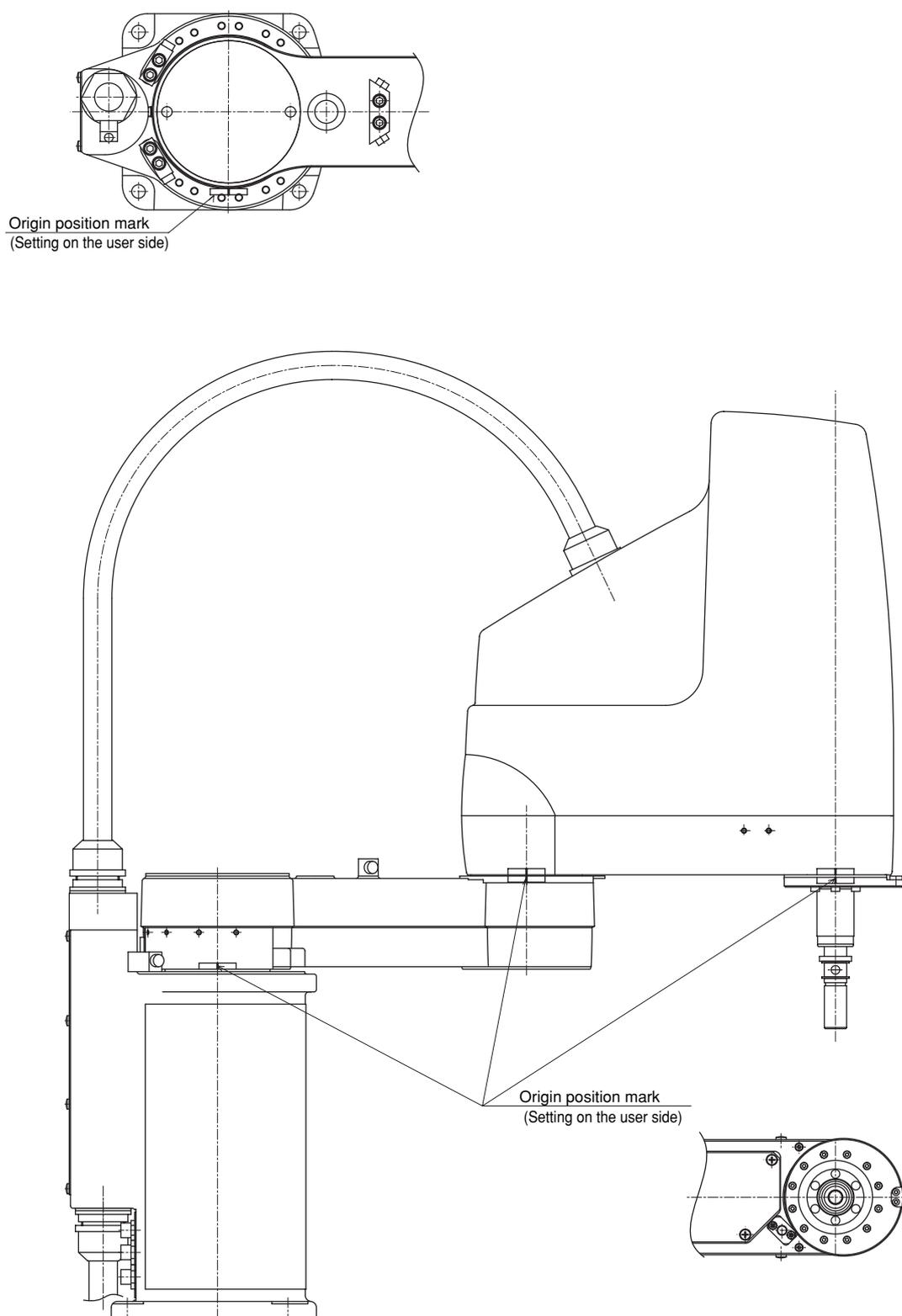


Fig. 4-6 Origin position mark setting example YK500X, YK600X

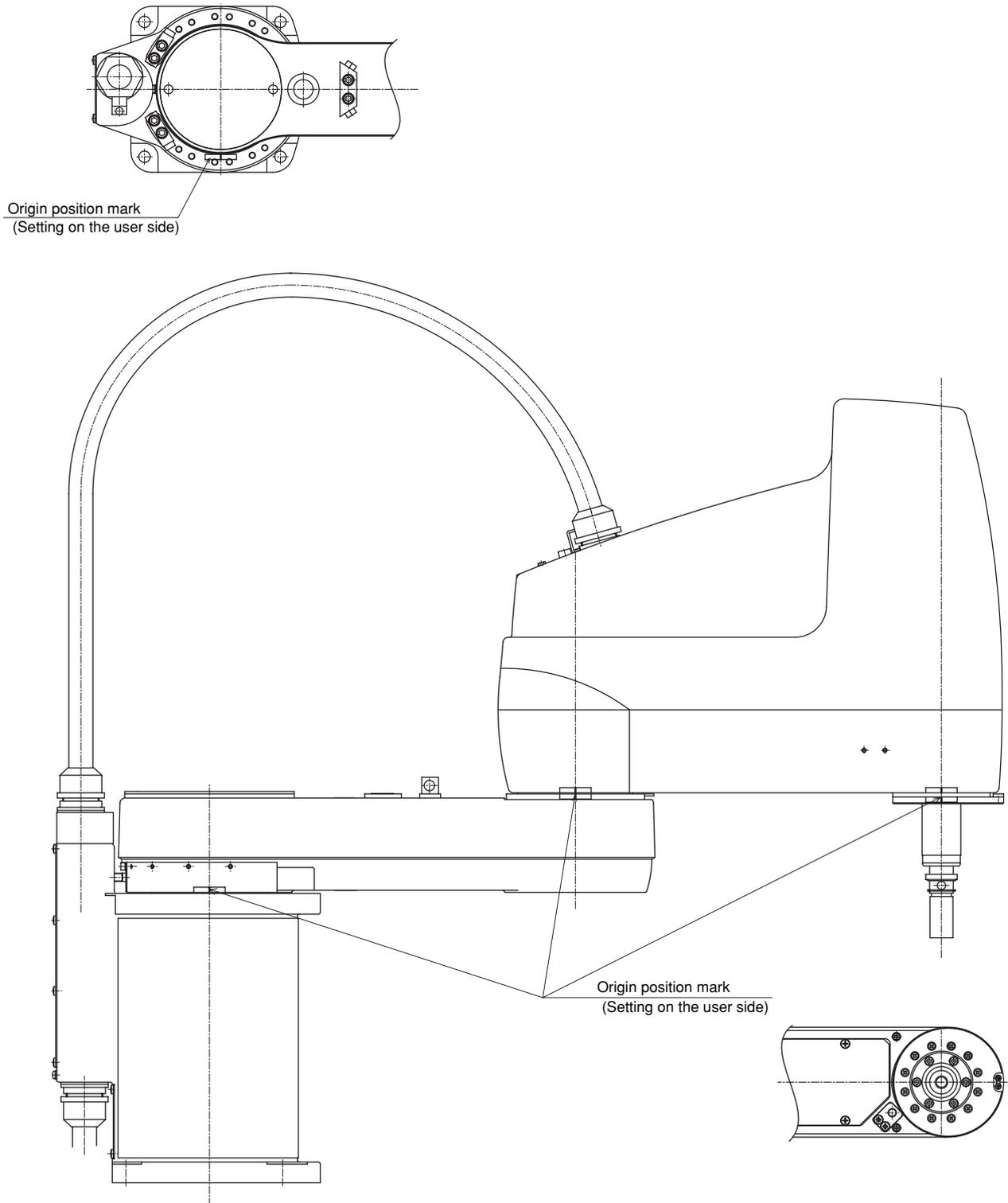


Fig. 4-7 Origin position mark setting example YK700X, YK800X, YK1000X

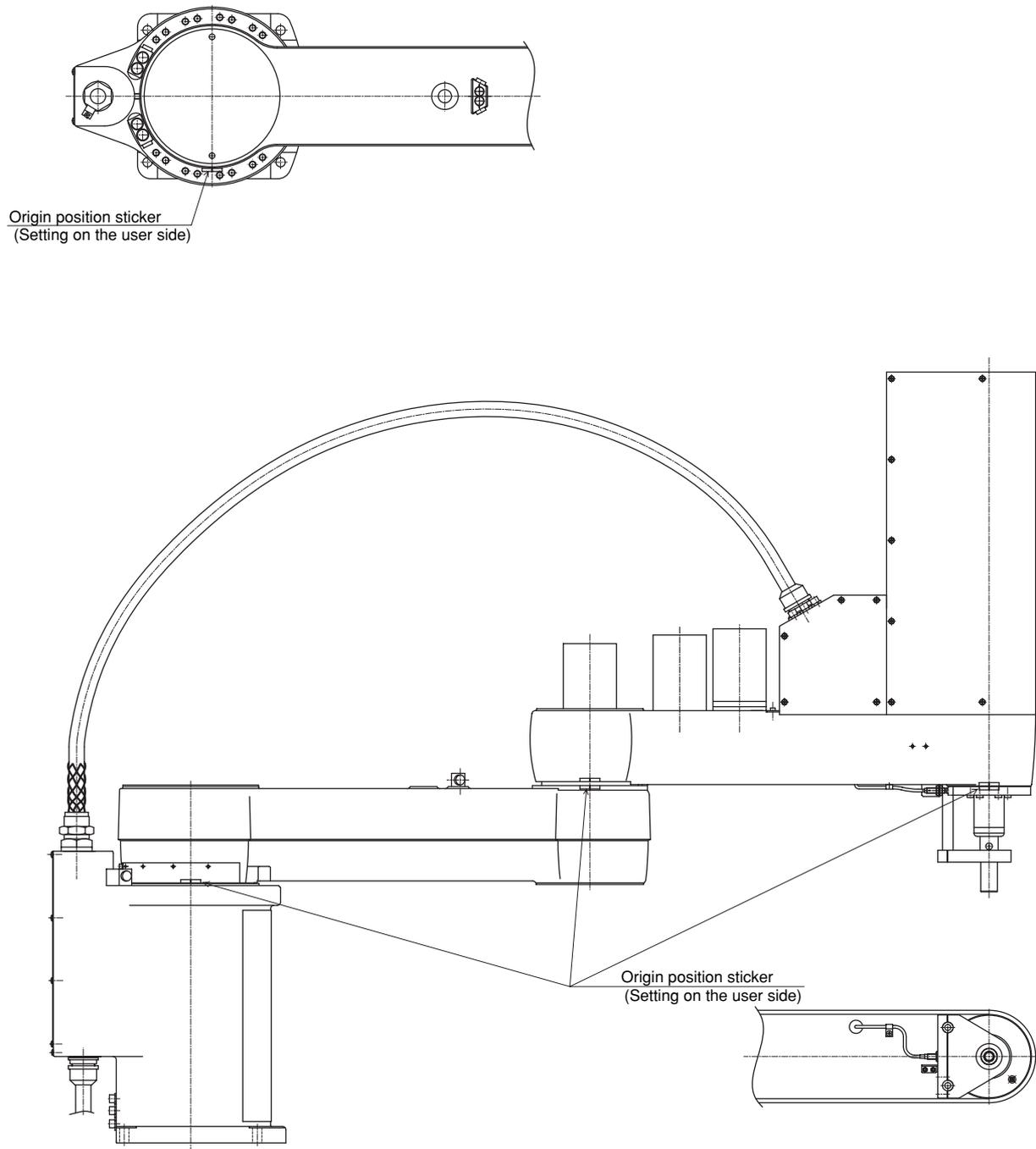


Fig. 4-8 Origin position mark setting example YK1200X

### 3-3-3 Stroke end method (Z-axis)

**⚠ WARNING**

Serious injury might occur from physical contact with the robot during operation.

Never enter within the robot movement range during absolute reset.

---

The operation procedure using the MPB/RPB is described next. (Press the ESC key on the MPB/RPB if you want to return to the preceding step.)

See the "YAMAHA Robot Controller User's Manual" for information on operating the robot controller.

- 1) Check that no one is inside the safeguard enclosure and then turn on the controller.
- 2) Place a sign indicating the robot is being adjusted, to keep others from touching the controller switch or operation panel.
- 3) Set the controller to MANUAL mode, if not in MANUAL mode.
- 4) Press the F13 (LOWER+F3) key to select "RST. ABS".3-4
- 5) Select M3 (Z-axis).
- 6) Since the message "Reset ABS encoder OK?" is displayed, check that there are not any obstacles in the robot movement range, and press the F4 key (YES).
- 7) After the absolute reset is completed, check that the machine reference value displayed on the MPB/RPB is within the absolute reset tolerance range (26 to 74).

If the machine reference value is outside the absolute reset tolerance range, then the next absolute reset may not be properly performed.

In this case, refer to "Chapter 4, 3-4 Changing the origin position and adjusting the machine reference" and make the necessary adjustments.

---

## 3-4 Changing the origin position and adjusting the machine reference

**⚠ CAUTION**

---

If the origin position has been changed, then the absolute reset must be performed, the machine reference must be adjusted, and the standard coordinate and point data must be reset.

---

**⚠ CAUTION**

---

If any machine reference is adjusted, the origin position may change. Before the adjustment, mark off the reference mark at the current origin position on the main body of the robot. After the machine reference is adjusted, be sure to check that the origin position has not deviated. If the origin position changes after the machine reference has been adjusted, then the standard coordinate and point data must be reset.

---

## 3-4-1 Sensor method

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### 3-4-1-1 YK250X(H), YK350X(H), YK400X(H)

#### 1-1 Adjusting the X-axis machine reference

The adjustment method for the X-axis machine reference is as follows.

- 1) Prepare the necessary tools.
  - Hex wrench set
- 2) Check that no one is inside the safeguard enclosure and then turn on the controller.
- 3) Perform the absolute reset from outside the safeguard enclosure.  
Refer to "3-3 Absolute reset procedures" for information about the absolute reset method.
- 4) If any machine reference value displayed on the MPB/RPB is not in the range between 40 and 60 (recommended range) after the absolute reset has been completed, then proceed with the following adjustment procedure.
- 5) Place a sign indicating that the robot is being adjusted in order to keep others from operating the controller or operation panel.
- 6) Turn off the controller and enter the safeguard enclosure.
- 7) Mark off the reference mark at the current origin position on the X-axis joint area of the robot.  
At this time, be careful to prevent the origin position from deviating since the X-axis arm is touched.
- 8) Use the hex wrench to loosen two setscrews which fasten the dog ring of the X-axis joint area. (See Fig. 4-9.)

 **CAUTION**

---

It is sufficient to loosen them. It is not necessary to completely remove them.

---

- 9) Refer to Fig. 4-9 and Table 4-2 and turn the dog ring to the minimum extent.
  - 10) Tighten the setscrews to fasten the dog ring.
  - 11) Go out of the safeguard enclosure, and check that no one is inside the safeguard enclosure. Then turn on the controller.
  - 12) Perform the absolute reset from outside the safeguard enclosure.
-

- 13) After the absolute reset is completed, read the machine reference value displayed on the MPB/RPB.
  
- 14) If the machine reference value is in the range between 40 and 60 (recommended range), then the machine reference has been completely adjusted. If it is outside the recommended range, then repeat the procedure that starts in 5) to readjust it.

## 1-2 Changing the X-axis origin position

**▲ CAUTION**

If the origin position has been changed, then the absolute reset must be performed, the machine reference must be adjusted, and the standard coordinate and point data must be reset.

---

The method to change the X-axis origin position is as follows.

- 1) Prepare the necessary tools.
  - Hex wrench set
- 2) Check that no one is inside the safeguard enclosure and then turn on the controller.
- 3) Perform the absolute reset from outside the safeguard enclosure. Refer to "3-3 Absolute reset procedures" for information about the absolute reset method.
- 4) Place a sign indicating that the robot is being adjusted in order to keep others from operating the controller or operation panel.
- 5) Turn off the controller and enter the safeguard enclosure.
- 6) Use the hex wrench to loosen two setscrews which fasten the dog ring of the X-axis joint area. (See Fig. 4-9.)

**▲ CAUTION**

It is sufficient to loosen them. It is not necessary to completely remove them.

---

- 7) Turn the dog ring to move the sensor detection area (dog) on the dog ring to the desired origin position.
- 8) Tighten the setscrews to fasten the dog ring.
- 9) Go out of the safeguard enclosure, and check that no one is inside the safeguard enclosure. Then turn on the controller.
- 10) Perform the absolute reset from outside the safeguard enclosure.
- 11) After the absolute reset is completed, read the machine reference value displayed on the MPB/RPB.
- 12) If the machine reference value is in the range between 40 and 60 (recommended range), then the origin position has been completely changed. If it is outside the recommended value, then adjust the machine reference by referring to "1-1 Adjusting the X-axis machine reference".

## 2-1 Adjusting the Y-axis machine reference

The adjustment method for the Y-axis machine reference is as follows.

- 1) Prepare the necessary tools.
  - Hex wrench set
- 2) Check that no one is inside the safeguard enclosure and then turn on the controller.
- 3) Perform the absolute reset from outside the safeguard enclosure. Refer to "3-3 Absolute reset procedures" for information about the absolute reset method.
- 4) If any machine reference value displayed on the MPB/RPB is not in the range between 40 and 60 (recommended range) after the absolute reset has been completed, then proceed with the following adjustment procedure.
- 5) Place a sign indicating that the robot is being adjusted in order to keep others from operating the controller or operation panel.
- 6) Turn off the controller and enter the safeguard enclosure.
- 7) Mark off the reference mark at the current origin position on the Y-axis joint area of the robot.  
At this time, be careful to prevent the origin position from deviating since the Y-axis arm is touched.
- 8) Use the hex wrench to loosen two setscrews which fasten the dog ring of the Y-axis joint area. (See Fig. 4-9.)

**⚠ CAUTION**

It is sufficient to loosen them. It is not necessary to completely remove them.

- 9) Refer to Fig. 4-9 and Table 4-2 and turn the dog ring to the minimum extent.
- 10) Tighten the setscrews to fasten the dog ring.
- 11) Go out of the safeguard enclosure, and check that no one is inside the safeguard enclosure. Then turn on the controller.
- 12) Perform the absolute reset from outside the safeguard enclosure.
- 13) After the absolute reset is completed, read the machine reference value displayed on the MPB/RPB.
- 14) If the machine reference value is in the range between 40 and 60 (recommended range), then the machine reference has been completely adjusted. If it is outside the recommended range, then repeat the procedure that starts in 5) to readjust it.

## 2-2 Changing the Y-axis origin position

**⚠ CAUTION**

If the origin position has been changed, then the absolute reset must be performed, the machine reference must be adjusted, and the standard coordinate and point data must be reset.

---

The method to change the Y-axis origin position is as follows.

- 1) Prepare the necessary tools.
  - Hex wrench set
- 2) Check that no one is inside the safeguard enclosure and then turn on the controller.
- 3) Perform the absolute reset from outside the safeguard enclosure. Refer to "3-3 Absolute reset procedures" for information about the absolute reset method.
- 4) Place a sign indicating that the robot is being adjusted in order to keep others from operating the controller or operation panel.
- 5) Turn off the controller and enter the safeguard enclosure.
- 6) Use the hex wrench to loosen two setscrews which fasten the dog ring of the Y-axis joint area. (See Fig. 4-9.)

**⚠ CAUTION**

It is sufficient to loosen them. It is not necessary to completely remove them.

---

- 7) Turn the dog ring to move the sensor detection area (dog) on the dog ring to the desired origin position.
- 8) Tighten the setscrews to fasten the dog ring.
- 9) Go out of the safeguard enclosure, and check that no one is inside the safeguard enclosure. Then turn on the controller.
- 10) Perform the absolute reset from outside the safeguard enclosure.
- 11) After the absolute reset is completed, read the machine reference value displayed on the MPB/RPB.
- 12) If the machine reference value is in the range between 40 and 60 (recommended range), then the origin position has been completely changed. If it is outside the recommended value, then adjust the machine reference by referring to "2-1 Adjusting the Y-axis machine reference".

### 3-1 Adjusting the R-axis machine reference

The adjustment method for the R-axis machine reference is as follows.

- 1) Prepare the necessary tools.
  - Hex wrench set
- 2) Check that no one is inside the safeguard enclosure and then turn on the controller.
- 3) Perform the absolute reset from outside the safeguard enclosure. Refer to "3-3 Absolute reset procedures" for information about the absolute reset method.
- 4) If any machine reference value displayed on the MPB/RPB is not in the range between 40 and 60 (recommended range) after the absolute reset has been completed, then proceed with the following adjustment procedure.
- 5) Place a sign indicating that the robot is being adjusted in order to keep others from operating the controller or operation panel.
- 6) Turn off the controller and enter the safeguard enclosure.
- 7) Mark off the reference mark at the current origin position on the R-axis area of the robot.  
At this time, be careful not to touch the tool at the tip of the robot arm so that the origin position does not shift.
- 8) Use the hex wrench to loosen the two setscrews which fasten the dog ring on the R-axis area. (See Fig. 4-9.)

**⚠ CAUTION**

It is sufficient to loosen them. It is not necessary to completely remove them.

- 9) Refer to Fig. 4-9 and Table 4-2 and turn the dog ring to the minimum extent.
- 10) Tighten the setscrews to fasten the dog ring.
- 11) Go out of the safeguard enclosure, and check that no one is inside the safeguard enclosure. Then turn on the controller.
- 12) Perform the absolute reset from outside the safeguard enclosure.
- 13) After the absolute reset is completed, read the machine reference value displayed on the MPB/RPB.
- 14) If the machine reference value is in the range between 40 and 60 (recommended range), then the machine reference has been completely adjusted. If it is outside the recommended range, then repeat the procedure that starts in 5) to readjust it.

### 3-2 Changing the R-axis origin position

**⚠ CAUTION**

If the origin position has been changed, then the absolute reset must be performed, the machine reference must be adjusted, and point data must be reset.

---

The method to change the R-axis origin position is as follows.

- 1) Prepare the necessary tools.
  - Hex wrench set
- 2) Check that no one is inside the safeguard enclosure and then turn on the controller.
- 3) Perform the absolute reset from outside the safeguard enclosure. Refer to "3-3 Absolute reset procedures" for information about the absolute reset method.
- 4) Place a sign indicating that the robot is being adjusted in order to keep others from operating the controller or operation panel.
- 5) Turn off the controller and enter the safeguard enclosure.
- 6) Use the hex wrench to loosen the two setscrews which fasten the dog ring on the R-axis area. (See Fig. 4-9.)

**⚠ CAUTION**

It is sufficient to loosen them. It is not necessary to completely remove them.

---

- 7) Turn the dog ring to move the sensor detection area (dog) on the dog ring to the desired origin position.
- 8) Tighten the setscrews to fasten the dog ring.
- 9) Go out of the safeguard enclosure, and check that no one is inside the safeguard enclosure. Then turn on the controller.
- 10) Perform the absolute reset from outside the safeguard enclosure.
- 11) After the absolute reset is completed, read the machine reference value displayed on the MPB/RPB.
- 12) If the machine reference value is in the range between 40 and 60 (recommended range), then the origin position has been completely changed. If it is outside the recommended value, then adjust the machine reference by referring to "3-1 Adjusting the R-axis machine reference".

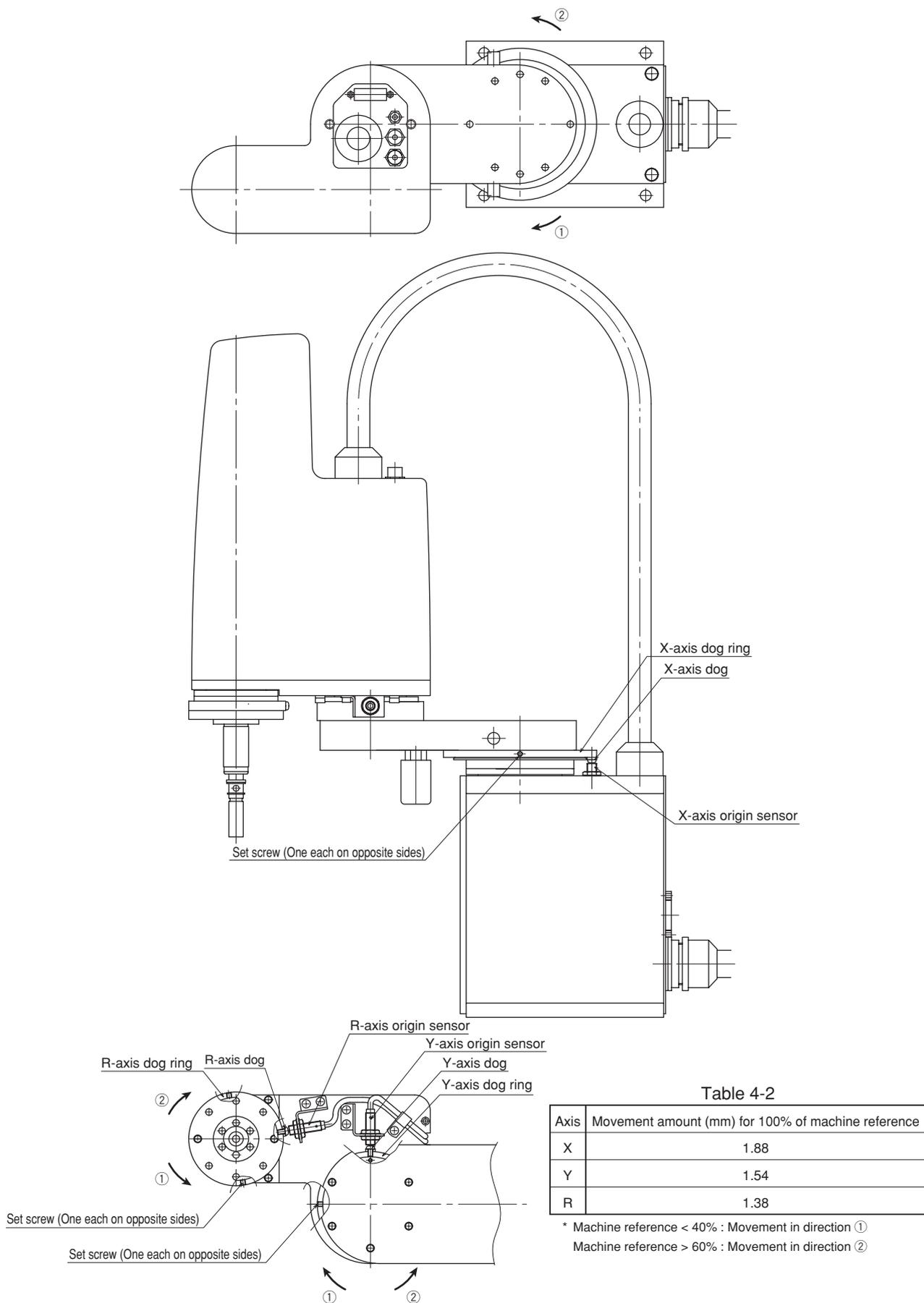


Fig. 4-9

### 3-4-1-2 YK500X, YK600X, YK700X, YK800X, YK1000X

#### 1-1 Adjusting the X-axis machine reference

The adjustment method for the X-axis machine reference is as follows.

- 1) Prepare the necessary tools.
  - Hex wrench set
- 2) Check that no one is inside the safeguard enclosure and then turn on the controller.
- 3) Perform the absolute reset from outside the safeguard enclosure.  
Refer to "3-3 Absolute reset procedures" for information about the absolute reset method.
- 4) If any machine reference value displayed on the MPB/RPB is not in the range between 40 and 60 (recommended range) after the absolute reset has been completed, then proceed with the following adjustment procedure.
- 5) Place a sign indicating that the robot is being adjusted in order to keep others from operating the controller or operation panel.
- 6) Turn off the controller and enter the safeguard enclosure.
- 7) Mark off the reference mark at the current origin position on the X-axis joint area of the robot.  
At this time, be careful to prevent the origin position from deviating since the X-axis arm is touched.
- 8) Use the hex wrench to loosen the two M4 bolts which fasten the dog plate to the X-axis joint area. (See Fig. 4-10.)

**CAUTION**

---

It is sufficient to loosen the M4 bolts. It is not necessary to completely remove them.

---

- 9) Refer to Fig. 4-10 and Table 4-3 and turn the dog ring to the minimum extent.
- 10) Tighten the M4 bolts to fasten the dog plate.
- 11) Go out of the safeguard enclosure, and check that no one is inside the safeguard enclosure. Then turn on the controller.
- 12) Perform the absolute reset from outside the safeguard enclosure.
- 13) After the absolute reset is completed, read the machine reference value displayed on the MPB/RPB.

- 14) If the machine reference value is in the range between 40 and 60 (recommended range), then the machine reference has been completely adjusted. If it is outside the recommended range, then repeat the procedure that starts in 5) to readjust it.

## 1-2 Changing the X-axis origin position

### **⚠ CAUTION**

---

If the origin position has been changed, then the absolute reset must be performed, the machine reference must be adjusted, and the standard coordinate and point data must be reset.

---

The method to change the X-axis origin position is as follows.

- 1) Prepare the necessary tools.
  - Hex wrench set
- 2) Check that no one is inside the safeguard enclosure and then turn on the controller.
- 3) Perform the absolute reset from outside the safeguard enclosure. Refer to "3-3 Absolute reset procedures" for information about the absolute reset method.
- 4) Place a sign indicating that the robot is being adjusted in order to keep others from operating the controller or operation panel.
- 5) Turn off the controller and enter the safeguard enclosure.
- 6) Use the hex wrench to loosen the two M4 bolts which fasten the dog plate to the X-axis joint area. (See Fig. 4-10.)
- 7) Move the dog plate to position the sensor detection area (dog) on the dog plate at the desired origin position.

### **⚠ CAUTION**

---

The upper and lower parts of the dog plate are symmetric. Move the dog plate to position it at the desired origin position.

---

- 8) Tighten the M4 bolts to fasten the dog plate.
- 9) Go out of the safeguard enclosure, and check that no one is inside the safeguard enclosure. Then turn on the controller.
- 10) Perform the absolute reset from outside the safeguard enclosure.
- 11) After the absolute reset is completed, read the machine reference value displayed on the MPB/RPB.
- 12) If the machine reference value is between 40 and 60 (recommended range), then the origin position has been completely changed. If it is outside the recommended range, then adjust the machine reference by referring to "1-1 Adjusting the X-axis machine reference".

## 2-1 Adjusting the Y-axis machine reference

The adjustment method for the Y-axis machine reference is as follows.

- 1) Prepare the necessary tools.
  - Hex wrench set
- 2) Check that no one is inside the safeguard enclosure and then turn on the controller.
- 3) Perform the absolute reset from outside the safeguard enclosure.  
Refer to "3-3 Absolute reset procedures" for information about the absolute reset method.
- 4) If any machine reference value displayed on the MPB/RPB is not in the range between 40 and 60 (recommended range) after the absolute reset has been completed, then proceed with the following adjustment procedure.
- 5) Place a sign indicating that the robot is being adjusted in order to keep others from operating the controller or operation panel.
- 6) Turn off the controller and enter the safeguard enclosure.
- 7) Mark off the reference mark at the current origin position on the Y-axis joint area of the robot.  
At this time, be careful to prevent the origin position from deviating since the Y-axis arm is touched.
- 8) Use the hex wrench to loosen two setscrews which fasten the dog ring of the Y-axis joint area. (See Fig. 4-10.)

---

**CAUTION**

The collar is placed between the setscrew and Y-axis arm.  
It is sufficient to loosen the setscrew. It is not necessary to completely remove it.

---

- 9) Refer to Fig. 4-10 and Table 4-3 and turn the dog ring to the minimum extent.
- 10) Tighten the setscrews to fasten the dog ring.

---

**CAUTION**

Depending on the origin position, the dog ring may not be able to be fastened with the two setscrews.  
In this case, fasten the dog ring with one setscrew.

---

- 11) Go out of the safeguard enclosure, and check that no one is inside the safeguard enclosure. Then turn on the controller.

- 12) Perform the absolute reset from outside the safeguard enclosure.
- 13) After the absolute reset is completed, read the machine reference value displayed on the MPB/RPB.
- 14) If the machine reference value is in the range between 40 and 60 (recommended range), then the machine reference has been completely adjusted. If it is outside the recommended range, then repeat the procedure that starts in 5) to readjust it.

## 2-2 Changing the Y-axis origin position

### **⚠ CAUTION**

If the origin position has been changed, then the absolute reset must be performed, the machine reference must be adjusted, and the standard coordinate and point data must be reset.

The method to change the Y-axis origin position is as follows.

- 1) Prepare the necessary tools.
  - Hex wrench set
- 2) Check that no one is inside the safeguard enclosure and then turn on the controller.
- 3) Perform the absolute reset from outside the safeguard enclosure.  
Refer to "3-3 Absolute reset procedures" for information about the absolute reset method.
- 4) Place a sign indicating that the robot is being adjusted in order to keep others from operating the controller or operation panel.
- 5) Turn off the controller and enter the safeguard enclosure.
- 6) Use the hex wrench to loosen two setscrews which fasten the dog ring of the Y-axis joint area. (See Fig. 4-10.)

### **⚠ CAUTION**

The collar is placed between the setscrew and Y-axis arm.  
It is sufficient to loosen the setscrew. It is not necessary to completely remove it.

- 7) Turn the dog ring to move the sensor detection area (dog) on the dog ring to the desired origin position.
- 8) Tighten the setscrews to fasten the dog ring.

### **⚠ CAUTION**

Depending on the origin position, the dog ring may not be able to be fastened with the two setscrews.  
In this case, fasten the dog ring with one setscrew.

- 9) Go out of the safeguard enclosure, and check that no one is inside the safeguard enclosure. Then turn on the controller.
- 10) Perform the absolute reset from outside the safeguard enclosure.

- 11) After the absolute reset is completed, read the machine reference value displayed on the MPB/RPB.
- 12) If the machine reference value is between 40 and 60 (recommended range), then the origin position has been completely changed.  
If it is outside the recommended range, then adjust the machine reference by referring to "2-1 Adjusting the Y-axis machine reference".

### 3-1 Adjusting the R-axis machine reference

The adjustment method for the R-axis machine reference is as follows.

- 1) Prepare the necessary tools.
  - Hex wrench set
- 2) Check that no one is inside the safeguard enclosure and then turn on the controller.
- 3) Perform the absolute reset from outside the safeguard enclosure. Refer to "3-3 Absolute reset procedures" for information about the absolute reset method.
- 4) If any machine reference value displayed on the MPB/RPB is not in the range between 40 and 60 (recommended range) after the absolute reset has been completed, then proceed with the following adjustment procedure.
- 5) Place a sign indicating that the robot is being adjusted in order to keep others from operating the controller or operation panel.
- 6) Turn off the controller and enter the safeguard enclosure.
- 7) Mark off the reference mark at the current origin position on the R-axis area of the robot.  
At this time, be careful not to touch the tool at the tip of the robot arm so that the origin position does not shift.
- 8) Use the hex wrench to loosen the two M4 bolts which fasten the dog ring on the R-axis area. (See Fig. 4-10.)

** CAUTION**

It is sufficient to loosen the M4 bolts. It is not necessary to completely remove them.

- 9) Refer to Fig. 4-10 and Table 4-3 and turn the dog ring to the minimum extent.
- 10) Tighten the M4 bolts to fasten the dog ring.
- 11) Go out of the safeguard enclosure, and check that no one is inside the safeguard enclosure. Then turn on the controller.
- 12) Perform the absolute reset from outside the safeguard enclosure.
- 13) After the absolute reset is completed, read the machine reference value displayed on the MPB/RPB.
- 14) If the machine reference value is in the range between 40 and 60 (recommended range), then the machine reference has been completely adjusted. If it is outside the recommended range, then repeat the procedure that starts in 5) to readjust it.

**3-2 R-axis origin position change**

The R-axis origin position cannot be changed on the YK500X, YK600X, YK700X, YK800X, and YK1000X.

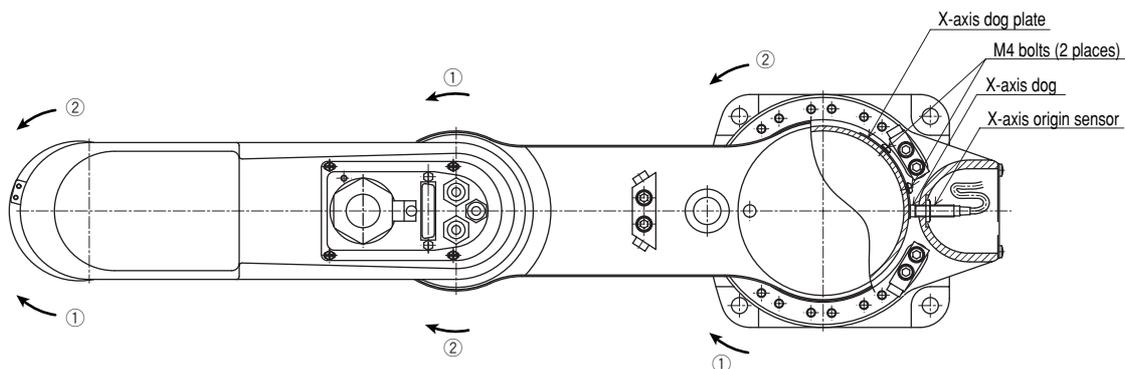


Table 4-3

Axis	Movement amount (mm) for 100% of machine reference	
	YK500X, YK600X	YK700X, YK800X, YK1000X
X	1.23	1.63 (YK1000X : 1.31)
Y	1.17	1.48
R	1.58	1.71

\* Machine reference < 40% : Movement in direction ①  
Machine reference > 60% : Movement in direction ②

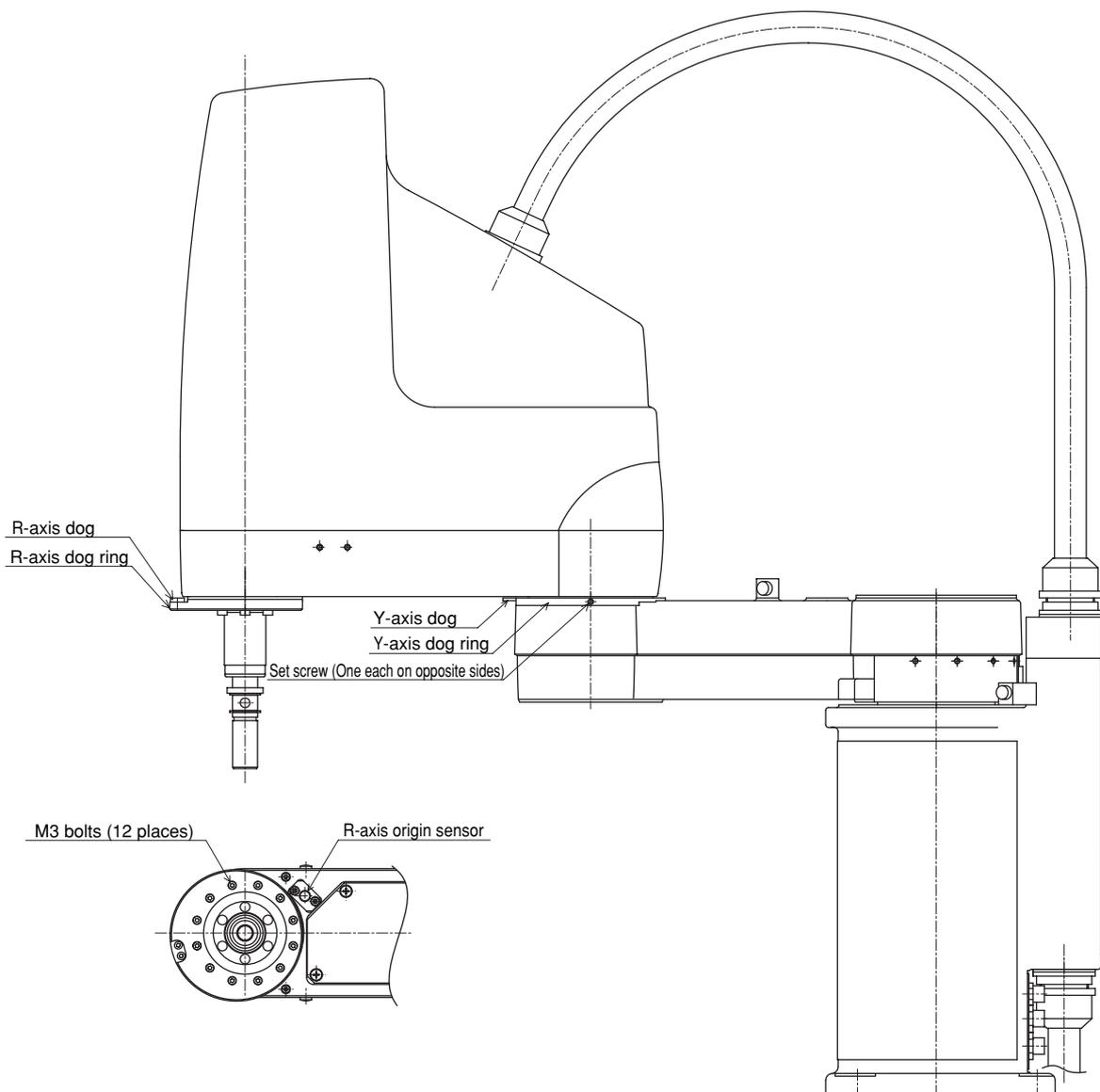
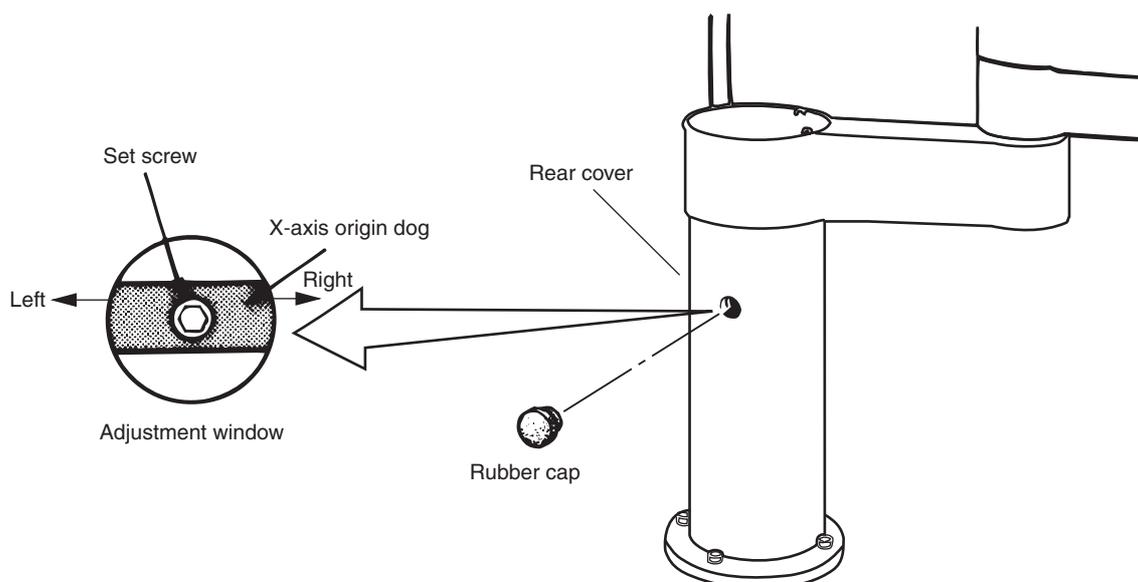


Fig. 4-10

**3-4-1-3 YK550X**

**1 Changing the X-axis origin position and adjusting the machine reference value**

- 1) Prepare the necessary tools.
  - Slotted screwdriver
  - Hex wrench set
  - Plastic hammer
- 2) Check that no one is inside the safeguard enclosure, and then turn on the controller.
- 3) Perform the absolute reset from outside the safeguard enclosure.  
Refer to "3-3 Absolute reset procedures" for information about the absolute reset method.
- 4) Check that return-to-origin is complete.
- 5) Turn off the controller.
- 6) Place a sign indicating the robot is being adjusted, to keep others from operating the controller switch.
- 7) Enter the safeguard enclosure.
- 8) Remove the cover on the left side of the robot base (pedestal) as viewed from the front and pry off the rubber cap with a slotted screwdriver. The X-axis origin dog and its mounting screw can be seen through the circular adjustment window. (See Fig. 4-11.)
- 9) Use the 2mm hex wrench to loosen the set screw of the X-axis origin dog (but, do not remove it).
- 10) With the 2mm hex wrench still inserted into the set screw, move the X-axis arm by hand to the desired origin position.
- 11) Move the X-axis origin dog so that the set screw is positioned in the center of the adjustment window.  
At this position the X-axis origin sensor is aligned with the origin dog.
- 12) Tighten the set screw of the X-axis origin dog.



**Fig. 4-11 X-axis origin dog**

- 13) Go outside the safeguard enclosure, check that no one is inside the safeguard enclosure, and turn on the controller. Then perform absolute reset and check the X-axis origin position when return-to-origin is complete.
- 14) Check the machine reference value displayed on the MPB/RPB. When it is within the allowable range (between 40 and 60%), the X-axis origin adjustment is now complete. If the machine reference value is outside the allowable range, make a note of the machine reference value and make adjustment with the following procedure.
- 15) Turn off the controller.
- 16) Enter the safeguard enclosure.
- 17) Loosen the set screw and move the X-axis origin dog as indicated in NOTE below. Retighten the set screw, then repeat the above procedure from step 13) until the X-axis machine reference value is set within the allowable range.

**NOTE**

Move the origin dog as follows:

X-axis machine reference value < 40% : Turn to the left.

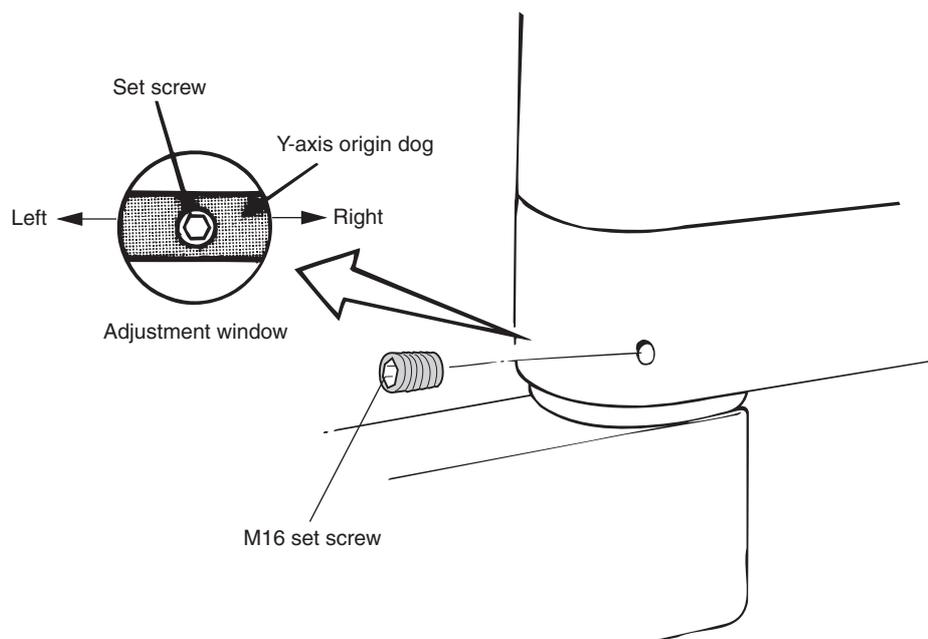
X-axis machine reference value > 60% : Turn to the right.

As an approximate guide, a 1.2mm movement equals 100%.

- 18) After adjustment is complete, turn off the controller. Then enter the safeguard enclosure, refit the rubber cap by tapping it with a plastic hammer, and reattach the cover.

## 2 Changing the Y-axis origin position and adjusting the machine reference value

- 1) Prepare the necessary tools.
  - Hex wrench set
- 2) Check that no one is inside the safeguard enclosure, and then turn on the controller.
- 3) Perform the absolute reset from outside the safeguard enclosure. Refer to "3-3 Absolute reset procedures" for information about the absolute reset method.
- 4) Check that return-to-origin is complete.
- 5) Turn off the controller.
- 6) Place a sign indicating the robot is being adjusted, to keep others from operating the controller switch.
- 7) Enter the safeguard enclosure.
- 8) Remove the M16 set screw located on the Y-axis arm joint with the 8mm hex wrench. The Y-axis origin dog and set screw can be seen through the adjustment window. (See Fig. 4-12)
- 9) Use the 2mm hex wrench to loosen the set screw of the Y-axis origin dog (but, do not remove it).
- 10) With the 2mm hex wrench still inserted into the set screw, move the Y-axis arm by hand to the desired origin position.
- 11) Move the Y-axis origin dog so that the set screw is positioned in the center of the adjustment window.  
At this position the Y-axis origin sensor is aligned with the origin dog.
- 12) Tighten the set screw of the Y-axis origin dog.



**Fig. 4-12 Y-axis origin dog**

- 13) Go outside the safeguard enclosure, check that no one is inside the safeguard enclosure, and turn on the controller. Then perform absolute reset and check the Y-axis origin position when return-to-origin is complete.
- 14) Check the machine reference value displayed on the MPB/RPB. When it is within the allowable range (between 40 and 60%), the Y-axis origin adjustment is now complete. If the machine reference value is outside the allowable range, make a note of the machine reference value and make adjustment with the following procedure.
- 15) Turn off the controller.
- 16) Enter the safeguard enclosure.
- 17) Loosen the set screw and move the Y-axis origin dog as indicated in NOTE below. Retighten the set screw, then repeat the above procedure from step 13) until the Y-axis machine reference value is set within the allowable range.

**NOTE**

Move the origin dog as follows:

Y-axis machine reference value < 40% : Turn to the right.

Y-axis machine reference value > 60% : Turn to the left.

As an approximate guide, a 0.8mm movement equals 100%.

- 18) After adjustment is complete, turn off the controller, then enter the safeguard enclosure and reattach the M16 set screw by tightening it.

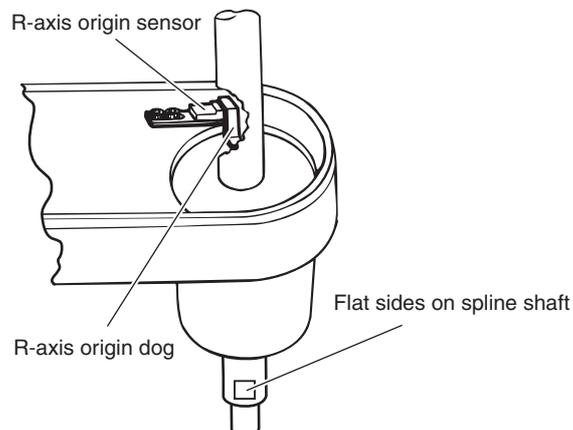
### 3 Changing the R-axis origin position and adjusting the machine reference value

The R-axis origin position is fixed and cannot be changed. The R-axis machine reference value is preadjusted before shipment and does not deviate from the allowable range (40 to 60%) during normal operation. However, if for some reason the machine reference value goes outside the allowable range, adjust as needed with the procedure below.

**CAUTION**

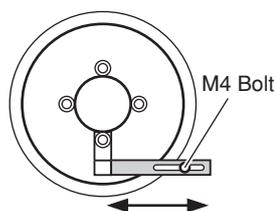
The origin position may shift if the origin sensor is moved too far.

- 1) Prepare the necessary tools.
  - Phillips screwdriver
  - Hex wrench set
  - 14mm wrench
- 2) Check that no one is inside the safeguard enclosure, and then turn on the controller.
- 3) Perform the absolute reset from outside the safeguard enclosure. Refer to "3-3 Absolute reset procedures" for information about the absolute reset method.
- 4) After return-to-origin is complete, note the R-axis machine reference value displayed on the MPB/RPB. When this value is within the allowable range (40 to 60%), no adjustment is required. If not, adjust as follows.
- 5) Turn off the controller.
- 6) Place a sign indicating the robot is being adjusted, to keep others from operating the controller switch.
- 7) Enter the safeguard enclosure.
- 8) Remove the cover on the Y-axis arm. (See Fig. 4-21.) Place the cover on the robot pedestal side with the machine harness still connected. The R-axis origin sensor and dog can be seen at the location shown in Figure 4-13.



**Fig. 4-13 R-axis origin sensor and origin dog**

- 9) Put a mark on the current position of the R-axis origin sensor, then loosen the bolts (M4, 1 piece) securing the installation plate of the R-axis origin sensor. (See Fig. 4-14.)



**Fig. 4-14 Adjusting the R-axis origin sensor**

- 10) Move the R-axis origin sensor as indicated in NOTE below.

**NOTE**

Move the origin sensor as follows:

R-axis machine reference value < 40% : Move to the right.

R-axis machine reference value > 60% : Move to the left.

As an approximate guide, a 0.8mm movement equals 100%. (1.3mm/100% for high-speed R-axis specifications)

- 11) Retighten the bolts to secure the installation plate.  
Place the 10mm wrench on the flat sides on the spline shaft and turn it to check that the origin sensor does not touch the origin dog. If the origin sensor touches the origin dog, adjust the position of the origin sensor so that they do not interfere with each other.
- 12) Go outside the safeguard enclosure, check that no one is inside the safeguard enclosure, and turn on the controller. Then perform absolute reset and check the R-axis machine reference value when return-to-origin is complete.
- 13) Repeat the above steps until the R-axis machine reference value is set within the allowable range.
- 14) After adjustment is complete, turn off the controller, then enter the safeguard enclosure and reattach the cover to the Y-axis arm.

### 3-4-2 Mark method

In the mark method, the origin position can be changed with the absolute reset at the desired position.

It is not necessary to adjust the machine reference.

Refer to "Chapter 4, 3-3 Absolute reset procedures" for information about the absolute reset method with the mark method.

---

**▲ CAUTION**

If the origin position has been changed, then the absolute reset must be performed and the standard coordinate and point data must be reset.

---

**▲ CAUTION**

Mark off the reference mark at the position where the absolute reset is performed so that the absolute reset position can be easily checked the next time an absolute reset is performed.

Unless it can be precisely checked, then the repeatability of the absolute reset position cannot be assured.

Refer to "Chapter 4, 3-3 Absolute reset procedures" for information about the absolute reset.

---

### 3-4-3 Stroke end method

The stroke end method is employed on the YK-X series robots for the absolute reset of the Z-axis.

The origin position of the Z-axis is fixed at the upper end of the Z-axis stroke, and it cannot be changed.

The machine reference is factory-adjusted at shipment, and readjustment is not necessary for normal use.

The readjustment in the following procedure is required, however, if the machine reference exceeds the tolerance range (26 to 74) of the absolute reset for any reason.

#### **⚠ WARNING**

Injury can occur if hands or fingers are squeezed between the drive pulley and belt. Always turn off the controller and use caution when handling these parts.

#### **⚠ CAUTION**

The positional shift will occur after adjusting the machine reference value, so point data settings are required again.

#### 3-4-3-1 YK250X(H), YK350X(H), YK400X(H), YK500X, YK600X, YK700X, YK800X, YK1000X, YK1200X

- 1) Check that no one is inside the safeguard enclosure, and then turn on the controller.
- 2) Place a sign indicating the robot is being adjusted, to keep others from operating the controller or operation panel.
- 3) Perform the Z-axis absolute reset.  
To perform the Z-axis absolute reset, see "3-3 Absolute reset procedures" in Chapter 4.
- 4) Turn off the controller.
- 5) Enter the safeguard enclosure.
- 6) Remove the Y-axis upper cover and under cover (YK500X to YK1000X).  
To remove the covers, see "7 Removing the Robot Covers" in Chapter 4.  
Place the upper cover on the robot base (pedestal) side with the machine harness still connected.
- 7) Prop the spline or end effector with a support stand to prevent the Z-axis from dropping.

- 8) Remove the bolts securing the Z-axis motor (See Figs. 4-15 to 4-18) and then remove the Z-axis motor.

**⚠ WARNING**

If the Z-axis motor comes off the Z-axis belt, the Z-axis drops causing a hazardous situation. Be sure to prop the Z-axis with a support stand.

---

- 9) Adjust the distance (L) between the Z-axis mechanical stopper and the axis end so it is set to the value shown in Table 4-4. Then tighten the four bolts to reassemble the Z-axis motor. (See Fig. 4-19, Fig4-20.) At this point, do not allow the spline shaft position to shift from the correct height.
- 10) After reassembling the Z-axis motor, adjust the timing belt tension.  
To adjust the timing belt tension, see "8 Adjusting the Timing Belt Tension" in Chapter 4.
- 11) Reattach the Y-axis upper cover and under cover (YK500X to YK1000X).  
To attach the covers, see "7 Removing the Robot Covers" in Chapter 4.
- 12) Go outside the safeguard enclosure.
- 13) Check that no one is inside the safeguard enclosure, and then turn on the controller.

## 14) Perform the Z-axis absolute reset.

To perform the Z-axis absolute reset, see "3-3 Absolute reset procedures" in Chapter 4.

After absolute reset is complete, use the following procedure to check if the **adjustment machine reference value** is within the tolerance range (26 and 74).

**CAUTION**

The **adjustment machine reference value** is displayed with the procedure below.

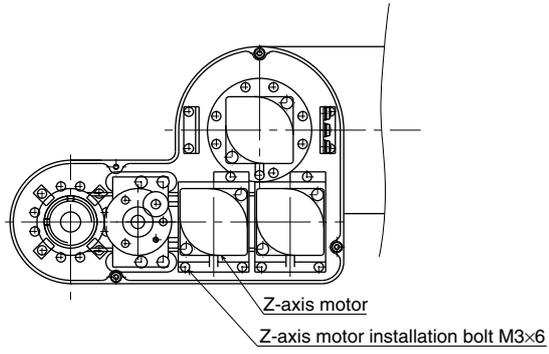
Always check the **adjustment machine reference value** when the machine reference is adjusted.

- ① Press the MODE key.
- ② Press the F3 key to set MANUAL mode.
- ③ Press the F13 (LOWER+F3) key to select "RST. ABS".
- ④ After the Z-axis absolute reset is complete, press the F10 (UPPER+F5) to display the **adjustment machine reference value (%)**.

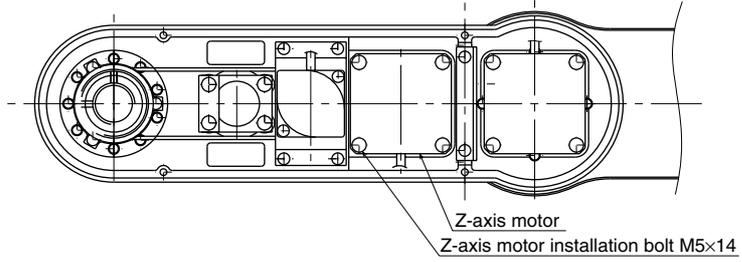
If **adjustment machine reference value** is outside the absolute reset tolerance range (26 to 74), remove the Z-axis motor again and make fine-adjustment to the spline shaft height, so that the **adjustment machine reference value** is within the absolute reset tolerance range.

Table 4-4

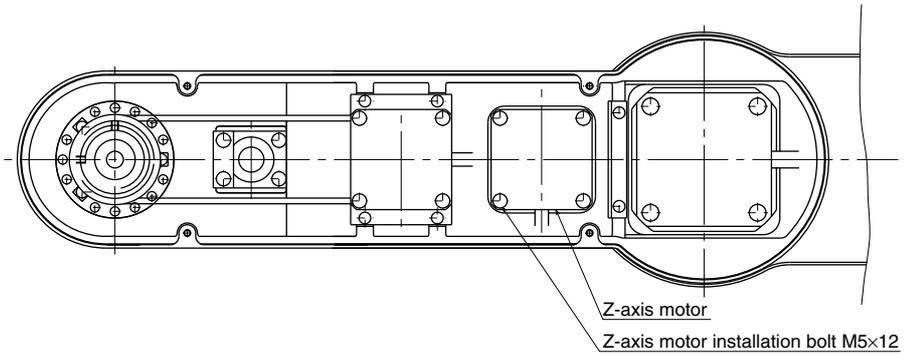
Robot Model	L
YK250X, YK350X, YK400X	5mm
YK250XH, YK350XH, YK400XH	4mm
YK500X, YK600X	8mm
YK700X, YK800X, 1000X	8mm
YK1200X	21mm



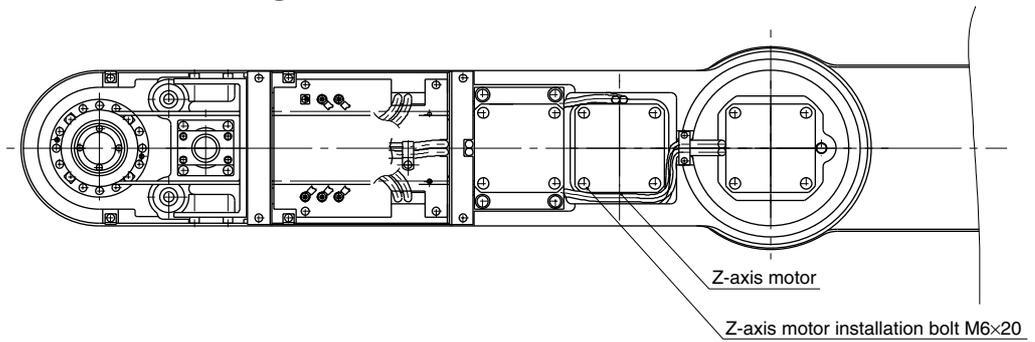
**Fig. 4-15 YK250X(H), YK350X(H), YK400X(H)**



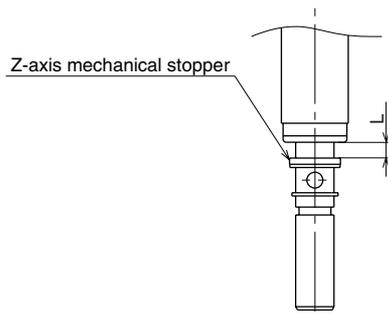
**Fig. 4-16 YK500X, YK600X**



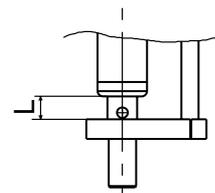
**Fig. 4-17 YK700X, YK800X, YK1000X**



**Fig. 4-18 YK1200X**



**YK250X(H) to YK400X(H),  
Fig. 4-19 YK500X to YK1000X**



**Fig. 4-20 YK1200X**

**3-4-3-2 YK550X**

- 1) Prepare the necessary tools.
  - Hex wrench set
  - Phillips screwdriver
  - Support stand
  - Ruler
- 2) Check that no one is inside the safeguard enclosure, and then turn on the controller.
- 3) Perform the absolute reset from outside the safeguard enclosure.  
Refer to "3-3 Absolute reset procedures" for information about the absolute reset method.  
To check the machine reference value, refer to step 14) in section 3-4-3-1.
- 4) After return-to-origin is complete, check the Z-axis machine reference value displayed on the MPB/RPB. When this value is within the allowable range (40 to 60%), no adjustment is required. If not, adjust as follows.
- 5) Turn off the controller.
- 6) Place a sign indicating the robot is being adjusted, to keep others from operating the controller switch.
- 7) Enter the safeguard enclosure.
- 8) Remove the screws (7 pieces) securing the upper cover on the Y-axis arm and remove the cover. Place the cover on the robot pedestal side with the machine harness still connected. Also remove the Y-axis arm under covers.
- 9) Before removing the Z-axis motor, use a support stand to prop the spline or end effector to prevent it from dropping along the Z-axis. Then, remove the four M4 bolts on the Z-axis motor underplate, but do not remove the bolts securing the Z-axis motor. It is unnecessary to remove the Z-axis motor underplate from the arm.

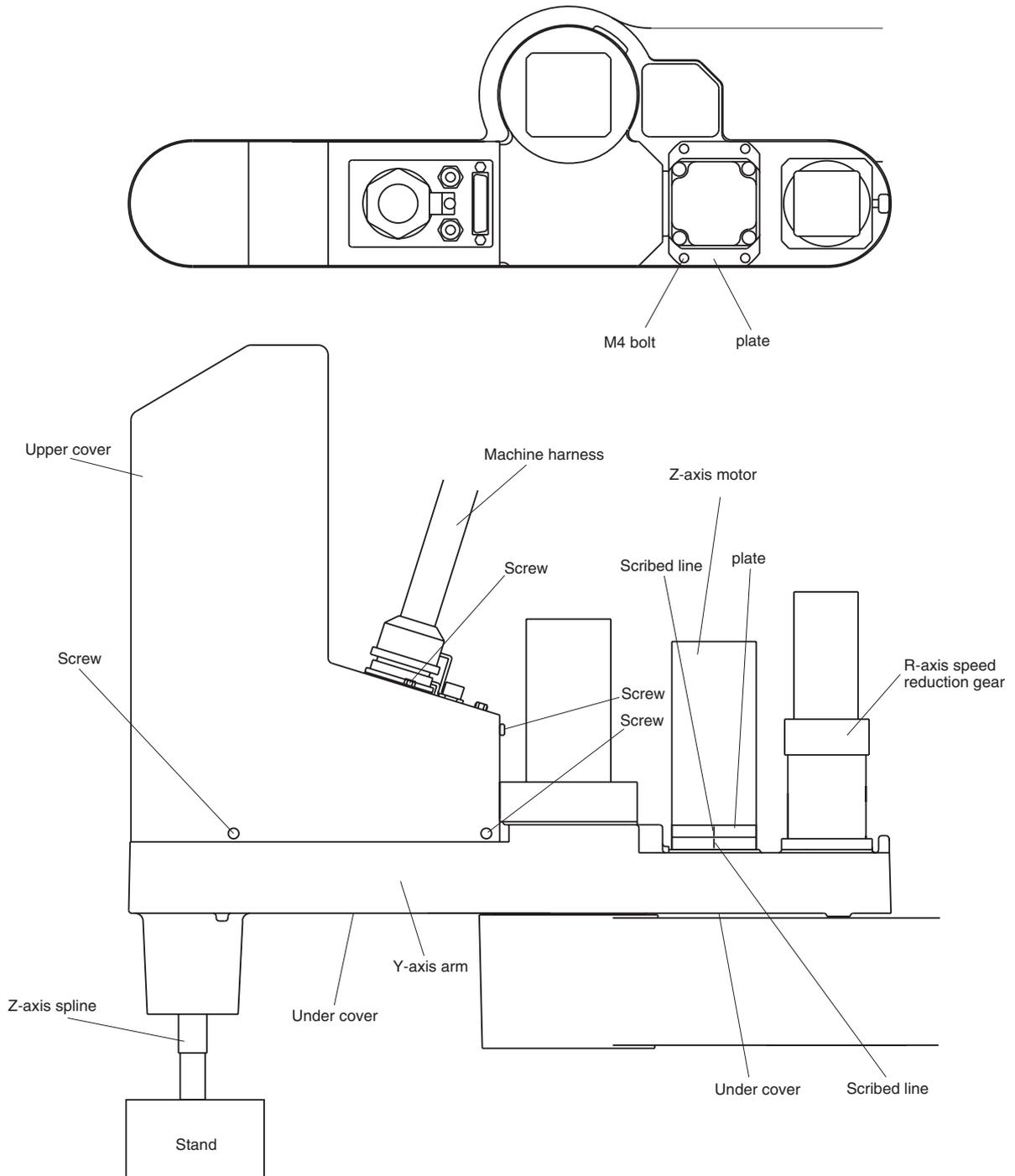


Fig. 4-21

- 10) Adjust the height of the support stand so that the distance between the urethane damper and the upper face of the ball screw nut is 12mm as shown in Fig. 4-22. Then, fit the Z-axis belt on the Z-axis motor pulley.
- 11) Lightly tighten the bolts to temporarily fasten the Z-axis motor underplate until it has no play in the vertical direction.
- 12) Viewing from the bottom of the Y-axis arm, check that the belt is properly engaged with the Z-axis motor pulley and ball screw pulley.
- 13) Pull the Z-axis motor in the direction of arrow and align the scribed lines (on both sides of the X-axis motor underplate) with the reference scribed lines. While maintaining this position, tighten the four M4 bolts to 4.5Nm (46kgf·cm) to secure the Z-axis motor underplate.

**▲ CAUTION**

---

If the scribed lines on the Z-axis motor underplate do not reach the reference scribed lines, the belt teeth may slip on the pulley. If they exceed the reference scribe lines on the arm, the Z-axis drive unit may wear out quickly. Align the scribed lines exactly.

---

- 14) Go outside the safeguard enclosure, check that no one is inside the safeguard enclosure, and turn on the controller. Then perform absolute reset.
- 15) Check that the Z-axis machine reference value is within the allowable range (40 to 60%).
- 16) After adjustment is complete, turn off the controller, then enter the safeguard enclosure and reattach the covers to the Y-axis arm.

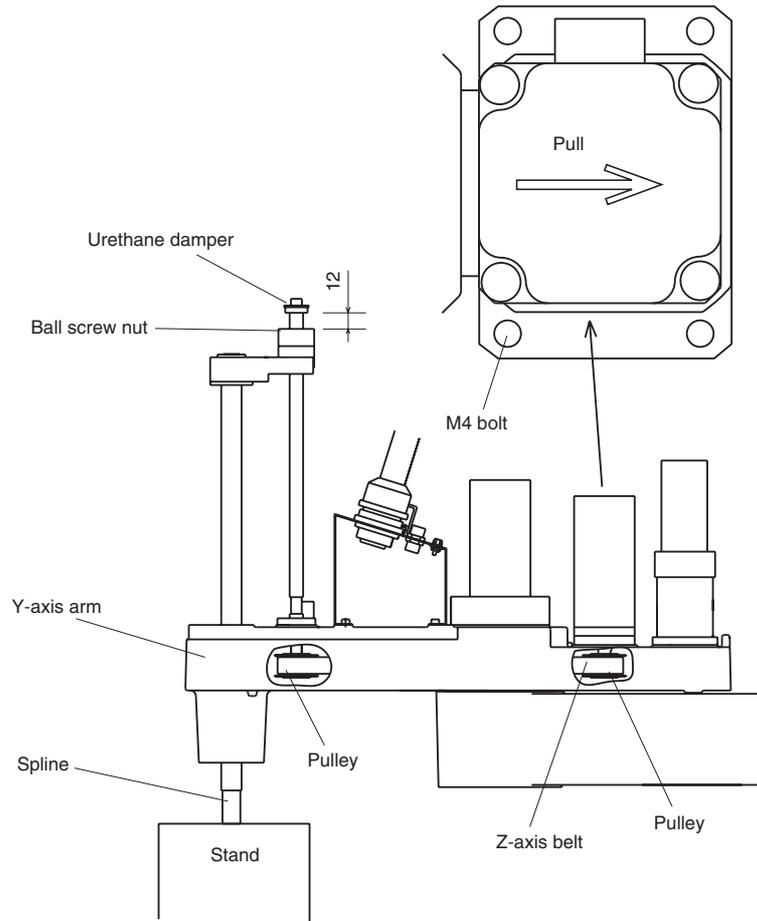


Fig. 4-22

## 4 Setting the Soft Limits

In the YK-X series, the working envelope during manual and automatic operation can be limited by setting the plus soft limit [pulse] and minus soft limit [pulse] on each axis.

The origin point ( 0 [pulse] ) is used as the reference to set the soft limits. The working envelope can be limited by specifying the number of pulses from the 0 pulse position. Refer to the "YAMAHA Robot Controller User's Manual" for further details. Also refer to "1-2 External view and dimensions" in Chapter 7 for robot working envelopes.

When performing actual checks of the soft limit settings, operate the robot manually from outside the safeguard enclosure.

### (1) Setting the X-axis and Y-axis soft limits

The soft limits must be set within the movement range limited by the mechanical stoppers as explained in Section 7 in Chapter 3 or within the range where the manipulator does not interfere with the peripheral equipment (but within maximum working envelope). Set the soft limits with the following procedure. Also use this procedure when the origin position has been changed. Likewise, in models where the mechanical stopper position cannot be changed, reduce the soft limits to narrow the working envelope when the actual working range of the robot is small or the manipulator interferes with the peripheral equipment.

- 1) Check that no one is inside the safeguard enclosure, and then turn on the controller.
- 2) Press the emergency stop button on the MPB/RPB to set emergency stop. Refer to the "YAMAHA Robot Controller User's Manual" for further details on emergency stop and canceling emergency stop.
- 3) Place a sign indicating the robot is being adjusted, to keep others from operating the controller or operation panel.
- 4) Enter the safeguard enclosure while holding the MPB/RPB.
- 5) Move the X-axis and Y-axis arms by hand to the mechanical stopper positions or to the point where interference with the peripheral equipment occurs, and note the X-axis and Y-axis plus (+) and minus (-) direction pulses displayed on the MPB/RPB.
- 6) Check that no one is inside the safeguard enclosure, then cancel emergency stop from outside the safeguard enclosure.
- 7) Set the soft limits to within the figure for the X-axis and Y-axis encoder pulses that you noted above in step 5). This software limit setting must be made from outside the safeguard enclosure.  
Refer to the "YAMAHA Robot Controller User's Manual" for further details on soft limit settings.

**⚠ CAUTION**

The origin position factory-adjusted at shipment is not completely aligned with the front face position of the robot.

When introducing the robot, be sure to set the soft limits with the number of pulses from the origin position (0 pulse position).

---

(2) Setting the Z-axis soft limits

Make this setting from outside the safeguard enclosure.

The Z-axis has mechanical stoppers fixed at the upper and lower ends of the Z-axis movement range. When the actual working range of the robot is smaller than the maximum working envelope or the manipulator interferes with the peripheral equipment, reduce the Z-axis plus (+) soft limit [pulses] to narrow the working envelope.

(3) Setting the R-axis soft limit

To make this setting, set emergency stop just as for the X-axis and Y-axis, or be sure to do this from outside the safeguard enclosure. The R-axis has no mechanical stoppers. When the actual working range of the R-axis is small or it interferes with the peripheral equipment, reduce the R axis plus (+) soft limit [pulse] and minus (-) soft limit [pulses] to narrow the working envelope.

**CAUTION**

Overloads may occur if the soft limit is almost near the encoder pulse at the mechanical stopper and the operating point is used at the edge of the movement range. Set the soft limit to the inner side of the mechanical stopper with an ample safety margin.

(4) Relation between the X, Y and R-axis movement angle, the Z-axis movement distance and the number of pulses

The tables below are for calculating resolver pulses with respect to the X, Y and R-axis movement angles and to the Z-axis movement distance for each robot. Use these figures as a guide to set the soft limits.

X, Y and R-axis speed reduction ratio and Z-axis ball screw lead for each robot

Robot model	X-axis	Y-axis	Z-axis	R-axis
YK250X(H), YK350X(H), YK400X(H)	50	50	12mm	50
YK500X, YK600X	80	80	20mm	50
YK700X, YK800X	80	80	20mm	50
YK1000X	100	80	20mm	50
YK1200X	121	105	10mm	50
YK550X	50	50	30mm	50
YK550X with high-speed R-axis specifications	50	50	30mm	30

Operation angle/distance vs. number of resolver pulses

X, Y and R-axis speed reduction ratio

Speed ratio	Number of resolver pulses per turn (360 degrees)
30	491520
50	819200
80	1310720
100	1638400
105	1720320
121	1982464

Z-axis

Lead	Number of resolver pulses per lead movement
10mm	16384
12mm	16384
20mm	16384
30mm	16384

## 5 Setting the Standard Coordinates

### CAUTION

If the standard coordinate settings are incorrect, the acceleration cannot be optimized to match the arm position. This results in too short a service life, damage to the drive unit, or residual vibration during positioning. In addition, the cartesian coordinate accuracy will be impaired.

Setting the standard coordinates enables the following operations and functions.

1. Optimizes acceleration according to arm position during automatic operation.
2. Allows moving robot arm tip at right angles.
3. Allows using shift coordinates.
4. Enables commands such as linear interpolation and arm switching.

The procedure for setting standard coordinates and cautions are shown below.

- 1) Check that no one is inside the safeguard enclosure, and then turn on the controller.
- 2) Check that the soft limits are correctly set.  
If not correctly set, adjust the soft limits while referring to the description of "4 Setting the Soft Limits" in Chapter 4.
- 3) Place a sign indicating the robot is being adjusted, to keep others from operating the controller or operation panel.
- 4) Enter the safeguard enclosure while holding the MPB/RPB. Stay outside the robot movement range at this time.
- 5) Make the standard coordinate settings while referring to methods for "Setting the Standard Coordinates" as explained in the "YAMAHA Robot Controller User's Manual". Never enter within the robot movement range.
- 6) When the standard coordinate settings are complete, check the following points from outside the safeguard enclosure.
  1. Check that the robot arm tip can move at right angles in MANUAL operation (cartesian coordinates).
  2. Check that the values nearly equal to the X-axis and Y-axis arm lengths are entered in "Arm length" of the axis parameters.If the above points are not satisfied, the standard coordinate settings are incorrect, so make the standard coordinate settings again.

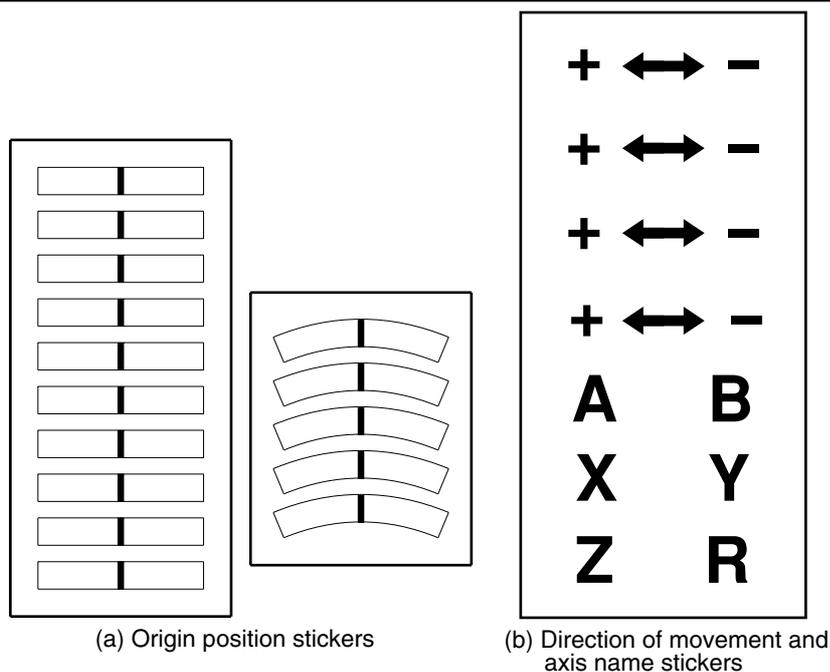
## 6 Affixing Stickers for Origin Positions, Movement Directions and Axis Names

The robot comes packed with stickers showing origin positions, movement directions and axis names as shown in Fig. 4-23. Using the following procedure, attach these stickers in conspicuous points on the robot after changing the origin position and installing peripheral equipment.

- 1) Check that no one is inside the safeguard enclosure, and then turn on the controller.
- 2) Move the robot to the 0 pulse position.  
To move the axes to their "0" pulse positions, see "Chapter 4 Point trace function" in the "YAMAHA Robot Controller User's Manual".
- 3) Turn off the controller.
- 4) Place a sign indicating the robot is being adjusted, to keep others from operating the controller switch.
- 5) Enter the safeguard enclosure.
- 6) Being careful not to move the origin positions, attach stickers at conspicuous points on matching sides of components such as the robot arm of each axis, base (robot pedestal) and end effector. Affix stickers nearby showing the axis name and direction of movement. Use a cloth moistened with alcohol to remove grease from the surface where you will affix the stickers. After the surface is dry, affix the stickers securely. (See Fig. 4-24)

### **⚠ WARNING**

Affix the origin position stickers precisely on the origin positions. Align the direction of movement stickers with the jog direction and affix them correctly. Affix each axis name sticker on the correct axis. Affixing the sticker at a wrong location may cause faulty operation and hazardous situations.



**Fig. 4-23**

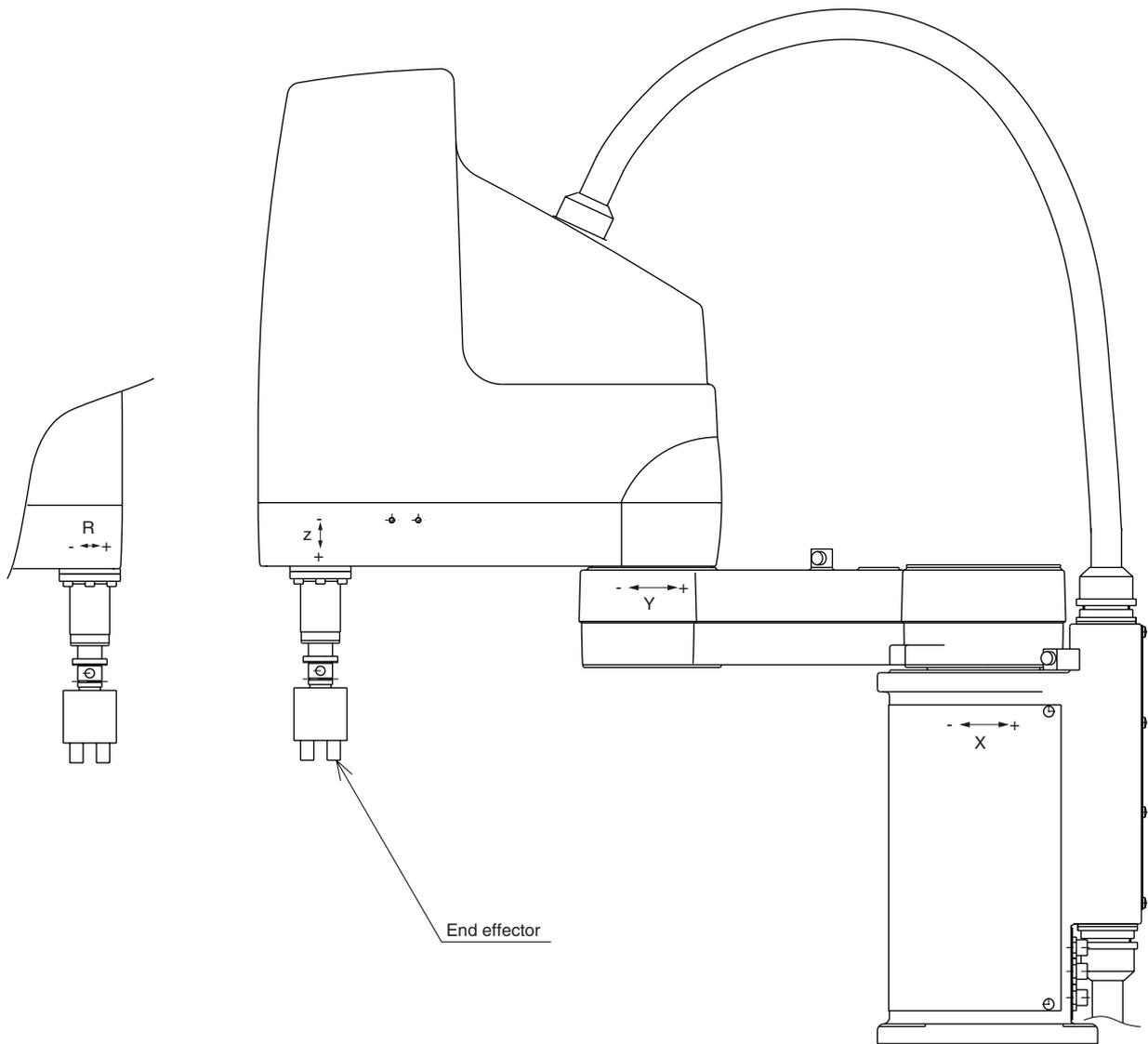


Fig. 4-24 Positions for affixing the stickers (YK500X)

## 7 Removing the Robot Covers

To remove the robot cover, follow the procedure below.

- 1) Prepare the necessary tools.
  - Hex wrench set
  - Phillips-head screwdriver
- 2) Turn off the controller.
- 3) Place a sign indicating the robot is being adjusted, to keep others from operating the controller switch.
- 4) Enter the safeguard enclosure.
- 5) Remove the covers while referring to Fig. 4-25 to Fig. 4-28.  
Screws used to fasten each cover are listed in Tables 4-5 to 4-8.

**Table 4-5 YK250X(H), YK350X(H), YK400X(H) (See Fig. 4-25)**

Cover name	Screw No.	Screw size	Qty
Base (robot pedestal) rear cover	①	M4×6	4
Base (robot pedestal) front cover	②	M4×6	4
Y-axis arm upper cover	③	M3×6	2
	④	M3×10	2
	⑤	M3×16	2

**Table 4-6 YK500X, YK600X (See Fig. 4-26)**

Cover name	Screw No.	Screw size	Qty
Base (robot pedestal) rear cover 1	①	M4×6	8
Base (robot pedestal) rear cover 2	②	M4×6	4
Base (robot pedestal) front cover	③	M4×6	8
X-axis arm upper cover	④	M4×6	2
Y-axis arm upper cover	⑤	M3×6	4
	⑥	M3×50	4
Y-axis arm under cover	⑦	M4×6	4

**Table 4-7 YK700X, YK800X, YK1000X (See Fig. 4-27)**

Cover name	Screw No.	Screw size	Qty
Base (robot pedestal) rear cover 1	①	M4×6	8
Base (robot pedestal) rear cover 2	②	M4×6	4
Base (robot pedestal) front cover	③	M4×6	8
X-axis arm upper cover	④	M4×8	2
Y-axis arm upper cover	⑤	M4×6	4
	⑥	M4×50	4
Y-axis arm under cover	⑦	M4×6	4 (6 for YK1000X)

**Table 4-8 YK1200X (See Fig. 4-28)**

Cover name	Screw No.	Screw size	Qty
Base (robot pedestal) rear cover 1	①	M4×6	8
Base (robot pedestal) rear cover 2	②	M4×6	4
Base (robot pedestal) front cover	③	M4×6	4
X-axis arm upper cover	④	M4×6	2
X-axis arm under cover	⑤	M4×6	2
Y-axis arm front cover	⑥	M4×6	14
Y-axis arm side cover	⑦	M4×6	10

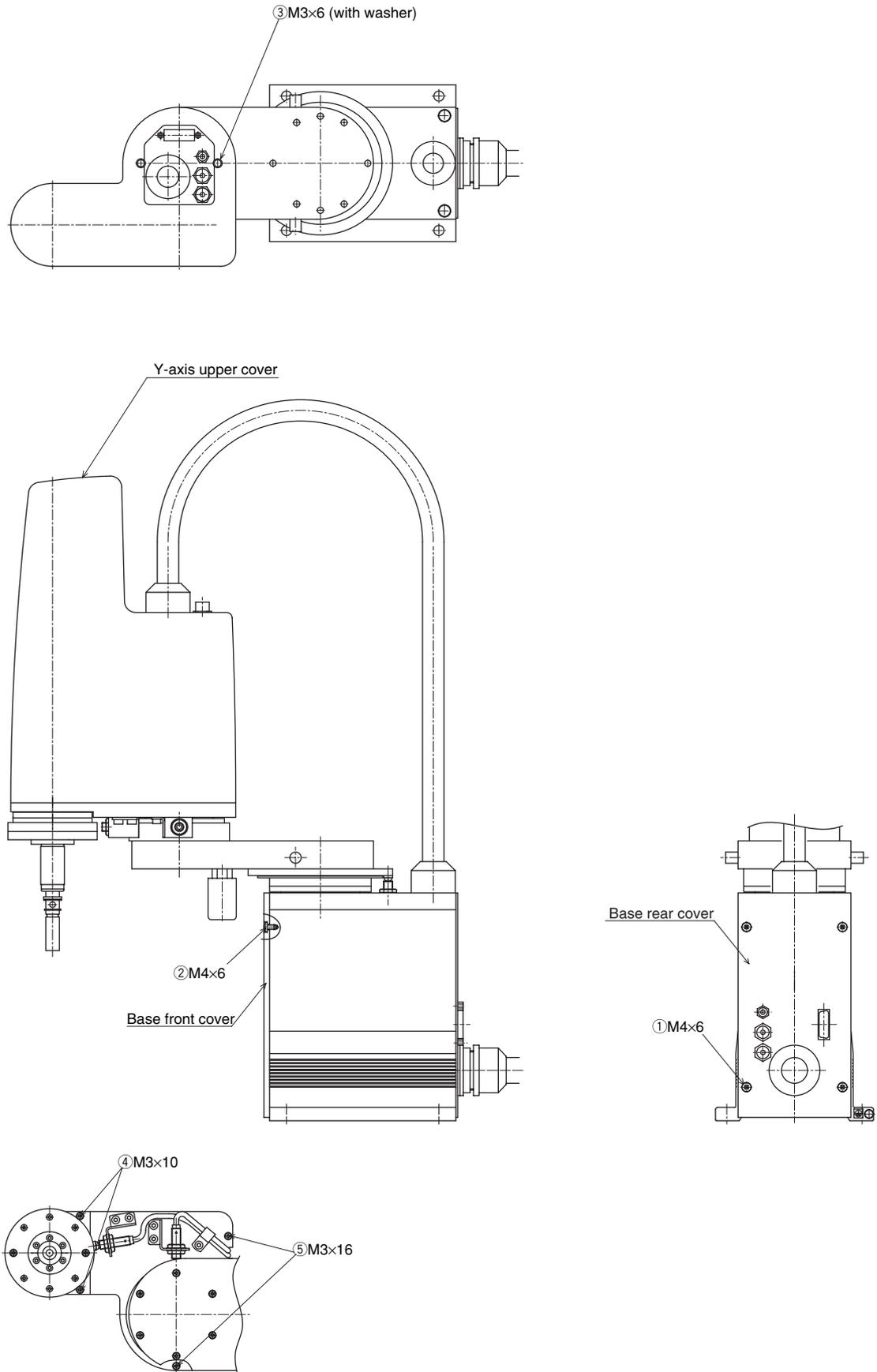


Fig. 4-25

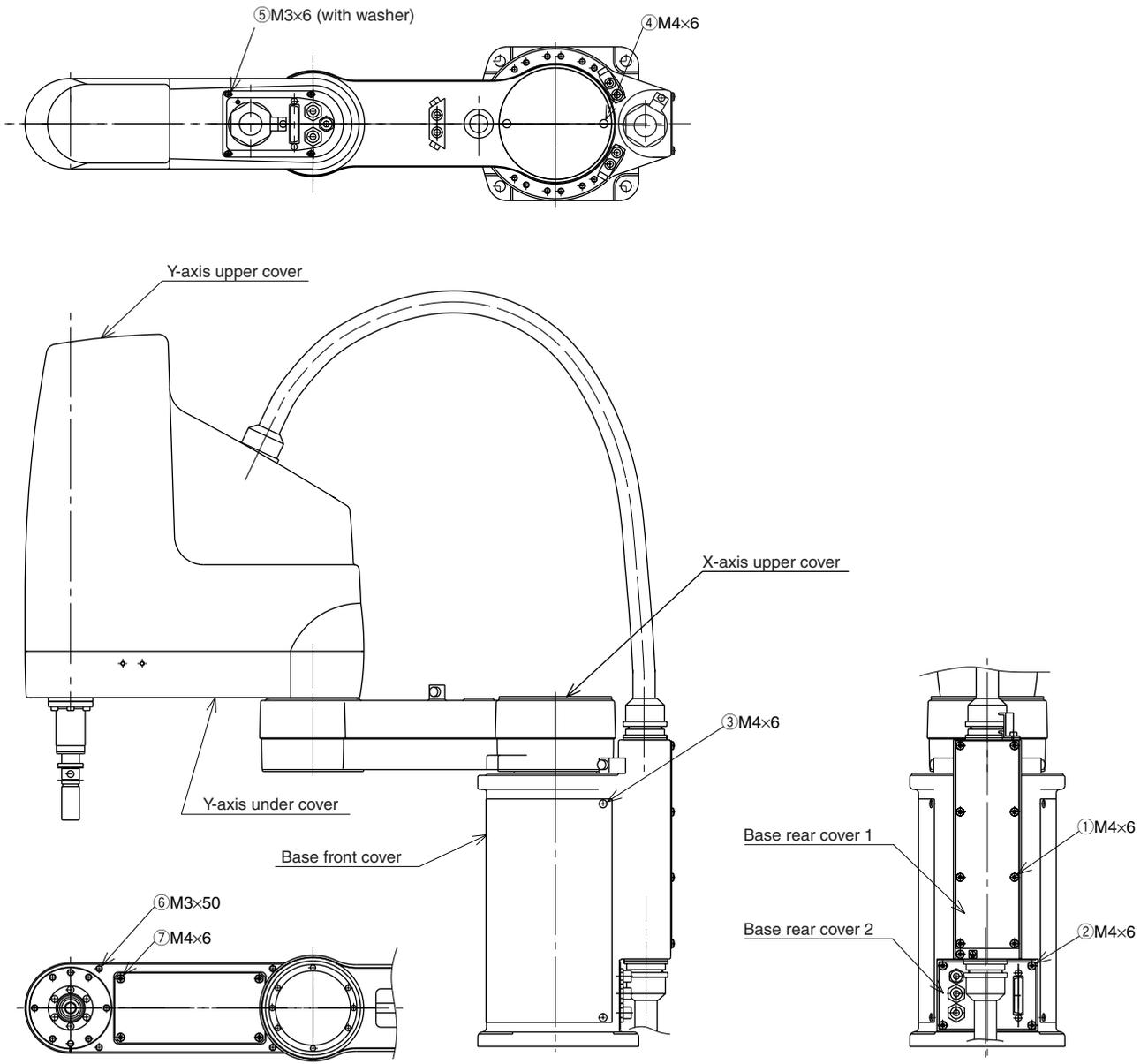


Fig. 4-26

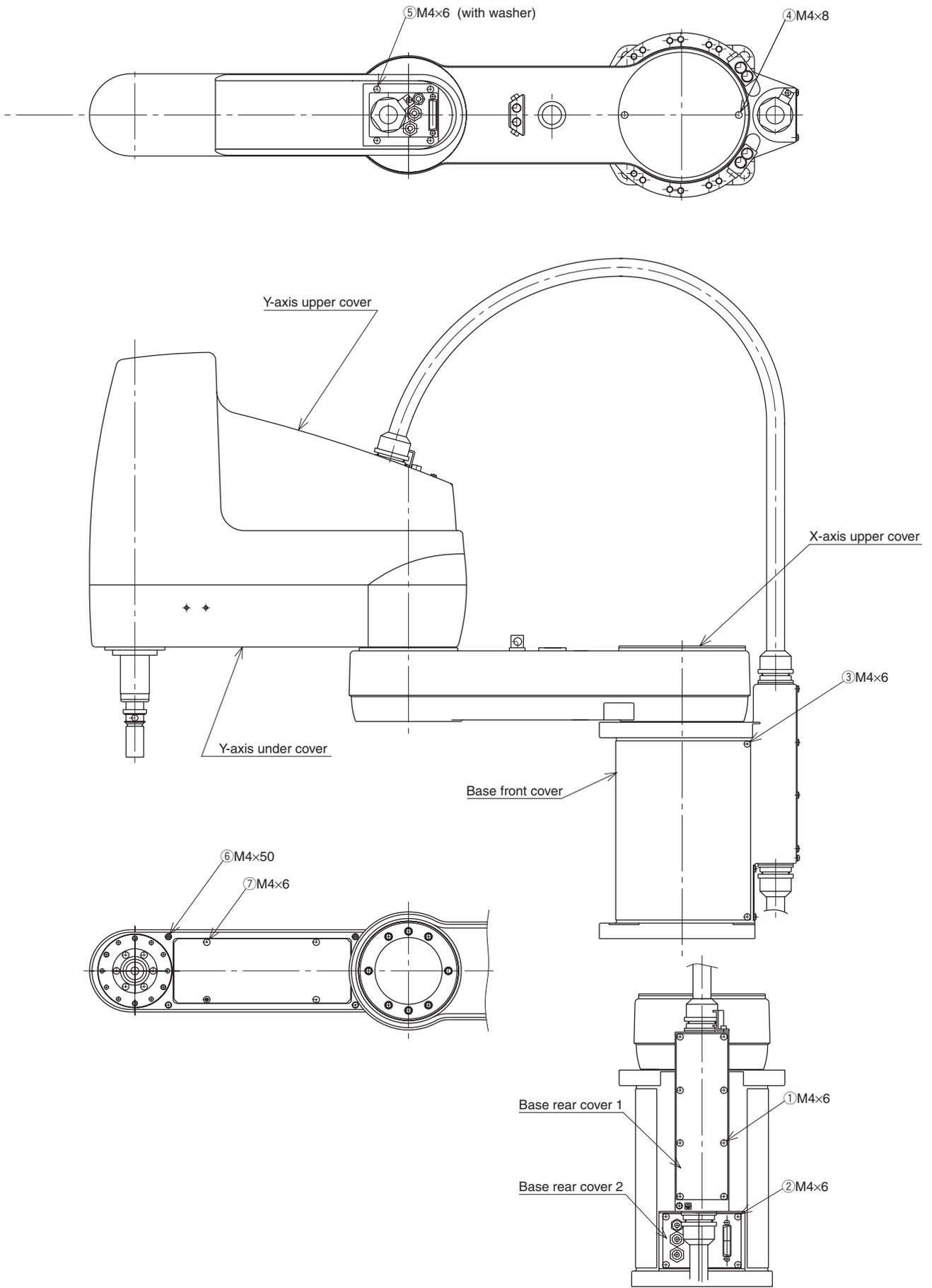


Fig. 4-27

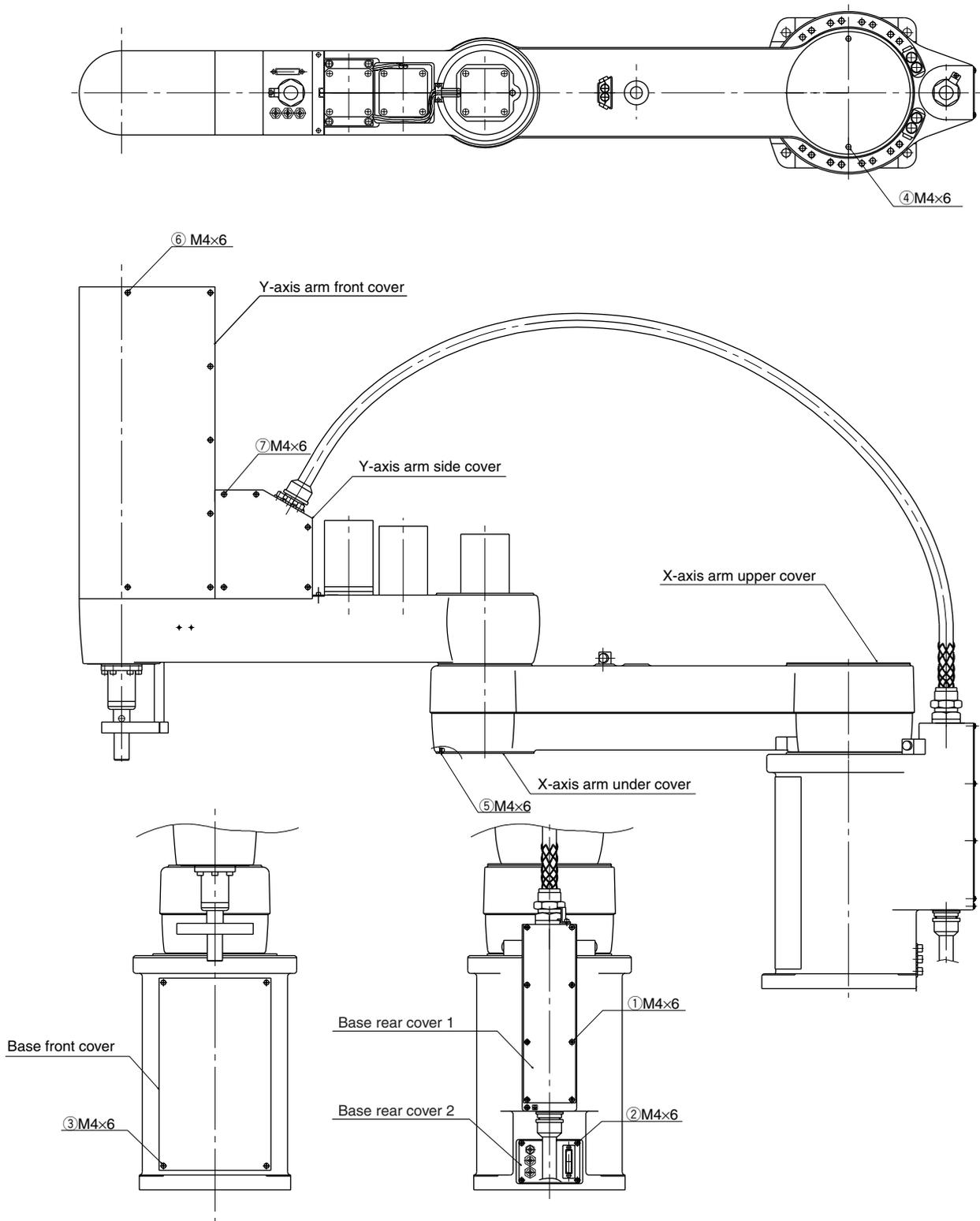


Fig. 4-28

## 8 Adjusting the Timing Belt Tension

The YK-X series robots use a timing belt for controlling the movement of the Z and R axes. If the belt becomes slack, use the following procedure to give proper tension to the belt.

**⚠ WARNING**

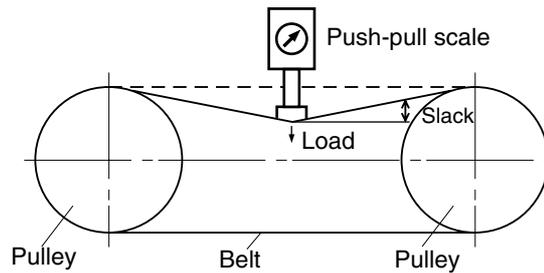
The motor and speed reduction gear casing are extremely hot after automatic operation, so burns may occur if these are touched. Before touching these parts, turn off the controller, wait for a while and check that the temperature has cooled.

**⚠ WARNING**

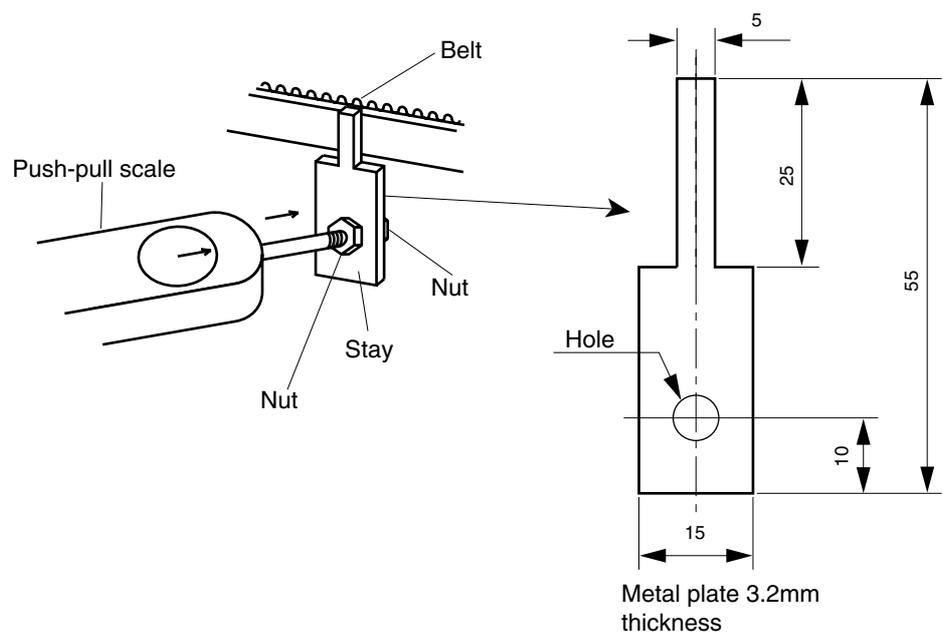
Injury can occur if hands or fingers are squeezed between the drive pulley and belt. Always turn off the controller and use caution when handling these parts.

**⚠ CAUTION**

Since a positional shift occurs after adjusting the belt tension, it is necessary to make absolute reset, standard coordinate setting and point data setting again.



**Fig. 4-29 Belt tension adjustment**



**Fig. 4-30 Stay (example)**

## Adjusting the belt tension (YK250X(H), YK350X(H), YK400X(H))

### **⚠ WARNING**

If the Z-axis pulley comes off the Z-axis belt, the Z-axis drops causing a hazardous situation. Turn off the controller and be sure to prop the Z-axis with a support stand before beginning adjustment.

Adjust the Z-axis and R-axis timing belts of the YK250X, YK350X and YK400X with the procedure below.

- 1) Prepare the necessary tools.
  - Push-pull scale
  - Stay (See Fig. 4-30. This stay should be prepared by the user.)
  - Hex wrench set
  - Phillips-head screwdriver
  - Scale
- 2) Turn off the controller.
- 3) Place a sign indicating the robot is being adjusted, to keep others from operating the controller switch.
- 4) Enter the safeguard enclosure.
- 5) Remove the Y-axis upper cover.

Refer to "7 Removing the Robot Covers" in Chapter 4 for removing the cover. Place the upper cover on the robot base (pedestal) side with the machine harness still connected.

- 6) Prop the spline or end effector with a support stand to prevent the Z-axis from dropping (when adjusting the Z-axis belt tension).
- 7) Adjust the belt tension by two people as follows.
 

Using the push-pull scale, one person applies a load perpendicular to the middle of the belt. The other person checks the slack of the belt. (See Fig. 4-29 and Fig. 4-30.)
- 8) The correct load to be applied to the belt of each robot model and the resulting slack are shown in Tables 4-7 and 4-7. When the load producing the specified slack is within this range, no adjustment is required. If not, adjust the tension with the following procedure.

#### (1) Z-axis belt adjustment

1. Loosen the bolt ① shown in Fig. 4-31.
2. If the load producing the slack specified in Table 4-9 (step 7) above) is smaller than the specified range, move the Z-axis motor in the direction increasing the tension. If the load is greater than this, move it in the direction reducing the tension. Then, retighten the bolt.
3. Recheck the belt tension using the same procedure in step 7). When the load applied to produce the specified slack is within the specified range of Table 4-9, the adjustment is okay. If not, repeat the above procedure from steps 1 to 3.

- (2) R-axis belt adjustment
1. Loosen the bolt ② shown in Fig. 4-31.
  2. If the load producing the slack specified in Table 4-10 (step 7) above) is smaller than the specified range, move the R-axis motor in the direction increasing the tension. If the load is greater than this, move it in the direction reducing the tension. Then, retighten the bolt.
  3. Recheck the belt tension using the same procedure in step 7). When the load applied to produce the specified slack is within the specified range of Table 4-10, the adjustment is okay. If not, repeat the above procedure from steps 1 to 3.
- 9) After adjustment is complete, tighten the bolt ① or ② to the torque specified in Table 4-11.
  - 10) Reattach the upper cover to the Y-axis arm.  
Refer to "7 Removing the Robot Covers" in Chapter 4 for attaching the cover.
  - 11) Go outside the safeguard enclosure.
  - 12) Check that no one is inside the safeguard enclosure, and then turn on the controller.

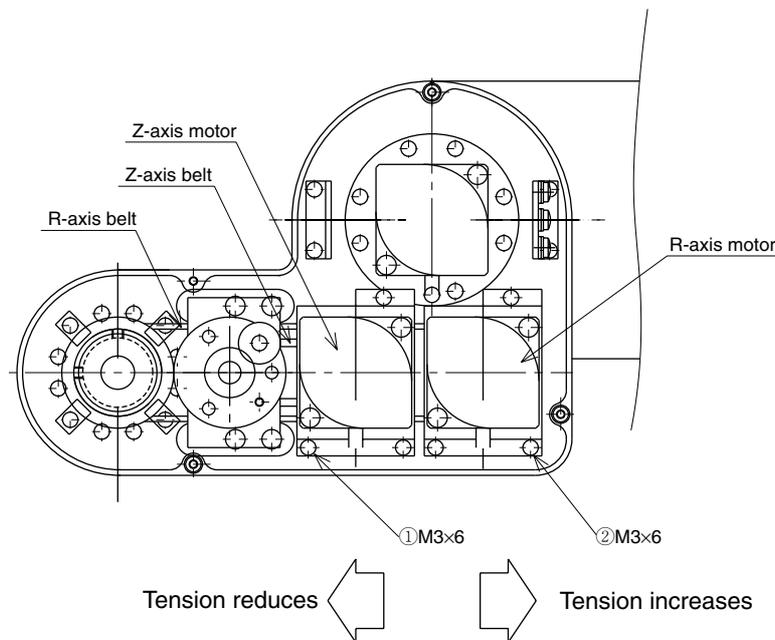


Fig. 4-31 YK250X(H), YK350X(H), YK400X(H)

## 8-2

## Adjusting the belt tension (YK500X, YK600X)

**⚠ WARNING**

If the Z-axis pulley comes off the Z-axis belt, the Z-axis drops causing a hazardous situation. Turn off the controller and be sure to prop the Z-axis with a support stand before beginning adjustment.

Adjust the Z-axis and R-axis timing belts of the YK500X and YK600X with the procedure below.

- 1) Prepare the necessary tools.
  - Push-pull scale
  - Stay (See Fig. 4-30. This stay should be prepared by the user.)
  - Hex wrench set
  - Phillips-head screwdriver
  - Scale
- 2) Turn off the controller.
- 3) Place a sign indicating the robot is being adjusted, to keep others from operating the controller switch.
- 4) Enter the safeguard enclosure.
- 5) Remove the Y-axis upper and under covers.  
Refer to "7 Removing the Robot Covers" in Chapter 4 for removing the covers.  
Place the upper cover on the robot base (pedestal) side with the machine harness still connected.
- 6) Prop the spline or end effector with a support stand to prevent the Z-axis from dropping (when adjusting the Z-axis belt tension).
- 7) Adjust the belt tension by two people as follows.  
Using the push-pull scale, one person applies a load perpendicular to the middle of the belt. The other person checks the slack of the belt. (See Figs. 4-29 and 4-30.)
- 8) The correct load to be applied to the belt of each robot model and the resulting slack are shown in Tables 4-9 and 4-10. When the load producing the specified slack is within this range, no adjustment is required. If not, adjust the tension with the following procedure.

## (1) Z-axis belt adjustment

1. Loosen the bolt ① shown in Fig. 4-32.
2. If the load producing the slack specified in Table 4-9 (step 7) above) is smaller than the specified range, move the Z-axis motor in the direction increasing the tension. If the load is greater than this, move it in the direction reducing the tension. Then, retighten the bolt.
3. Recheck the belt tension using the same procedure in step 7). When the load applied to produce the specified slack is within the specified range of Table 4-9, the adjustment is okay. If not, repeat the above procedure from steps 1 to 3.

(2) R-axis belt adjustment

1. Loosen the bolt ② shown in Fig. 4-32.
  2. If the load producing the slack specified in Table 4-10 (step 7) above) is smaller than the specified range, move the R-axis motor in the direction increasing the tension. If the load is greater than this, move it in the direction reducing the tension. Then, retighten the bolt.
  3. Recheck the belt tension using the same procedure in step 7). When the load applied to produce the specified slack is within the specified range of Table 4-10, the adjustment is okay. If not, repeat the above procedure from steps 1 to 3.
- 9) After adjustment is complete, tighten the bolt ① or ② to the torque specified in Table 4-11.
  - 10) Reattach the upper and under covers to the Y-axis arm.  
Refer to "7 Removing the Robot Covers" in Chapter 4 for attaching the covers.
  - 11) Go outside the safeguard enclosure.
  - 12) Check that no one is inside the safeguard enclosure, and then turn on the controller.

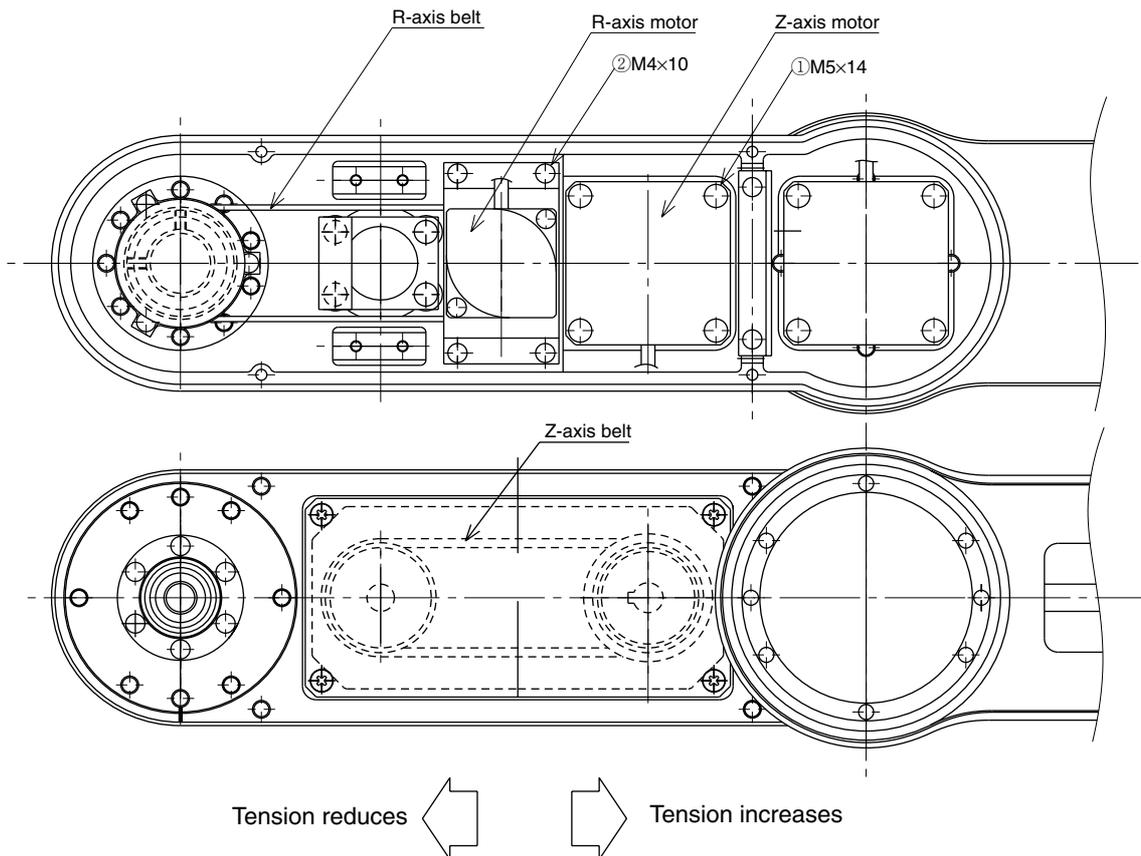


Fig. 4-32 YK500X, YK600X

## 8-3

## Adjusting the belt tension (YK700X, YK800X, YK1000X)

**⚠ WARNING**

If the Z-axis pulley comes off the Z-axis belt, the Z-axis drops causing a hazardous situation. Turn off the controller and be sure to prop the Z-axis with a support stand before beginning adjustment.

Adjust the Z-axis and R-axis timing belts of the YK700X, YK800X and YK1000X with the procedure below.

- 1) Prepare the necessary tools.
  - Push-pull scale
  - Stay (See Fig. 4-30. This stay should be prepared by the user.)
  - Hex wrench set
  - Phillips-head screwdriver
  - Scale
- 2) Turn off the controller.
- 3) Place a sign indicating the robot is being adjusted, to keep others from operating the controller switch.
- 4) Enter the safeguard enclosure.
- 5) Remove the Y-axis upper and under covers.  
Refer to "7 Removing the Robot Covers" in Chapter 4 for removing the covers.  
Place the upper cover on the robot base (pedestal) side with the machine harness still connected.
- 6) Prop the spline or end effector with a support stand to prevent the Z-axis from dropping (when adjusting the Z-axis belt tension).
- 7) Adjust the belt tension by two people as follows.  
Using the push-pull scale, one person applies a load perpendicular to the middle of the belt. The other person checks the slack of the belt. (See Figs. 4-29 and 4-30.)
- 8) The correct load to be applied to the belt of each robot model and the resulting slack are shown in Tables 4-9 and 4-10. When the load producing the specified slack is within this range, no adjustment is required. If not, adjust the tension with the following procedure.

## (1) Z-axis belt adjustment

1. Loosen the bolt ① shown in Fig. 4-33.
2. If the load producing the slack specified in Table 4-9 (step 7) above) is smaller than the specified range, move the Z-axis motor in the direction increasing the tension. If the load is greater than this, move it in the direction reducing the tension. Then, retighten the bolt.
3. Recheck the belt tension using the same procedure in step 7). When the load applied to produce the specified slack is within the specified range of Table 4-9, the adjustment is okay. If not, repeat the above procedure from steps 1 to 3.

- (2) R-axis belt adjustment
1. Loosen the bolt ② shown in Fig. 4-33.
  2. If the load producing the slack specified in Table 4-10 (step 7) above) is smaller than the specified range, move the R-axis motor in the direction increasing the tension. If the load is greater than this, move it in the direction reducing the tension. Then, retighten the bolt.
  3. Recheck the belt tension using the same procedure in step 7). When the load applied to produce the specified slack is within the specified range of Table 4-10, the adjustment is okay. If not, repeat the above procedure from steps 1 to 3.
- 9) After adjustment is complete, tighten the bolt ① or ② to the torque specified in Table 4-11.
  - 10) Reattach the upper and under covers to the Y-axis arm.  
Refer to "7 Removing the Robot Covers" in Chapter 4 for attaching the covers.
  - 11) Go outside the safeguard enclosure.
  - 12) Check that no one is inside the safeguard enclosure, and then turn on the controller.

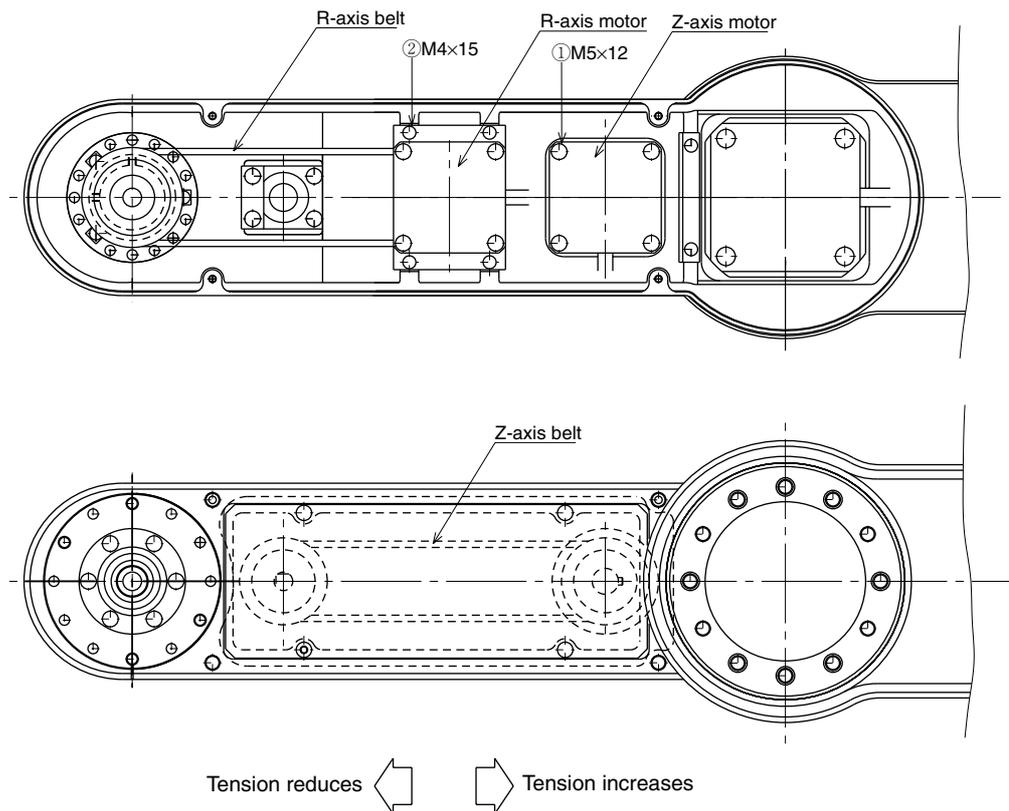


Fig. 4-33 YK700X, YK800X, YK1000X

## Adjusting the belt tension (YK1200X)

### **⚠ WARNING**

If the Z-axis pulley comes off the Z-axis belt, the Z-axis drops causing a hazardous situation. Turn off the controller and be sure to prop the Z-axis with a support stand before beginning adjustment.

Adjust the Z-axis and R-axis timing belts of the YK1200X with the procedure below.

- 1) Prepare the necessary tools.
  - Push-pull scale
  - Stay (See Fig. 4-30. This stay should be prepared by the user.)
  - Hex wrench set
  - Phillips-head screwdriver
  - Scale
- 2) Turn off the controller.
- 3) Place a sign indicating the robot is being adjusted, to keep others from operating the controller switch.
- 4) Enter the safeguard enclosure.
- 5) Remove the Y-axis arm front cover and side cover.  
Refer to "7 Removing the Robot Covers" in Chapter 4 for removing the covers.
- 6) Remove the bolts (M4×10L, 4 pieces) and then remove the harness clamp stay from the Y-axis arm. (See Fig. 4-34.)
- 7) Prop the spline or end effector with a support stand to prevent the Z-axis from dropping (when adjusting the Z-axis belt tension).
- 8) Adjust the belt tension by two people as follows.  
Using the push-pull scale, one person applies a load perpendicular to the middle of the belt. The other person checks the slack of the belt. (See Figs. 4-29 and 4-30.)
- 9) The correct load to be applied to the belt of each robot model and the resulting slack are shown in Tables 4-9 and 4-10. When the load producing the specified slack is within this range, no adjustment is required. If not, adjust the tension with the following procedure.

#### (1) Z-axis belt adjustment

1. Loosen the bolt ① shown in Fig. 4-34.
2. If the load producing the slack specified in Table 4-9 (step 7) above) is smaller than the specified range, move the Z-axis motor in the direction increasing the tension. If the load is greater than this, move it in the direction reducing the tension. Then, retighten the bolt.
3. Recheck the belt tension using the same procedure in step 7). When the load applied to produce the specified slack is within the specified range of Table 4-9, the adjustment is okay. If not, repeat the above procedure from steps 1 to 3.

(2) R-axis belt adjustment

1. Loosen the bolt ② shown in Fig. 4-34.
2. If the load producing the slack specified in Table 4-10 (step 7) above) is smaller than the specified range, move the R-axis motor in the direction increasing the tension. If the load is greater than this, move it in the direction reducing the tension. Then, retighten the bolt.
3. Recheck the belt tension using the same procedure in step 7). When the load applied to produce the specified slack is within the specified range of Table 4-10, the adjustment is okay. If not, repeat the above procedure from steps 1 to 3.

- 10) After adjustment is complete, tighten the bolt ① or ② to the torque specified in Table 4-11.
- 11) Reattach the harness clamp stay to the Y-axis arm. (See Fig. 4-34.)  
Be careful not to allow the R-axis belt to make contact with the harness clamp stay and harness.
- 12) Reattach the Y-axis arm front cover and side cover.  
Refer to "7 Removing the Robot Covers" in Chapter 4 for attaching the covers.
- 13) Go outside the safeguard enclosure.
- 14) Check that no one is inside the safeguard enclosure, and then turn on the controller.

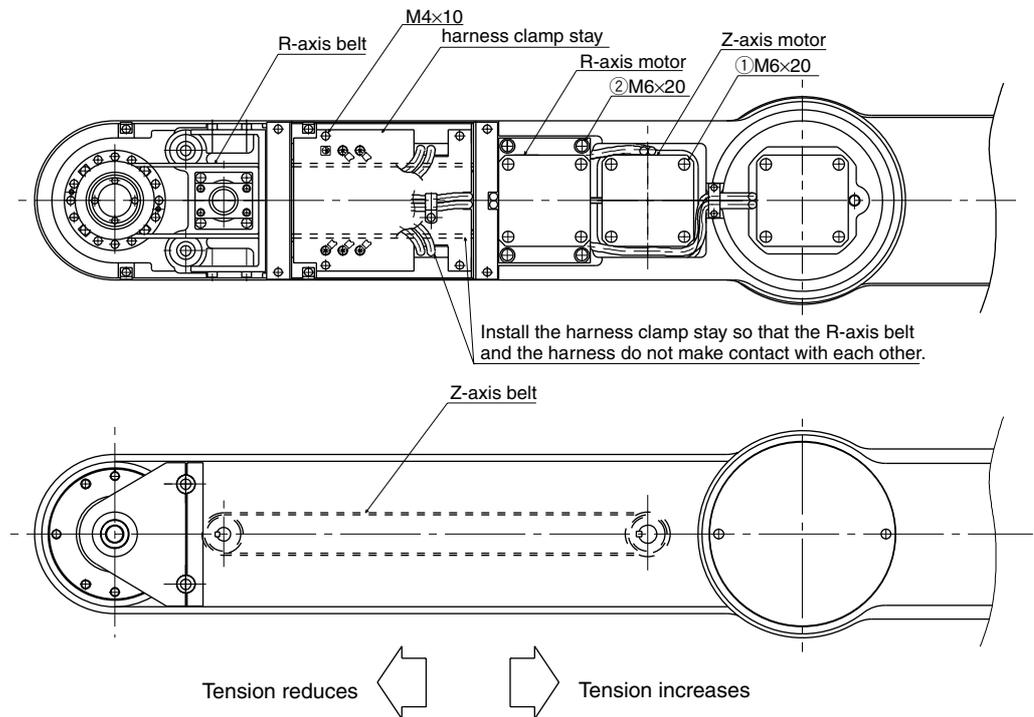


Fig. 4-34 YK1200X

Table 4-9 Z-axis belt specifications

Robot model	Load(N)	Load(kgf)	Slack (mm)	(Ref.) Belt vibration frequency(Hz)
YK250X(H), YK350X(H)	2.7 to 2.9	0.28 to 0.30	0.7	430 to 453
YK400X(H)	2.8 to 3.1	0.29 to 0.32	1.4	215 to 226
YK500X, YK600X	9.5 to 10.1	0.97 to 1.03	1.6	213 to 225
YK700X, YK800X	10.3 to 10.9	1.05 to 1.11	2.8	121 to 127
YK1000X	10.9 to 11.5	1.11 to 1.17	4.4	76 to 80
YK1200X	11.7 to 12.6	1.19 to 1.29	5.9	66 to 70

Table 4-10 R-axis belt specifications

Robot model	Load(N)	Load(kgf)	Slack (mm)	(Ref.) Belt vibration frequency(Hz)
YK250X(H), YK350X(H)	1.9 to 2.3	0.19 to 0.23	2.1	159 to 185
YK400X(H)	1.9 to 2.3	0.19 to 0.13	2.8	118 to 137
YK500X, YK600X	3.1 to 3.8	0.32 to 0.39	1.9	182 to 194
YK700X, YK800X	3.6 to 7.6	0.64 to 0.78	2.7	97 to 115
YK1000X	6.7 to 8.0	0.68 to 0.82	4.3	61 to 72
YK1200X	6.8 to 8.1	0.69 to 0.83	6.0	54 to 64

Table 4-11 Tightening torque

Robot model	Axis	Bolt size	Tightening torque (kgf•cm)	Tightening torque (N•m)
YK250X(H), YK350X(H), YK400X(H)	Z	M3	20	2.0
	R	M3	20	2.0
YK500X, YK600X	Z	M5	92	9.0
	R	M4	46	4.5
YK700X, YK800X, YK1000X	Z	M5	92	9.0
	R	M4	46	4.5
YK1200X	Z	M6	156	15.3
	R			

## 8-5 Adjusting the Z-axis and R-axis belts (YK550X)

The Z-axis and R-axis timing belts of the YK550X use a material that will not stretch under normal operation. The proper belt tension will be maintained unless otherwise the position of the Z-axis motor or R-axis speed reduction gear unit is moved. If for some reason their positions have moved, adjust the belt tension with the following procedure.

### (1) Adjusting the Z-axis belt tension

#### **⚠ WARNING**

If the Z-axis pulley comes off the Z-axis belt, the Z-axis drops causing a hazardous situation. Turn off the controller and be sure to prop the Z-axis with a support stand before beginning adjustment.

- 1) Prepare the necessary tools.
  - Hex wrench set
  - Phillips screwdriver
  - Support stand
- 2) Turn off the controller.
- 3) Place a sign indicating the robot is being adjusted, to keep others from operating the controller switch.
- 4) Enter the safeguard enclosure.
- 5) Remove the screws (7 pieces) shown in Fig. 4-35 and remove the upper cover. Place the upper cover on the robot pedestal side with the machine harness still connected.  
Also remove the under cover.
- 6) Check whether the edge of the Z-axis motor flange is aligned with the scribed lines (on both sides of plate) shown in Fig. 4-36. When exactly aligned, no adjustment is required. If not aligned, make adjustment as follows.
- 7) Prop the spline or end effector with a support stand to prevent the Z-axis from dropping.(See Fig. 4-36.)
- 8) Slightly loosen the four M4 bolts on the plate under the Z-axis motor as long as no backlash occurs between the plate and the Y-axis arm.
- 9) Check from the bottom of the Y-axis arm that the belt is properly engaged with the Z-axis motor pulley and ball screw pulley.

- 10) Pull the Z-axis motor in the direction of arrow and align the scribed lines (on both sides of the X-axis motor underplate) with the reference scribed lines. While maintaining this position, tighten the four M4 bolts to 4.5Nm (46kgf·cm) to secure the Z-axis motor underplate.

**CAUTION**

If the scribed lines on the Z-axis motor underplate do not reach the reference scribed lines, the belt teeth may slip on the pulley. If they exceed the reference scribe lines on the arm, the Z-axis drive unit may wear out quickly. Align the scribed lines exactly.

- 11) Reattach the covers.

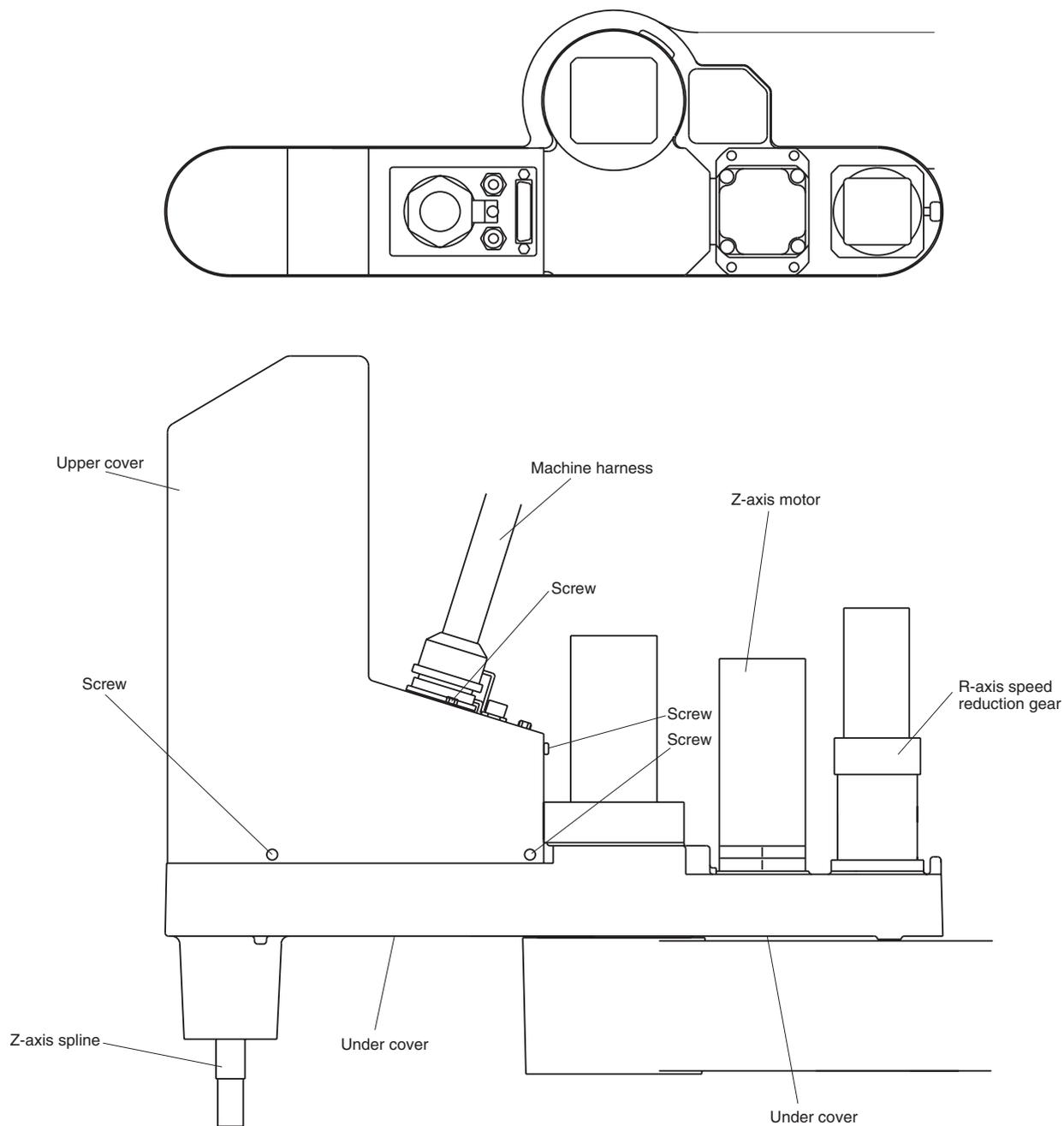
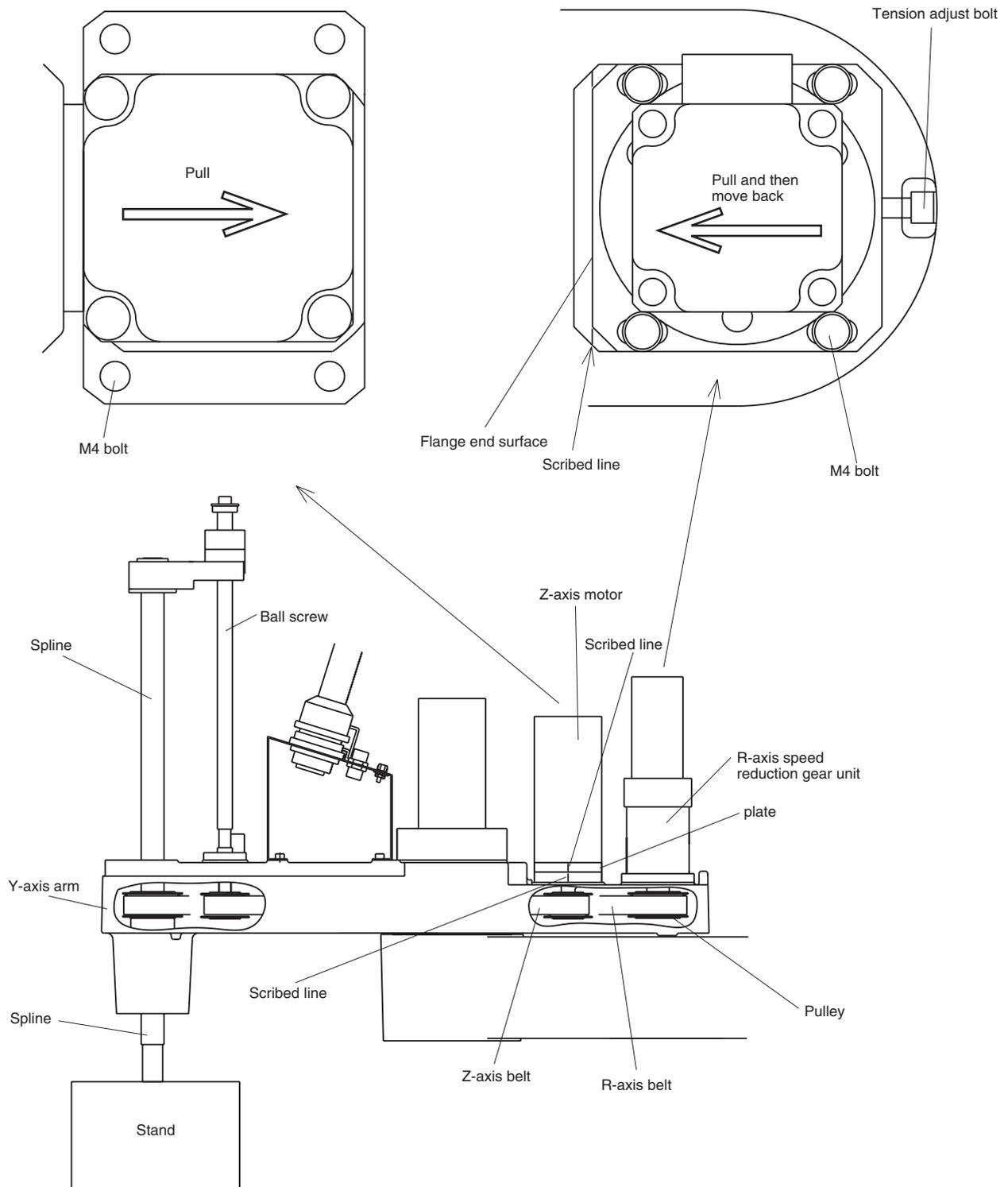


Fig. 4-35



**Fig. 4-36 Adjusting the belt tension**

## (2) Adjusting the R-axis belt tension

- 1) Prepare the necessary tools.
  - Hex wrench set
  - Phillips screwdriver
- 2) Turn off the controller.
- 3) Place a sign indicating the robot is being adjusted, to keep others from operating the controller switch.
- 4) Enter the safeguard enclosure.
- 5) Remove the screws (7 pieces) shown in Fig. 4-35 and remove the upper cover. Place the upper cover on the robot pedestal side with the machine harness still connected.  
Also remove the under cover.
- 6) Check whether the edge of the R-axis speed reduction gear unit is aligned with the scribed line shown in Fig. 4-36. When exactly aligned, no adjustment is required. If not aligned, make adjustment as follows
- 7) Slightly loosen the four M4 bolts securing the R-axis speed reduction gear unit as long as no backlash occurs between the unit and the Y-axis arm.

### CAUTION

For high-speed R-axis specifications, an O-ring is fitted between the arm and the plate under the bolts. This O-ring might come off if the gap between the arm and plate becomes large. Loosen the bolts so that the gap does not become large.

- 8) Check from the top and bottom of the Y-axis arm that the belt is properly engaged with the pulleys on the speed reduction gear unit and spline.
- 9) Utilizing the tension adjust bolt, pull speed reduction gear unit in the reverse direction of arrow and then move it back. When the unit flange edge is exactly aligned with the scribed line, tighten the four M4 bolts to secure the unit. The tightening torque should be 4.5Nm (46kgf·cm). Slightly tighten the tension adjust bolt.

### CAUTION

If the flange edge of the speed reduction gear unit does not reach the scribed line, the belt may slip on the pulleys. If it exceeds the scribed line, the belt is too tight causing the drive parts to wear prematurely. Align the flange edge exactly with the scribed line.

- 10) Reattach the covers.

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# MEMO

# CHAPTER 5

## Periodic Inspection

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# MEMO

# 1 Overview

Daily and periodic inspection of the YAMAHA robot is essential in order to ensure safe and efficient operation. This chapter describes the periodic inspection items and procedures for the YAMAHA YK-X series robots.

Periodic inspection includes:

- Daily inspection
- 6-month inspection
- Replacement of speed reduction gear (harmonic drive)
- Replacing the grease for speed reduction gear (harmonic drive)
- Replacing the grease for RV speed reduction gears

Make sure that you thoroughly understand details of the inspection and follow the procedures and precautions explained in this chapter.

## 2 Precautions

- (1) Periodic inspection must be performed by or in the presence of personnel who have received the Robot Training given by YAMAHA or YAMAHA dealers.
- (2) Do not attempt any inspection, adjustment, repair and parts replacement not described in this manual. This work requires specialized technical knowledge and skill, and may also involve work hazards.
- (3) When inspection is required inside the safeguard enclosure, always turn off the controller and also the external switch board.
- (4) If the inspection or maintenance procedure calls for operation of the robot, stay outside the safeguard enclosure.
- (5) Place a sign indicating the robot is being inspected, to keep others from operating the controller switch, programming box or operation panel.
- (6) Use only the lubricants specified by YAMAHA or YAMAHA dealers.
- (7) To check the operation after inspection, refer to "6 Trial operation" in Chapter 1.

---

### **⚠ WARNING**

- When you need to touch the terminals or connectors on the outside of the controller during inspection, always first turn off the controller power switch and also the power source in order to prevent possible electrical shock.
  - Never touch any internal parts of the controller.
- 

For precautions on handling the controller, refer to the "YAMAHA Robot Controller User's Manual".

### 3 Daily Inspection

The following is an inspection list that must be performed every day before and after operating the robot.

#### (1) Inspection to be performed with the controller turned off

- 1) Turn off the controller.
- 2) Place a sign indicating the robot is being inspected, to keep others from operating the controller switch.
- 3) Enter the safeguard enclosure and check the following points.

Checkpoint	Procedure
Machine harness Robot cable User cable and wiring	Check for scratches, dents and excessive bend and kinks. (If the machine harness or robot cable is damaged, contact YAMAHA dealer.)
Regulator, joints, air tube, solenoid valve, air cylinder	Check air pressure. Check for air leaks. Check drain. Check air filter for clogging or damage.
Robot exterior	Check for damage. (If a damage is found, contact YAMAHA dealer.)

#### (2) Inspection to be performed with the controller turned on

- 1) Check that no one is inside the safeguard enclosure, and then turn on the controller.
- 2) Place a sign indicating the robot is being inspected, to keep others from operating the controller, programming box or operation panel.
- 3) Check the following points from outside the safeguard enclosure.

Checkpoint	Procedure
Safeguard enclosure	Check if the safeguard enclosure is in place. Check if emergency stop is triggered when the door is opened. Check if warning labels are affixed at the entrance and clearly visible.
Emergency stop device	Press the emergency stop button to check if it works.
Robot movement	Check for abnormal movement and excessive vibration and noise. (If any abnormal symptom is found, contact YAMAHA dealer.)
Z-axis brake operation *1	Check if the brake works to stop the Z-axis from dropping more than 3mm from the stationary point. (If any abnormal operation is found, contact YAMAHA dealer.)

- \*1 Visually check the Z-axis movement when you press the emergency stop button from outside the safeguard enclosure and also when you turn off the controller.

**(3) Adjustment and parts replacement**

- 1) After inspection, if you notice any adjustment or parts replacement is needed, first turn off the controller and then enter the safeguard enclosure to perform the necessary work. After adjustment or replacement is finished, again review the checkpoints outlined in (1) and (2) above.
  
- 2) If repair or parts replacement is required for the robot or controller, please contact your YAMAHA dealer. This work requires specialized technical knowledge and skill, so do not attempt it by yourself.

## 4 Six-Month Inspection

Take the following precautions when performing 6-month inspection.

### **⚠ WARNING**

Injury can occur if hands or fingers are squeezed between the drive pulley and belt. Always turn off the controller and use caution when handling these parts.

### **⚠ WARNING**

The Z-axis will slide down when the Z-axis brake is released, causing a hazardous situation. Do not release the brake when lubricating the Z-axis parts.

When lubricating the ball screw, spline shaft and linear busing shaft, observe the following precautions.

### **⚠ WARNING**

Precautions when handling grease:

- Inflammation may occur if this gets in the eyes.  
Before handling the grease, wear your safety goggles to ensure the grease will not come in contact with the eyes.
- Inflammation may occur if the grease comes into contact with skin. Be sure to wear protective gloves to prevent contact with skin.
- Do not take orally or eat. (Eating will cause diarrhea and vomiting.)
- Hands and fingers might be cut when opening the container, so use protective gloves.
- Keep out of the reach of children.
- Do not heat the grease or place near an open flame since this could lead to sparks and fires.

Emergency Treatment:

- If this grease gets in the eyes, wash liberally with pure water for about 15 minutes and consult a physician for treatment.
- If this grease comes in contact with the skin, wash away completely with soap and water.
- If taken internally, do not induce vomiting but promptly consult a physician for treatment.

### **⚠ WARNING**

Disposing of grease and the container:

- Proper disposal is compulsory under federal, state and local regulations. Take appropriate measures in compliance with legal regulations.
- Do not pressurize the empty container. Pressurizing may cause the container to rupture.
- Do not attempt to weld, heat up, drill holes or cut this container. This might cause the container to explode and the remaining materials inside it to ignite.

### **⚠ CAUTION**

Unless grease specified by YAMAHA is used, the service life of the ball screw, ball spline and linear bushing shaft will shorten.

**(1) Inspection to be performed with the controller turned off**

- 1) Turn off the controller.
- 2) Place a sign showing that the robot is being inspected, to keep others from operating the controller switch.
- 3) Enter the safeguard enclosure and check the following points.

Checkpoint	Procedure
Manipulator bolts and screws (Only for major bolts and screws exposed externally)	Check for looseness and tighten if necessary.*1
Z-axis and R-axis timing belts	Check belt tension. (See 8 in Chapter 4.)
Detection areas of the origin sensors of the X-axis, Y-axis, and R-axis	Clean if it is dirty.
Controller	Check for looseness at each terminal and connector on the panel. (See 4 in Chapter 3.)
Grease lubrication of Z-axis ball screw, spline, linear shaft	Every 6 month, lubricate the Z-axis ball screw nut with grease gun, and the linear shaft, spline shaft and ball screw shaft by hand after removing the old grease. The specified grease is Alvania No.2 (SHOWA SHELL SEKIYU KK).
Z-axis ball spline, ball screw	Check for backlash. (If any abnormality is found, contact YAMAHA dealer.)

**\*1 Bolt tightening torque**

Bolt size	Tightening torque (kgf·cm)	Tightening torque (N·m)
M3 button head bolt	14	1.4
M4 set screw	20	2.0
M3	20	2.0
M4	46	4.5
M5	92	9.0
M6	156	15.3
M8	380	37
M10	720	71
M12	1310	128
M14	2090	205

**(2) Inspection to be performed with the controller turned on**

**⚠ WARNING**

The robot controller must be installed outside the safeguard enclosure, to prevent a hazardous situation in which you or anyone enter the safeguard enclosure to inspect the controller while it is turned on.

**⚠ WARNING**

- Bodily injury may occur from coming into contact with the fan while it is rotating.
- When removing the fan cover for inspection, first turn off the controller and make sure the fan has stopped.

- 1) Check that no one is inside the safeguard enclosure, and then turn on the controller.
- 2) Place a sign indicating the robot is being inspected, to keep others from operating the controller, programming box or operation panel.
- 3) Check the following points from outside the safeguard enclosure (except checkpoint marked \*1).

Checkpoint	Procedure
<ul style="list-style-type: none"> <li>• Cooling fan at rear of controller</li> <li>• X-axis motor cooling fan inside robot base (pedestal) (YK550X only; see Fig. 5-63) *1</li> </ul>	<ul style="list-style-type: none"> <li>• Check if the fan rotates normally.</li> <li>• Check if objects blocking the fan are located and remove if any are found.</li> <li>• Check for abnormal noise from the rotating fan. If abnormal noise is heard, visually check and remove the cause. If no cause is found, contact YAMAHA dealer.</li> <li>• Check for dust on the fan cover. Remove and clean if necessary.</li> </ul>

\*1 After pressing the emergency stop button, enter the safeguard enclosure and make checks. Place a sign indicating the robot is being inspected, to keep others from operating the controller, programming box or operation panel.

**(3) Adjustment and parts replacement**

- 1) After inspection, if you notice any adjustment or parts replacement is needed, first turn off the controller and then enter the safeguard enclosure to perform the necessary work. After adjustment or replacement is finished, again review the checkpoints outlined in (1) and (2) above.
- 2) If repair or parts replacement is required for the robot or controller, please contact your YAMAHA dealer. This work requires specialized technical knowledge and skill, so do not attempt it by yourself.

## 5 Replacing the Harmonic Drive

The YK-X series robots listed in Table 5-1 use a harmonic drive as the speed reduction gear for the X, Y and R axes. Harmonic drives need to be replaced after a specified operation time. Use the guideline explained below to determine the replacement period and replace the harmonic drive periodically.

Since the YK-X series robots listed in Table 5-1 use long-life harmonic grease, it is not necessary to replace the harmonic grease.

### 5-1 Replacement period

The harmonic drive replacement period is determined by the total number of turns of the wave generator used in the harmonic drive. It is recommended to replace the harmonic drive when the total number of turns has reached  $8.4 \times 10^8$  (at ambient operating temperatures of  $0^\circ\text{C}$  to  $+40^\circ\text{C}$ ). This means that the replacement period will differ depending on the following operating conditions. If the robot operation duty ratio is high or the robot is operated in environments at higher temperatures, the harmonic drive should be replaced earlier.

$$\text{Replacement period} = 8.4 \times 10^8 / (n \times 60 \times h \times D \times N \times \theta) \text{ years}$$

- where
- n : Number of axis movements per minute
  - $\theta$  : Average turn per axis movement
  - N : Speed reduction ratio
  - h : Operation time per day
  - D : Operation days per year

For example, when the robot is used under the following conditions, the replacement period for the X-axis harmonic drive of the YK500X can be calculated as follows.

- n : 10
- $\theta$  : 0.25
- N : 80
- h : 24 hours per day
- D : 240 days per year

$$\begin{aligned} \text{Replacement period} &= 8.4 \times 10^8 / (n \times 60 \times h \times D \times N \times \theta) \\ &= 8.4 \times 10^8 / (10 \times 60 \times 24 \times 240 \times 80 \times 0.25) \\ &= 12.2 \text{ years} \end{aligned}$$

**Table 5-1 Harmonic drive speed reduction ratio**

Robot model	X-axis	Y-axis	R-axis
YK250X(H), YK350X(H), YK400X(H)	50	50	50
YK500X, YK600X	80	80	50
YK700X, YK800X	80	80	50
YK1000X	100	80	50
YK1200X	–	–	50
YK550X with high-speed R-axis specifications	–	–	30

**Table 5-2 Bolt tightening torque**

Bolt size	Tightening torque (kgf-cm)	Tightening torque (N-m)
M3 button head bolt	14	1.4
M4 set screw	20	2.0
M3	20	2.0
M4	46	4.5
M5	92	9.0
M6	156	15.3
M8	380	37
M10	720	71

## 5-2 Basic replacement procedure for harmonic drive and precautions

Basic procedures and precautions for replacing the harmonic drive are described below. Before beginning the replacement work, always be sure to read these replacement procedures and caution.

---

### **⚠ WARNING**

The motor and speed reduction gear casing are extremely hot after automatic operation, so burns may occur if these are touched. Before touching these parts, turn off the controller, wait for a while and check that the temperature has cooled.

---

---

### **⚠ WARNING**

Precautions when handling harmonic grease, cleaning oil:

- Inflammation may occur if they get in the eyes.  
Before handling them, wear your safety goggles to ensure they will not come in contact with the eyes.
- Inflammation may occur if they come into contact with skin. Be sure to wear protective gloves to prevent contact with skin.
- Do not take orally or eat. (Eating will cause diarrhea and vomiting.)
- Hands and fingers might be cut when opening the container, so use protective gloves.
- Keep out of the reach of children.
- Do not heat them or place near an open flame since this could lead to sparks and fires.

Emergency Treatment:

- If they get in the eyes, wash liberally with pure water for about 15 minutes and consult a physician for treatment.
  - If they come in contact with the skin, wash away completely with soap and water.
  - If taken internally, do not induce vomiting but promptly consult a physician for treatment.
- 

---

### **⚠ WARNING**

Disposing of harmonic grease, cleaning oil and the container:

- Proper disposal is compulsory under federal, state and local regulations. Take appropriate measures in compliance with legal regulations.
  - Do not pressurize the empty container. Pressurizing may cause the container to rupture.
  - Do not attempt to weld, heat up, drill holes or cut this container. This might cause the container to explode and the remaining materials inside it to ignite.
- 

---

### **⚠ WARNING**

When removing the wave generator from the motor shaft or reinstalling it back onto the motor shaft, use caution to avoid as much as possible, applying a thrust load to the motor shaft. If a load is applied, the resolver may be damaged resulting in a hazardous situation of the robot trouble.

---

**⚠ CAUTION**

The harmonic drive service life may shorten if the grease recommended by YAMAHA is not used.

---

**Recommended grease**

Use the following harmonic drive grease.  
4B No.2 (made by Harmonic Drive Systems Inc.)

**⚠ CAUTION**

Harmonic drive

- Do not apply strong shocks or impacts to these parts such as with a hammer. Also, do not scratch, scar or dent these parts by dropping, etc. Such actions will damage the harmonic drive.
  - The specified performance cannot be maintained if any part of the harmonic drive is used in a damaged state. This damage or wear may also lead to trouble with the harmonic drive.
- 

**⚠ CAUTION**

Since a positional shift occurs after replacing the harmonic drive, it is necessary to make absolute reset, standard coordinate setting and point data setting again.

---

**5-2-1 YK250X(H), YK350X(H), YK400X(H)**

The following steps describe procedures and precautions when replacing the harmonic drives of the YK250X, YK350X and YK400X. (The illustrations show the YK250X). For the bolt tightening torques in this work, refer to Table 5-2.

**1. X-axis**

- 1) Prepare the following tools and items.
  - Harmonic grease 4B No.2 (10g)
  - Waste cloth (rag)
  - Phillips-head screwdriver
  - Hex wrench set
  - Screw Lock (thread sealant)
  - Ratchet handle
  - Hexagonal socket set
  - Extension bar
  - Torque-limiting wrench
  - Replacement parts (See table below.)

Replacement parts			
Parts name	Type No.	YAMAHA Parts No.	Note
Harmonic drive	SHF-20-50	KN3-M2110-001	
O-ring	S71(JIS)	KN3-M2159-000	Top of harmonic drive
	Cross section diameter: 1.50mm Inner diameter: 49.00mm	KN3-M2143-000	For motor
	Cross section diameter: 0.99mm Inner diameter: 53.28mm	KN3-M2144-000	Supplied with harmonic drive

- 2) Turn off the controller.
- 3) Place a sign indicating that the robot is being inspected, to keep others from operating the controller switch.
- 4) Enter the safeguard enclosure.
- 5) Remove the base (robot pedestal) front and rear covers.  
Refer to "7 Removing the Robot Covers" in Chapter 4 for removing the covers.

**⚠ WARNING**

When you remove the X-axis arm installation bolts (M3×40L, 8 pieces) in the next step, the X-axis arm may come off causing a hazardous situation. Be especially careful to keep the arm from falling when a heavy tool is attached to the arm tip.

- 6) Remove the X-axis arm installation bolts (M3×40L, 8 pieces). (See Fig. 5-1.)

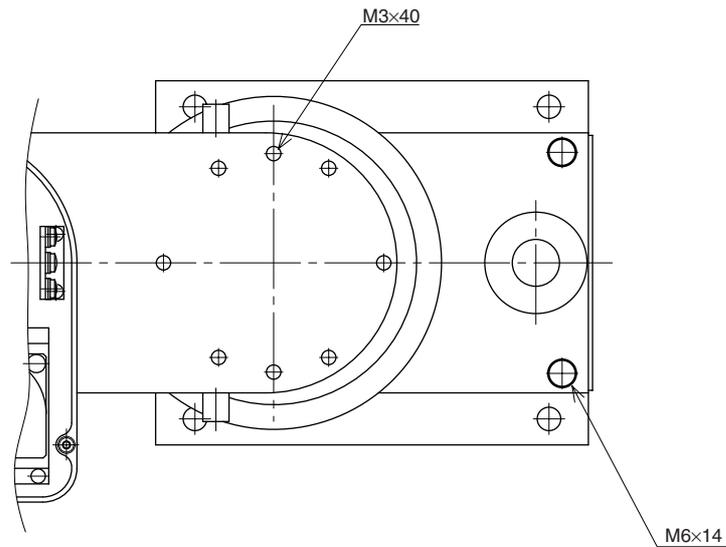


Fig. 5-1

**CAUTION**

An O-ring is fitted to the X-axis arm, so be careful not to let it drop into the peripheral unit. (See Fig. 5-2.)

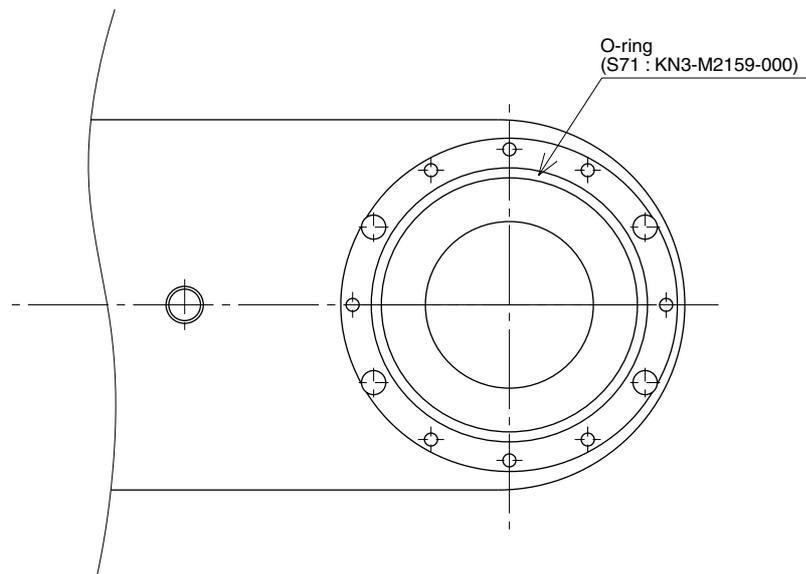


Fig. 5-2

- 7) Disconnect the connectors on the X-axis motor power cable XM and resolver cable XP.

- 8) Remove the base assembly bolts (M6×14L, 6 pieces) to separate base 1 and base 2. (See Fig. 5-1 and Fig. 5-3.)

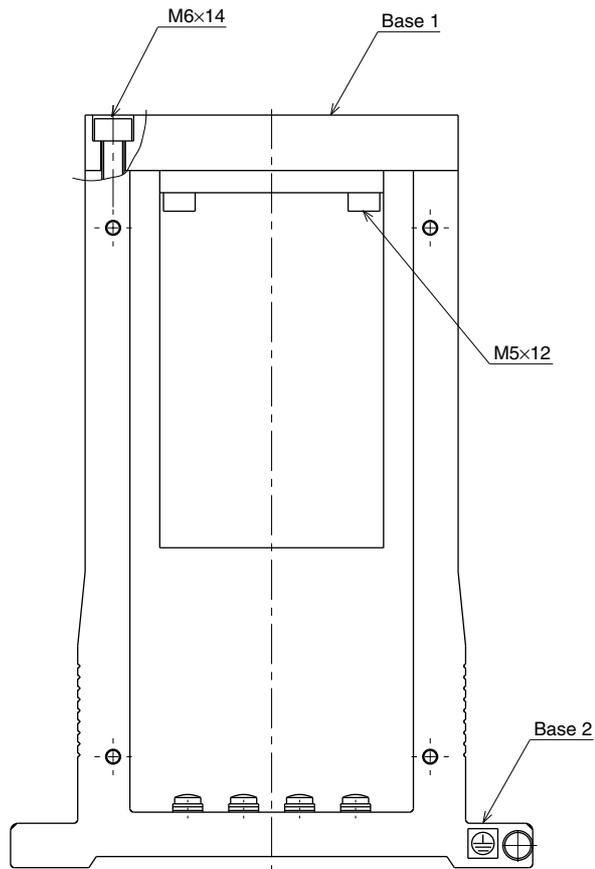


Fig. 5-3

- 9) Remove the bolts (M5×12L, 4 pieces) securing the motor and remove the motor from base 1. (See Fig. 5-4.)

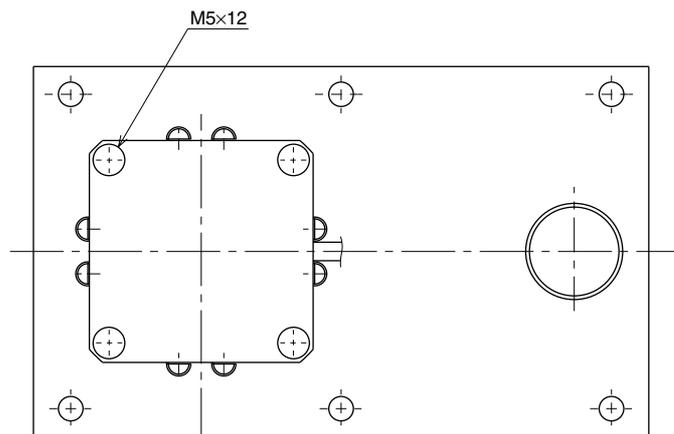
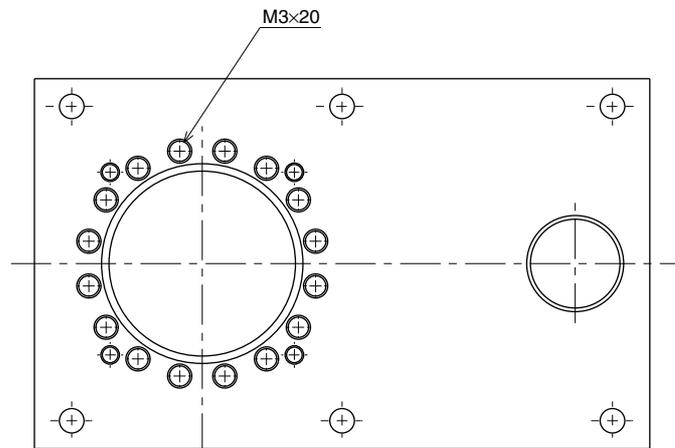


Fig. 5-4

**CAUTION**

An O-ring is fitted to the motor, so be careful not to let it drop into the peripheral unit.

- 10) Remove the wave generator from the motor shaft. The wave generator is secured with an M3 set screw. (See Fig. 5-6.)
- 11) Remove the X-axis harmonic drive installation bolts (M3×20L, 16 pieces)



**Fig. 5-5**

- 12) Remove the X-axis harmonic drive from the top of base 1.

**CAUTION**

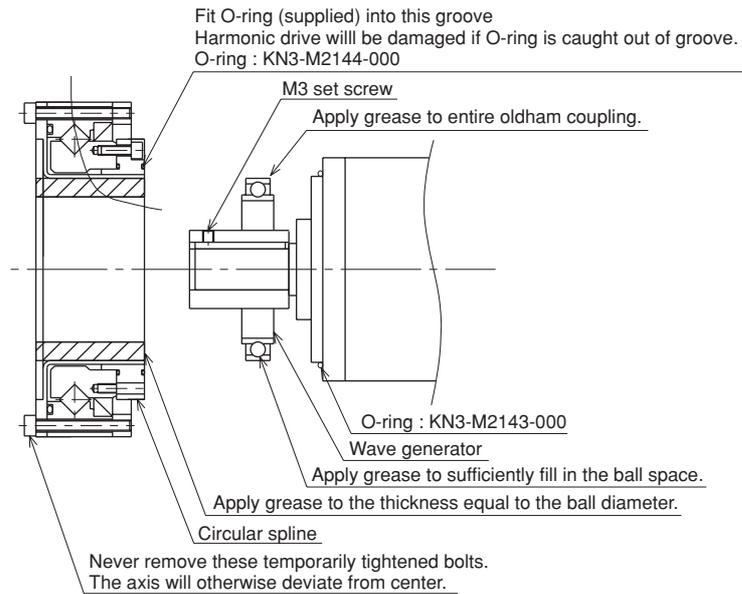
An O-ring is fitted to the X-axis harmonic drive, so be careful not to let it drop into the peripheral unit.

- 13) Fit an O-ring (supplied with the harmonic drive) coated with harmonic grease into the O-ring groove on the new harmonic drive.  
Apply small amounts of "Screw Lock" to the bolts (M3×20L, 16 pieces) and tighten them to secure the harmonic drive from the backside of the base. (See Fig. 5-5.)

**CAUTION**

Do not allow the O-ring to get caught out of the groove during reassembly. A problem will occur if the robot is operated with the O-ring left caught out of the groove.

- 14) Apply harmonic grease to the new wave generator and flexspline.  
See Fig. 5-6 for applying grease properly.



**Fig. 5-6**

- 15) Fit the wave generator onto the motor shaft and fully insert it against the motor. Then, apply small amounts of "Screw Lock" to the M3 set screw (1 piece) you removed earlier and tighten it to secure the wave generator. (See Fig. 5-6.)
- 16) Fit a new O-ring to the motor and secure the motor to base 1 with the bolts (M5×12L, 4 pieces) you removed earlier. (See Fig. 5-4.)

**CAUTION**

Do not allow the O-ring to get caught out of the groove during reassembly. A problem will occur if the robot is operated with the O-ring left caught out of the groove.

- 17) Fasten base 1 to base 2 with the bolts (M6×14L, 6 pieces) you removed earlier. (See Fig. 5-3.)
- 18) Reattach the connectors on the X-axis motor power cable XM and resolver cable XP.
- 19) Fit a new O-ring into the O-ring groove on the X-axis arm and place the arm on the harmonic drive. Then, apply small amounts of "Screw Lock" to the bolts (M3×40L, 8 pieces) you removed earlier and tighten them uniformly to secure the X-axis arm to the base. (See Fig. 5-1 and Fig. 5-2.)

**CAUTION**

Do not allow the O-ring to get caught out of the groove during reassembly. A problem will occur if the robot is operated with the O-ring left caught out of the groove.

- 20) Reattach the base (robot pedestal) front and rear covers.
- 21) Go outside the safeguard enclosure.
- 22) Check that no one is inside the safeguard enclosure, and then turn on the controller.

**⚠ CAUTION**

---

After the Harmonic drive is replaced, an absolute reset must be performed, and the standard coordinate and point data must be reset. Refer to "Chapter 4 Adjustment" to adjust it.

---

- 23) Turn the X-axis arm as much as possible (at least 10 degrees or more), and perform aging at 5% speed for 30 minutes and then at 20% speed for 30 minutes.

**2. Y-axis**

- 1) Prepare the following tools and items.
  - Harmonic grease 4B No.2 (8.5g)
  - Waste cloth (rag)
  - Phillips-head screwdriver
  - Hex wrench set
  - Screw Lock (thread sealant)
  - Torque-limiting wrench
  - Replacement parts (See table below.)

Replacement parts			
Parts name	Type No.	YAMAHA Parts No.	Note
Harmonic drive	SHF-17-50	KN3-M2510-002	
O-ring	S63(JIS)	KN3-M2519-000	Lower part of harmonic drive
	Cross section diameter: 1.00mm Inner diameter: 29.50mm	KN3-M257K-000	For motor
	Cross section diameter: 0.80mm Inner diameter: 45.40mm	90990-17J016	Supplied with harmonic drive

- 2) Turn off the controller.
- 3) Place a sign indicating that the robot is being inspected, to keep others from operating the controller switch.
- 4) Enter the safeguard enclosure.
- 5) Remove the Y-axis arm upper cover. Place the cover on the robot base (pedestal) side with the machine harness still connected.  
Refer to "7 Removing the Robot Covers" in Chapter 4 for removing the covers.

**⚠ WARNING**

When you remove the Y-axis arm installation bolts (M3×20L, 8 pieces) in the next step, the Y-axis arm may come off causing a hazardous situation. Be especially careful to keep the arm from falling when a heavy tool is attached to the arm tip.

- 6) Remove the Y-axis arm installation bolts (M3×20L, 8 pieces). (See Fig. 5-7.)

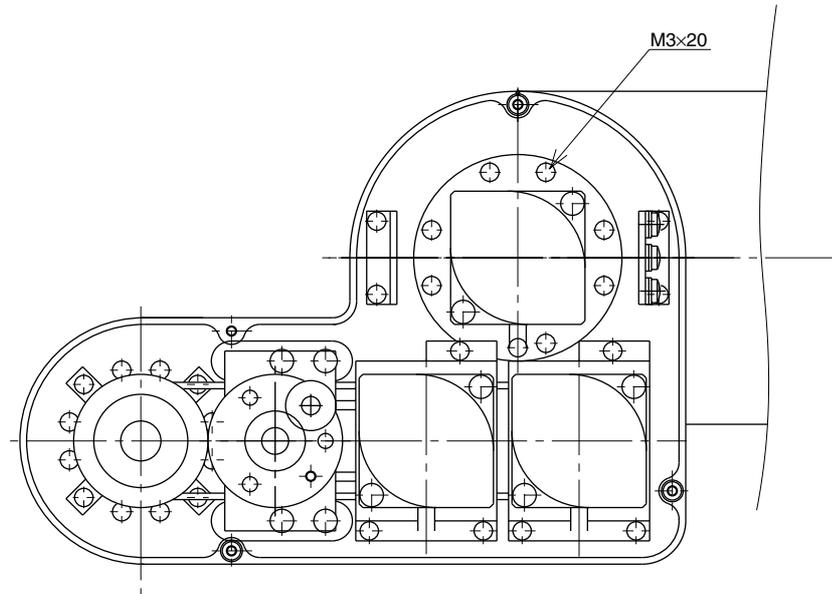


Fig. 5-7

- 7) Remove the Y-axis arm and place it where it will not obstruct the work.

**CAUTION**

An O-ring is fitted to the upper surface of the harmonic drive, so be careful not to let it drop into the peripheral unit.

- 8) Remove the wave generator from the motor shaft. The wave generator is secured with an M3 set screws (2 pieces). (See Fig. 5-10.)
- 9) Remove the Y-axis harmonic drive installation bolts (M3×40L, 6 pieces)

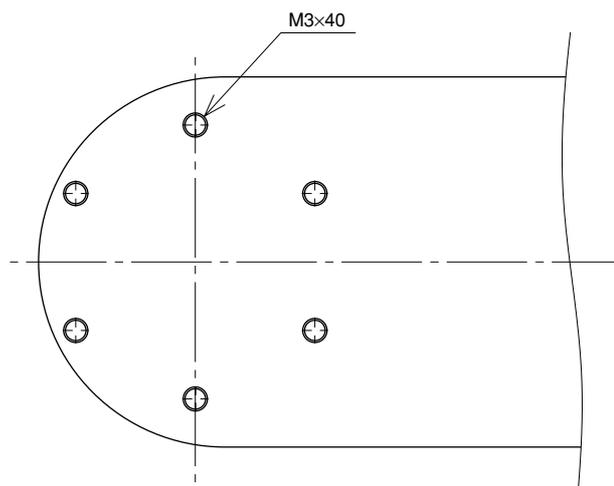


Fig. 5-8

- 10) Remove the Y-axis dog ring from the Y-axis Harmonic drive. The dog ring is fastened with M4 setscrews (2 pieces).

**CAUTION**

The dog ring is used for reassembly. Store it where the work will not be disturbed.

The dog ring is provided with the setscrews. Be careful to avoid losing them.

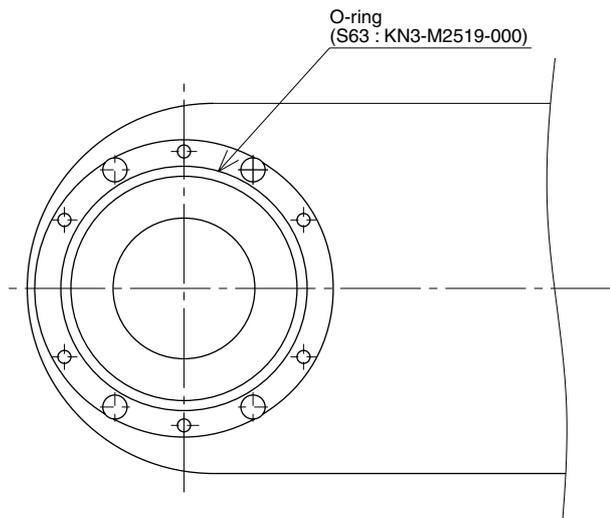
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11) Remove the Y-axis harmonic drive from the top of the X-axis arm.

**CAUTION**

An O-ring is fitted to the X-axis harmonic drive, so be careful not to let it drop into the peripheral unit. (See Fig. 5-9.)

---



**Fig. 5-9**

12) Remove the four bolts temporarily tightened to the new harmonic drive.

**CAUTION**

Remove only the four bolts shown in Fig. 5-10 at this point. Never remove the bolts on the opposite side. If they are removed, the harmonic drive axis may deviate from the center causing trouble.

---

13) Fit a new O-ring coated with harmonic grease into the O-ring groove on the X-axis arm. (See Fig. 5-9.)

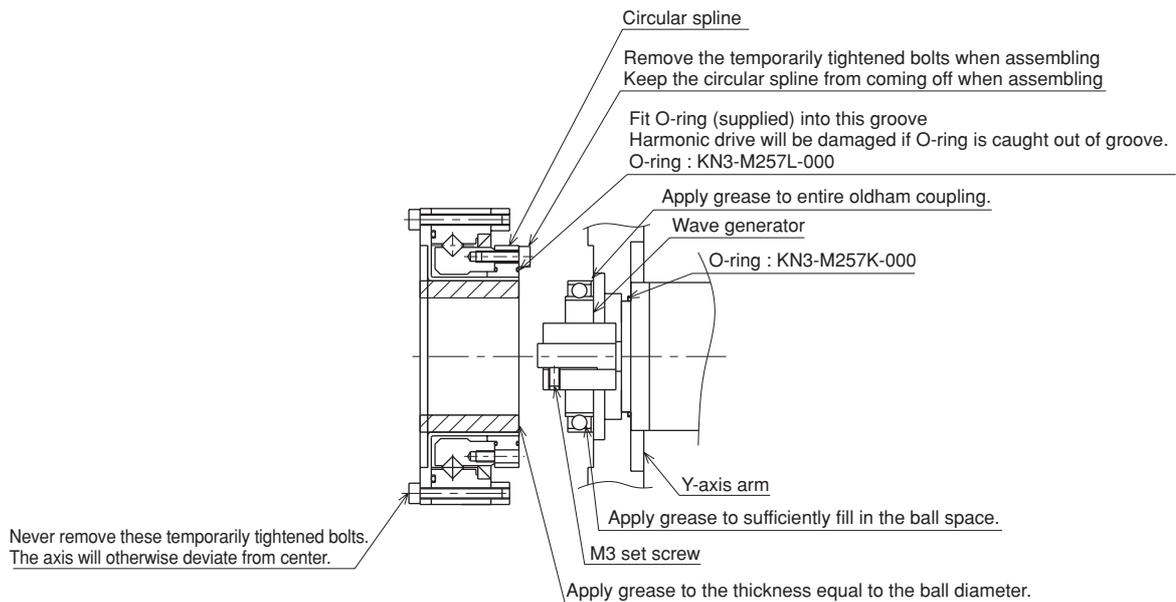
14) Place the new harmonic drive on the X-axis arm, and secure it with the bolts (M3×40L, 6 pieces). Apply small amounts of "Screw Lock" to the bolts and tighten uniformly them to secure the harmonic drive from the backside. (See Fig. 5-8.)

**CAUTION**

Do not allow the O-ring to get caught out of the groove during reassembly. A problem will occur if the robot is operated with the O-ring left caught out of the groove.

---

- 15) Fasten the dog ring on the Harmonic drive.
- 16) Fit an O-ring (supplied with the harmonic drive) coated with harmonic grease into the O-ring groove on the new harmonic drive
- 17) Apply harmonic grease to the new wave generator and flexspline.  
See Fig. 5-10 for applying grease properly.
- 18) Fit the wave generator onto the motor shaft and fully insert it against the motor. Then, apply small amounts of "Screw Lock" to the M3 set screw (2 piece) you removed earlier and tighten it to secure the wave generator. (See Fig. 5-10.)



**Fig. 5-10**

- 19) Secure the Y-axis arm to the harmonic drive with the bolts (M3×20L, 8 pieces) you removed earlier. Apply small amounts of "Screw Lock" to the bolts and tighten them uniformly to secure the Y-axis arm. (See Fig. 5-7.)

**CAUTION**

Do not allow the O-ring to get caught out of the groove during reassembly. A problem will occur if the robot is operated with the O-ring left caught out of the groove.

When reassembling the harmonic drive, be careful to keep the circular spline from coming off. If it comes off, the harmonic drive axis will deviate from the center causing trouble.

- 20) Reattach the Y-axis arm upper cover.
- 21) Go outside the safeguard enclosure.
- 22) Check that no one is inside the safeguard enclosure, and then turn on the controller.

**⚠ CAUTION**

---

After the Harmonic drive is replaced, an absolute reset must be performed, and the standard coordinate and point data must be reset. Refer to "Chapter 4 Adjustment" to adjust it.

---

- 23) Turn the Y-axis arm as much as possible (at least 10 degrees or more), and perform aging at 5% speed for 30 minutes and then at 20% speed for 30 minutes.

### 3. R-axis

- 1) Prepare the following tools and items.
  - Harmonic grease 4B No.2 (4.2g)
  - Waste cloth (rag)
  - Phillips-head screwdriver
  - Hex wrench set
  - Screw Lock (thread sealant)
  - Torque-limiting wrench
  - Adjustable wrench or spanner
  - Replacement parts (See table below.)

Replacement parts			
Parts name	Type No.	YAMAHA Parts No.	Note
Harmonic drive	SHF-14-50	KN3-M1821-001	
O-ring	S53(JIS)	KN3-M1895-000	Lower part of harmonic drive
	Cross section diameter: 0.80mm Inner diameter: 23.70mm	KN3-M181H-000	For wave generator
	Cross section diameter: 0.60mm Inner diameter: 37.10mm	90990-17J001	Supplied with harmonic drive
Edge seal	VR18A	KN3-M1886-000	

- 2) Turn off the controller.
- 3) Place a sign indicating that the robot is being inspected, to keep others from operating the controller switch.
- 4) Enter the safeguard enclosure.
- 5) Remove the Y-axis arm upper cover. Place the cover on the robot base (pedestal) side with the machine harness still connected.  
Refer to "7 Removing the Robot Covers" in Chapter 4 for removing the covers.
- 6) Remove the bolts (M4×8L, 4 pieces) securing the bearing to the upper end of the spline and remove the spline mount plate, spline and bearing from the holder. (See Fig. 5-11.)

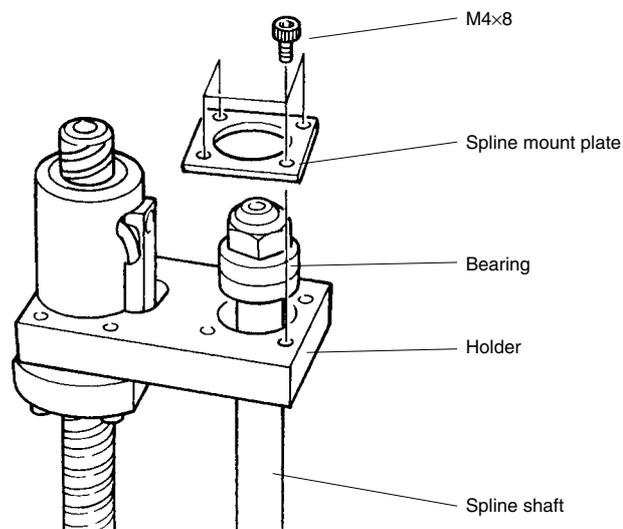


Fig. 5-11

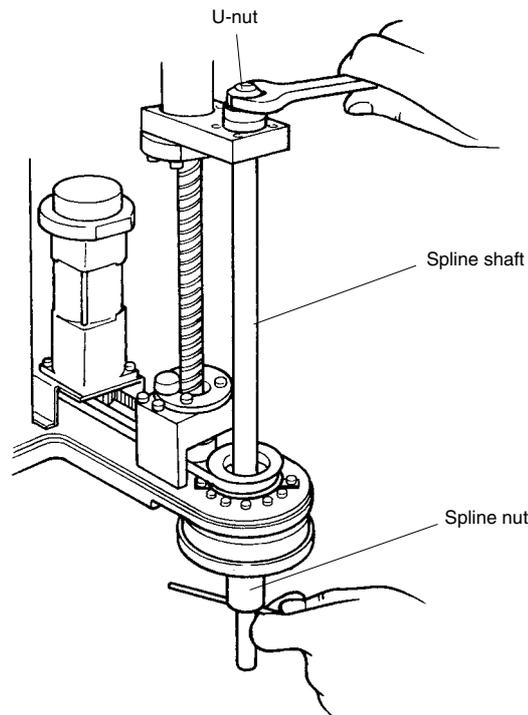
**⚠ WARNING**

The Z-axis will slide down when the U-nut is removed in the next step, causing a hazardous situation. Prop the Z-axis with a support stand before loosening the U-nut.

- 7) While placing a steel rod or similar tool through the 5mm diameter hole at the lower part of the spline, loosen the U-nut at the top of the spline with the wrench, and remove the bearing. (See Fig. 5-12.)

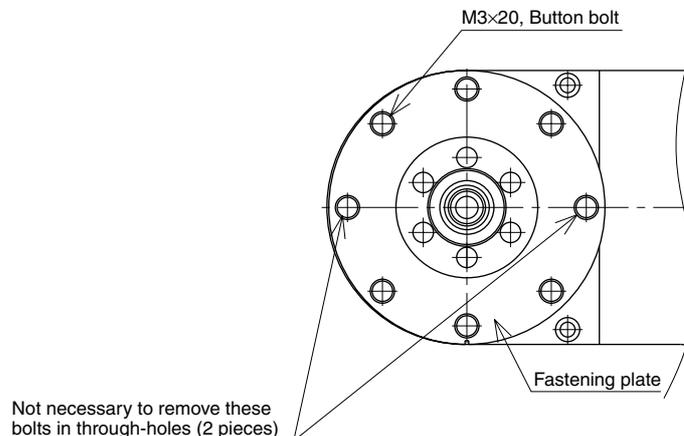
Use a round steel rod with a diameter slightly smaller than 5mm. Avoid using a square rod because the spline might be damaged by the edge of the rod.

After removing the bearing, refit the U-nut to the top of the spline shaft to keep the spline shaft from falling out.



**Fig. 5-12**

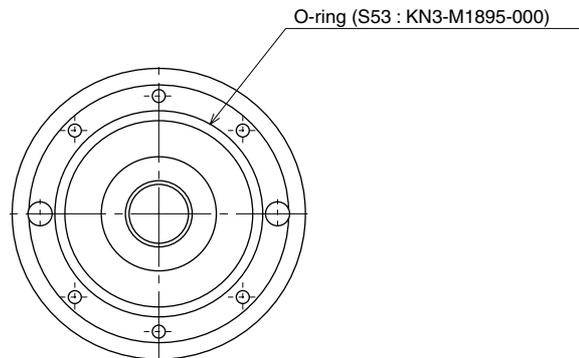
- 8) Remove the button bolts (M3×20L, 6 pieces) on the underside of the Y-axis arm and remove the plate fastening the spline and the harmonic drive. (See Fig. 5-13.)



**Fig. 5-13**

**CAUTION**

An O-ring is fitted to the fastening plate, so be careful not to let it drop into the peripheral unit. (See Fig. 5-14.)



**Fig. 5-14**

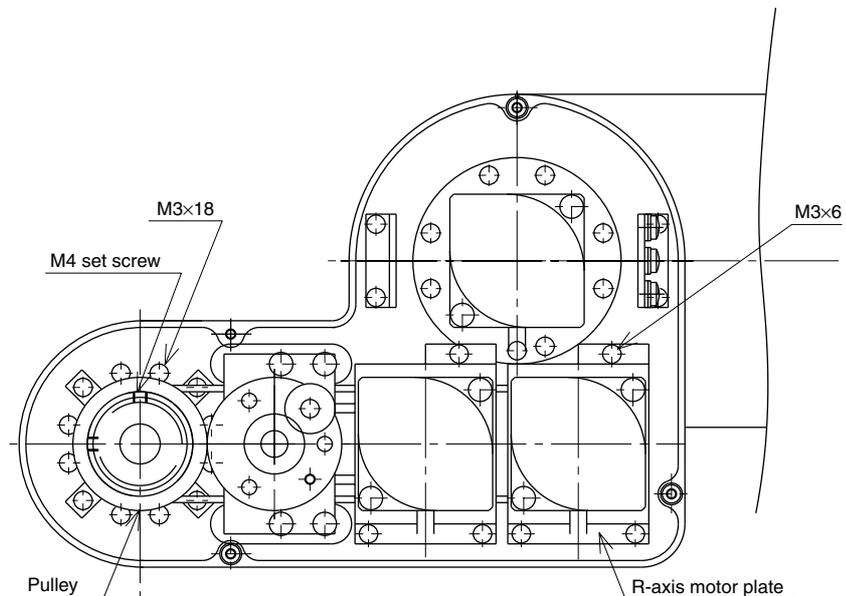
- 9) Remove the R-axis dog ring from the R-axis Harmonic drive. The dog ring is fastened with M4 setscrews (2 pieces).

**CAUTION**

The dog ring is used for reassembly. Store it where the work will not be disturbed.

The dog ring is provided with the setscrews. Be careful to avoid losing them.

- 10) Remove the bolts (M3×6L, 3 pieces) securing the R-axis motor plate at the top of the Y-axis arm. (See Fig. 5-15.)



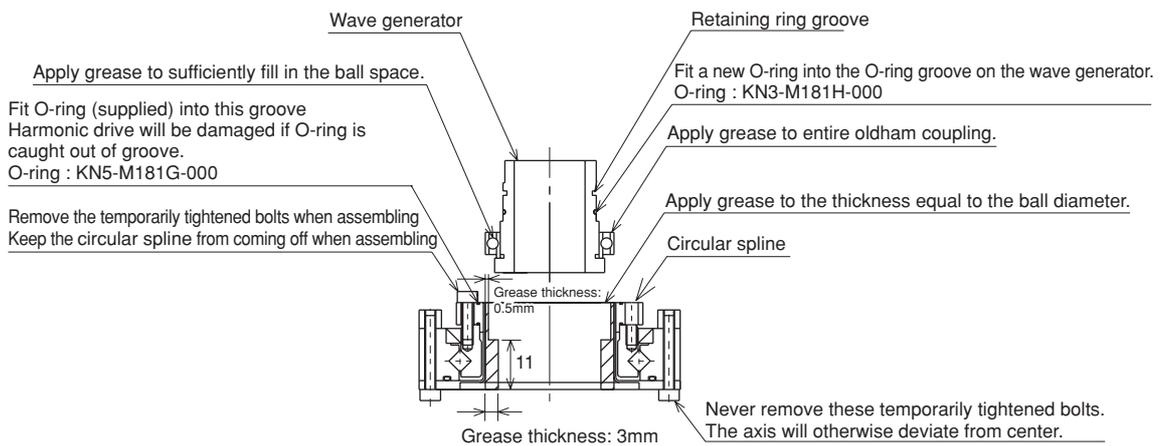
**Fig. 5-15**

- 11) Loosen the pulley set screw (M4, 2 pieces) and remove the pulley from the wave generator. (See Fig. 5-15.)
- 12) Remove the harmonic drive installation bolts (M3×18L, 8 pieces) and pull out the harmonic drive from the bottom of the Y-axis arm. (See Fig. 5-15.)

**CAUTION**

An O-ring is fitted to the harmonic drive, so be careful not to let it drop into the peripheral unit.

- 13) Remove the retaining ring for the wave generator and pull out the wave generator from the bottom of the Y-axis arm. (See Fig. 5-16.)
- 14) Apply harmonic grease to the new wave generator. See Fig. 5-16 for applying grease properly.
- 15) Fit a new O-ring into the O-ring groove on the wave generator. (See Fig. 5-16.)



**Fig. 5-16**

- 16) Insert the new wave generator into the Y-axis arm from the bottom, and secure it with the retaining ring. The chamfered side of the retaining ring should face downwards.

**CAUTION**

Do not allow the O-ring to get caught out of the groove during reassembly. A problem will occur if the robot is operated with the O-ring left caught out of the groove.

- 17) Apply the remaining harmonic grease to the circular spline. See Fig. 5-16 for applying grease properly.

- 18) Remove the four bolts temporarily tightened to the new harmonic drive.

**⚠ CAUTION**

Remove only the four bolts shown in Fig. 5-16 at this point. Never remove the bolts on the opposite side. If they are removed, the harmonic drive axis may deviate from the center causing trouble.

- 19) Fit an O-ring (supplied with the harmonic drive) coated with harmonic grease into the O-ring groove on the new harmonic drive.

Apply small amounts of "Screw Lock" to the bolts (M3×18L, 8 pieces) and tighten them to secure the harmonic drive to the Y-axis arm from the top of the Y-axis arm.

**⚠ CAUTION**

Do not allow the O-ring to get caught out of the groove during reassembly. A problem will occur if the robot is operated with the O-ring left caught out of the groove.

When reassembling the harmonic drive, be careful to keep the circular spline from coming off. If it comes off, the harmonic drive axis will deviate from the center causing trouble.

- 20) Apply small amounts of "Screw Lock" to the M4 set screws (2 pieces) and tighten them to secure the pulley to the wave generator.
- 21) Check that the timing belt is fitted on the wave generator pulley and motor pulley, and then secure the motor plate. (See Fig. 5-15.)

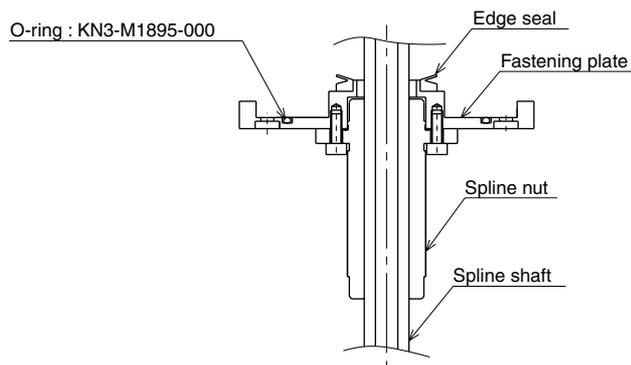
**⚠ CAUTION**

It is necessary to apply correct tension to the timing belt during reassembly. Refer to "8 Adjusting the Timing Belt Tension" in Chapter 4.

- 22) Fasten the dog ring on the Harmonic drive.
- 23) Next, secure the fastening plate to the harmonic drive with the button bolts (M3×20L, 6 pieces) coated with small amounts of "Screw Lock". (See Fig. 5-17.) At this point, be careful to keep the spline shaft from coming off the spline nut.

**⚠ CAUTION**

The harmonic drive service life may shorten if the edge seal effect is insufficient, so carefully reassemble the parts.



**Fig. 5-17**

- 24) Insert the spline into the holder, fit the bearing onto the spline and tighten the U-nut to secure the bearing. (Utilize the  $\phi 5$  through-hole when tightening the U-nut like you did to loosen it.) (See Fig. 5-11 and Fig. 5-12.)
- 25) Attach the bearing mount plate to the holder and fasten them with the bolts you removed earlier (M4×8L, 4 pieces).
- 26) Reattach the Y-axis arm upper cover.
- 27) Go outside the safeguard enclosure.
- 28) Check that no one is inside the safeguard enclosure, and then turn on the controller.

**CAUTION**

---

After the Harmonic drive is replaced, the absolute reset must be performed, and the point data must be reset. Refer to "Chapter 4 Adjustment" to adjust it.

---

- 29) Turn the R-axis arm as much as possible (at least 10 degrees or more), and perform aging at 5% speed for 30 minutes and then at 20% speed for 30 minutes.

## 5-2-2 YK500X, YK600X

The following steps describe procedures and precautions when replacing the harmonic drives of the YK500X and YK600X. (The illustrations show the YK500X). For the bolt tightening torques in this work, refer to Table 5-2.

### 1. X-axis

1) Prepare the following tools and items.

- Harmonic grease 4B No.2 (20g)
- Waste cloth (rag)
- Phillips-head screwdriver
- Hex wrench set
- Screw Lock (thread sealant)
- Ratchet handle
- Hexagonal socket set
- Extension bar
- Torque-limiting wrench
- Replacement parts (See table below.)

Replacement parts			
Parts name	Type No.	YAMAHA Parts No.	Note
Harmonic drive	SHF-25-80	KN4-M2110-001	
O-ring	S90(JIS)	KN4-M2143-000	Top of harmonic drive
	Cross section diameter: 1.78mm Inner diameter: 85.00mm	KN4-M2159-000	Base (robot pedestal)
	Cross section diameter: 1.78mm Inner diameter: 69.57mm	KN5-M2143-000	Motor
	Cross section diameter: 1.30mm Inner diameter: 66.50mm	KN5-M257L-000	Supplied with harmonic drive

- 2) Turn off the controller.
- 3) Place a sign indicating that the robot is being inspected, to keep others from operating the controller switch.
- 4) Enter the safeguard enclosure.
- 5) Remove the base (robot pedestal) front and rear covers and the X-axis arm upper cover.  
Refer to "7 Removing the Robot Covers" in Chapter 4 for removing the covers.
- 6) Disconnect the connectors on the X-axis motor power cable XM and resolver cable XP.

- 7) Remove the bolts (M6×20L, 4 pieces) securing the motor holder by using the ratchet handle, M6 hexagonal socket, socket adapter and extension bar. (See Fig. 5-18.)

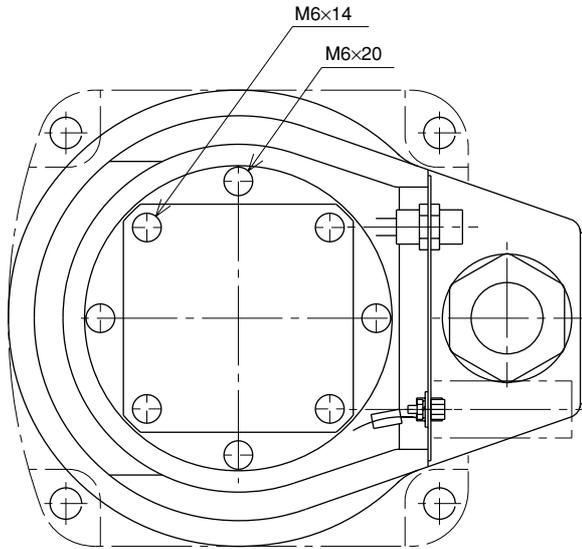


Fig. 5-18

- 8) With the motor still attached to the motor holder, pull out the motor by swaying it gently right and left. If it is difficult to remove the motor holder, slowly rotate the X-axis arm and again try removing the motor holder.

**CAUTION**

Carefully remove the motor holder so as not to let hands or fingers get pinched between the motor holder and the base.  
An O-ring is fitted to the motor holder, so be careful not to let it drop into the peripheral unit.

- 9) Remove the bolts (M6×14L, 4 pieces) securing the motor and remove the motor from the motor holder. (See Fig. 5-18.)

**CAUTION**

An O-ring is fitted to the motor, so be careful not to let it drop into the peripheral unit.

- 10) Remove the wave generator from the motor shaft. The wave generator is secured with an M4 set screw and key. (See Fig. 5-22.)

**CAUTION**

A spacer is inserted between the wave generator and the motor, so be careful not to lose it.

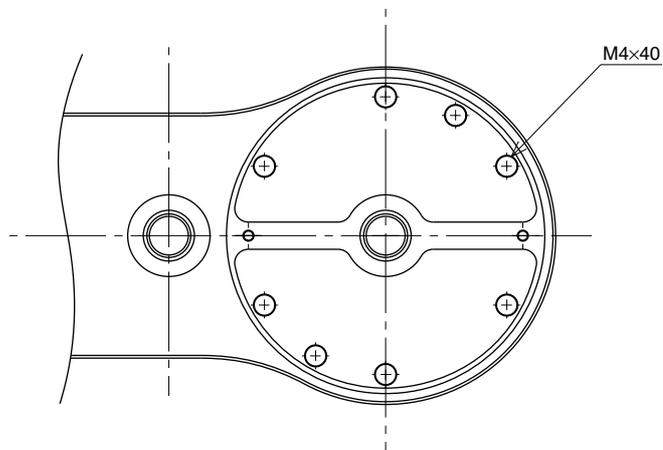
**⚠ WARNING**

When you remove the X-axis arm installation bolts (M4×40L, 8 pieces) in the next step, the X-axis arm may come off causing a hazardous situation. Be especially careful to keep the arm from falling when a heavy tool is attached to the arm tip.

**⚠ WARNING**

Removing the X-axis arm is dangerous for just one person. Always use two or more people, or remove the Y-axis arm in advance.  
Refer to "2. Y-axis" of "5-2-2" for removing the Y-axis arm.

- 11) Remove the X-axis arm installation bolts (M4×40L, 8 pieces). (See Fig. 5-19.)

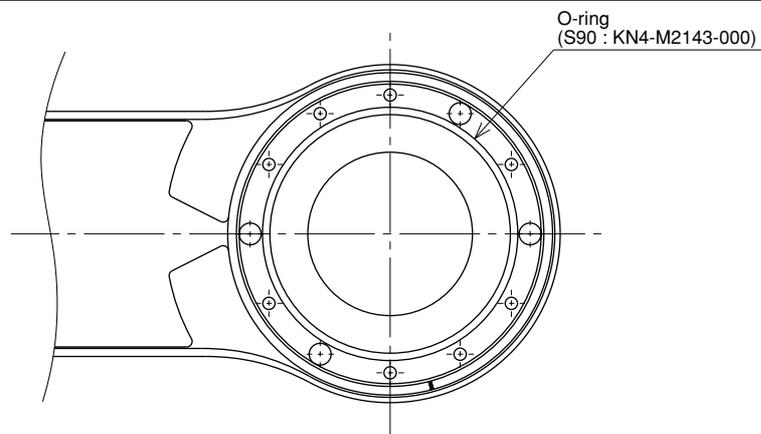


**Fig. 5-19**

- 12) Remove the X-axis arm and place it where it will not obstruct the work.

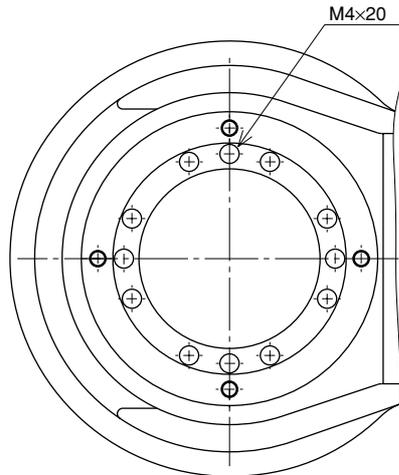
**⚠ CAUTION**

An O-ring is fitted to the X-axis arm, so be careful not to let it drop into the peripheral unit. (See Fig. 5-20.)



**Fig. 5-20**

- 13) Remove the bolts (M4×20L, 12 pieces) securing the X-axis harmonic drive. (See Fig. 5-21.)



**Fig. 5-21**

- 14) Remove the X-axis harmonic drive from the top of the base.

**CAUTION**

An O-ring is fitted to the X-axis harmonic drive, so be careful not to let it drop into the base or peripheral unit.

- 15) Fit an O-ring (supplied with the harmonic drive) coated with harmonic grease into the O-ring groove on the new harmonic drive. (See Fig. 5-22.)  
Apply small amounts of "Screw Lock" to the bolts (M4×20L, 12 pieces) and tighten them to secure the harmonic drive from the backside of the base. (See Fig. 5-21.)

**CAUTION**

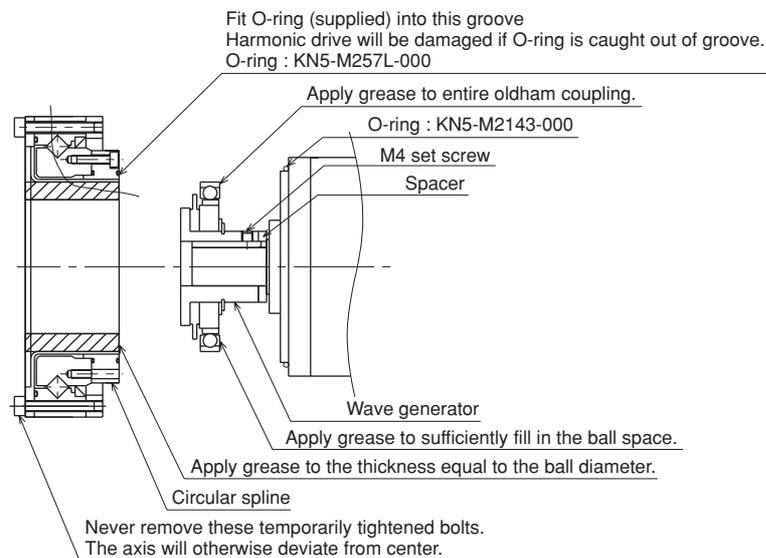
Do not allow the O-ring to get caught out of the groove during reassembly. A problem will occur if the robot is operated with the O-ring left caught out of the groove.

- 16) Apply harmonic grease to the new wave generator and flexspline.  
See Fig. 5-22 for applying grease properly.
- 17) Fit a new O-ring into the O-ring groove on the X-axis arm (see Fig. 5-20) and secure it to the harmonic drive. Then apply small amounts of "Screw Lock" to the bolts (M4×40L, 8 pieces) you removed earlier and tighten them uniformly to secure the X-axis arm. (See Fig. 5-19.)

**CAUTION**

Do not allow the O-ring to get caught out of the groove during reassembly. A problem will occur if the robot is operated with the O-ring left caught out of the groove.

- 18) Fit the spacer and wave generator onto the motor shaft, and fully insert them against the motor. Then, apply small amounts of "Screw Lock" to the M4 set screw (1 piece) you removed earlier and tighten it to secure the wave generator onto the motor shaft. (See Fig. 5-22.)



**Fig. 5-22**

- 19) Fit the O-ring to the motor and secure the motor to the motor holder with the bolts (M6×14L, 4 pieces) you removed earlier. (See Fig. 5-18 and Fig. 5-22.)

**CAUTION**

Do not allow the O-ring to get caught out of the groove during reassembly. A problem will occur if the robot is operated with the O-ring left caught out of the groove.

- 20) Fit a new O-ring coated with harmonic grease into the O-ring groove on the motor holder and tighten the bolts (M6×20L, 4 pieces) you removed earlier to temporarily secure the motor holder to the base. (See Fig. 5-18.)

**CAUTION**

Do not allow the O-ring to get caught out of the groove during reassembly. A problem will occur if the robot is operated with the O-ring left caught out of the groove.

- 21) Uniformly tighten the four bolts (M6×20L) temporarily fastened in the previous step while moving the X-axis by hand slowly left and right through 45°. If any jamming or catching is felt while moving the axis at this time, then reassemble from the beginning.
- 22) Reattach the connectors on the X-axis motor power cable XM and resolver cable XP.
- 23) Reattach the base (robot pedestal) front and rear covers and the X-axis arm upper cover.

- 24) Go outside the safeguard enclosure.
- 25) Check that no one is inside the safeguard enclosure, and then turn on the controller.

**⚠ CAUTION**

---

After the Harmonic drive is replaced, an absolute reset must be performed, and the standard coordinate and point data must be reset. Refer to "Chapter 4 Adjustment" to adjust it.

---

- 26) Turn the X-axis arm as much as possible (at least 10 degrees or more), and perform aging at 5% speed for 30 minutes and then at 20% speed for 30 minutes.

## 2. Y-axis

- 1) Prepare the following tools and items.
  - Harmonic grease 4B No.2 (12g)
  - Waste cloth (rag)
  - Phillips-head screwdriver
  - Hex wrench set
  - Screw Lock (thread sealant)
  - Torque-limiting wrench
  - Replacement parts (See table below.)

Replacement parts			
Parts name	Type No.	YAMAHA Parts No.	Note
Harmonic drive	SHF-20-80	KN4-M2510-001	
O-ring	Cross section diameter: 1.78mm Inner diameter: 72.75mm	KN4-M257K-000	Lower part of harmonic drive
	Cross section diameter: 1.50mm Inner diameter: 49.00mm	KN3-M2143-000	For motor
	Cross section diameter: 0.99mm Inner diameter: 53.28mm	KN3-M2144-000	Supplied with harmonic drive

- 2) Turn off the controller.
- 3) Place a sign indicating that the robot is being inspected, to keep others from operating the controller switch.
- 4) Enter the safeguard enclosure.
- 5) Remove the Y-axis arm upper cover. Place the cover on the robot base (pedestal) side with the machine harness still connected.  
Refer to "7 Removing the Robot Covers" in Chapter 4 for removing the covers.
- 6) Disconnect the connectors on the Y-axis motor power cable YM and resolver cable YP.
- 7) Remove the Y-axis motor installation bolts (M5×14L, 4 pieces) and then remove the Y-axis motor by swaying it gently right and left. (See Fig. 5-23.)

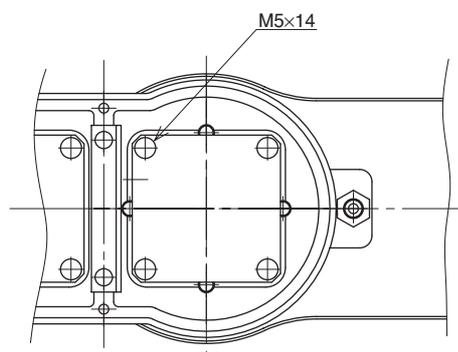


Fig. 5-23

**CAUTION**

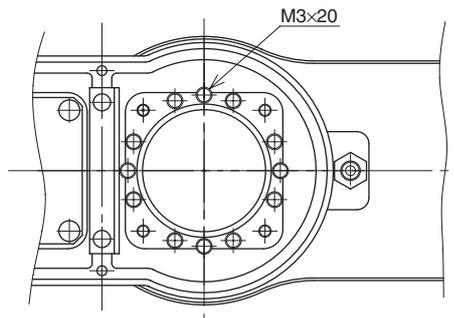
An O-ring is fitted to the motor, so be careful not to let it drop into the peripheral unit.

- 8) Remove the wave generator from the motor shaft. The wave generator is secured with an M4 set screws. (See Fig. 5-27.)

**⚠ WARNING**

When you remove the Y-axis arm installation bolts (M3×20L, 12 pieces) in the next step, the Y-axis arm may come off causing a hazardous situation. Be especially careful to keep the arm from falling when a heavy tool is attached to the arm tip.

- 9) Remove the Y-axis arm installation bolts (M3×20L, 12 pieces). (See Fig. 5-24.)



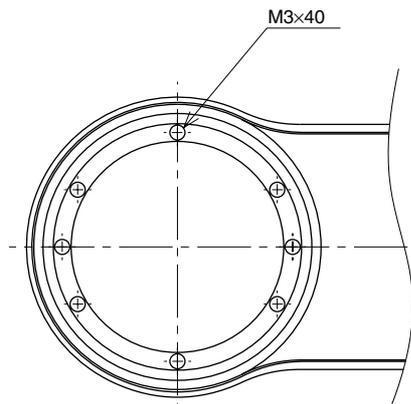
**Fig. 5-24**

- 10) Remove the Y-axis arm and place it where it will not obstruct the work.

**⚠ CAUTION**

An O-ring is fitted to the upper surface of the harmonic drive, so be careful not to let it drop into the peripheral unit.

- 11) Remove the Y-axis harmonic drive installation bolts (M3×40L, 8 pieces) from the bottom of the arm. (See Fig. 5-25.)

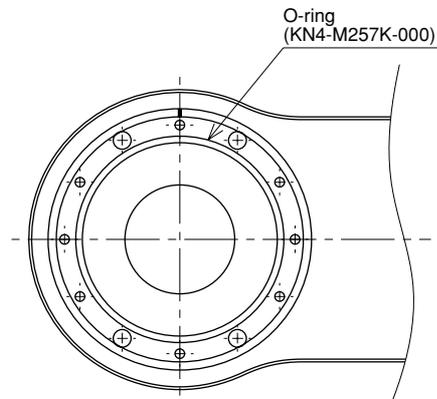


**Fig. 5-25**

- 12) Remove the Y-axis harmonic drive from the top of the X-axis arm.

**CAUTION**

An O-ring is fitted to the upper surface of the X-axis, so be careful not to let it drop into the peripheral unit. (See Fig. 5-26.)



**Fig. 5-26**

- 13) Fit a new O-ring coated with harmonic grease into the O-ring groove on the X-axis arm. (See Fig. 5-26.)
- 14) Place the new harmonic drive on the X-axis arm, and secure it with the bolts (M3×40L, 8 pieces) you removed earlier. Apply small amounts of "Screw Lock" to the bolts and tighten them uniformly to secure the harmonic drive from the backside. (See Fig. 5-25.)

**CAUTION**

Do not allow the O-ring to get caught out of the groove during reassembly. A problem will occur if the robot is operated with the O-ring left caught out of the groove.

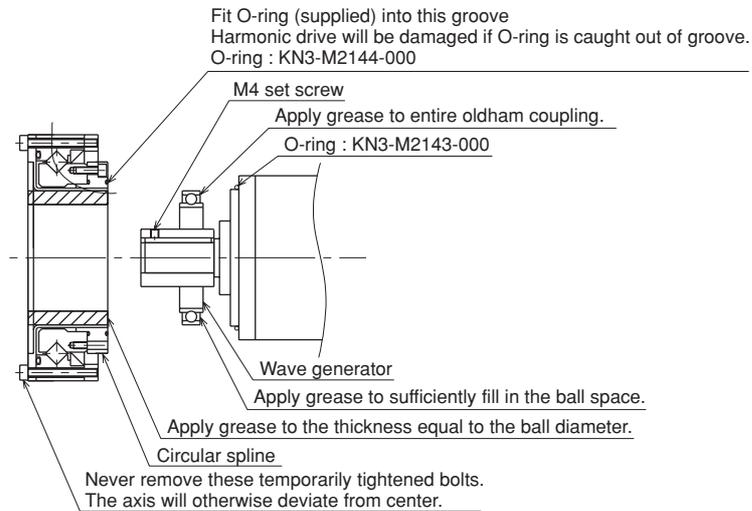
- 15) Fit an O-ring (supplied with the harmonic drive) coated with harmonic grease into the O-ring groove on the new harmonic drive. (See Fig. 5-27.)
- 16) Secure the Y-axis arm to the harmonic drive with the bolts (M3×20L, 12 pieces) you removed earlier. Apply small amounts of "Screw Lock" to the bolts and tighten them uniformly to secure the Y-axis arm. (See Fig. 5-24.)

**CAUTION**

Do not allow the O-ring to get caught out of the groove during reassembly. A problem will occur if the robot is operated with the O-ring left caught out of the groove.

- 17) Apply harmonic grease to the new wave generator and flexspline. See Fig. 5-27 for applying grease properly.

- 18) Fit the wave generator onto the motor shaft, and fully insert it against the motor. Then, apply small amounts of "Screw Lock" to the M4 set screw (1 piece) you removed earlier and tighten it to secure the wave generator. (See Fig. 5-27.)



**Fig. 5-27**

- 19) Fit a new O-ring to the motor and tighten the bolts (M5×14L, 4 pieces) you removed earlier to temporarily secure the motor to the Y-axis arm. (See Fig. 5-23 and Fig. 5-27.)

**CAUTION**

Do not allow the O-ring to get caught out of the groove during reassembly. A problem will occur if the robot is operated with the O-ring left caught out of groove.

- 20) Uniformly tighten the four bolts (M5×12L) temporarily fastened in the previous step while moving the Y-axis by hand slowly left and right through 45°. If any jamming or catching is felt while moving the axis at this time, then reassemble from the beginning.
- 21) Reattach the connectors on the Y-axis motor power cable YM and resolver cable YP.
- 22) Reattach the Y-axis arm upper cover.
- 23) Go outside the safeguard enclosure.
- 24) Check that no one is inside the safeguard enclosure, and then turn on the controller.

**CAUTION**

After the Harmonic drive is replaced, an absolute reset must be performed, and the standard coordinate and point data must be reset. Refer to "Chapter 4 Adjustment" to adjust it.

- 25) Turn the Y-axis arm as much as possible (at least 10 degrees or more), and perform aging at 5% speed for 30 minutes and then at 20% speed for 30 minutes.

### 3. R-axis

- 1) Prepare the following tools and items.
  - Harmonic grease 4B No.2 (7g)
  - Waste cloth (rag)
  - Phillips-head screwdriver
  - Hex wrench set
  - Screw Lock (thread sealant)
  - Torque-limiting wrench
  - Hook wrench
  - Replacement parts (See table below.)

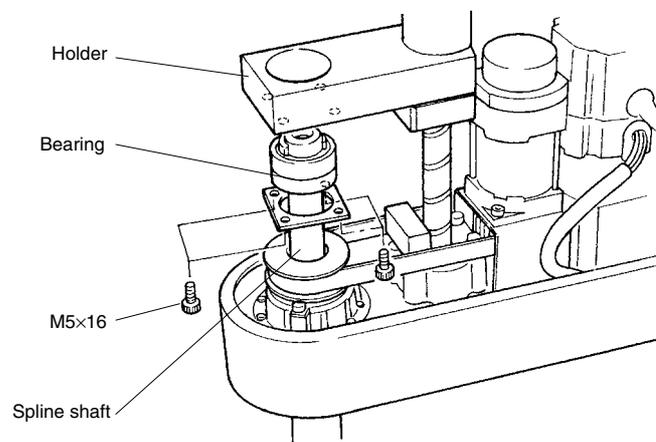
Replacement parts			
Parts name	Type No.	YAMAHA Parts No.	Note
Harmonic drive	SHF-17-50	KN4-M1821-000	
O-ring	Cross section diameter: 1.78mm × Inner diameter: 63.22mm	KN4-M1896-000	Lower part of harmonic drive
	Cross section diameter: 0.80mm × Inner diameter: 45.40mm	90990-17J016	Supplied with harmonic drive
Edge seal	VR22A	KN4-M1886-000	

- 2) Turn off the controller.
- 3) Place a sign indicating that the robot is being inspected, to keep others from operating the controller switch.
- 4) Enter the safeguard enclosure.
- 5) Remove the Y-axis arm upper cover. Place the cover on the robot base (pedestal) side with the machine harness still connected.  
Refer to "7 Removing the Robot Covers" in Chapter 4 for removing the covers.

**⚠ WARNING**

The Z-axis will slide down when the spline mounting bolts (M5×16L, 4 pieces) are removed in the next step, causing a hazardous situation. Prop the Z-axis with a support stand before loosening these bolts.

- 6) Remove the bolts (M5×16L, 4 pieces) securing the bearing to the upper end of the spline and remove the spline and bearing from the holder. (See Fig. 5-28.)



**Fig. 5-28**

- 7) While placing a steel rod or similar tool through the 7mm diameter hole at the lower part of the spline, loosen the U-nut at the top of the spline with the wrench, and remove the bearing and bearing mount plate. (See Fig. 5-29.) Use a round steel rod with a diameter slightly smaller than 7mm. Avoid using a square rod because the spline might be damaged by the edge of the rod. At this point, be careful to keep the spline shaft from coming off the spline nut.

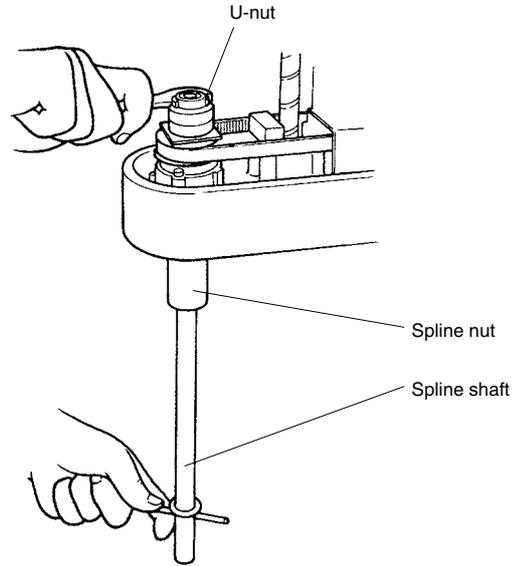


Fig. 5-29

- 8) Remove the bolts (M3×10L, 12 pieces) on the lower side of the Y-axis arm, and remove the R-axis dog ring from the fastening plate.
- 9) Remove the bolts (M3×25L, 8 pieces) on the underside of the Y-axis arm and remove the plate fastening the spline and the harmonic drive. (See Fig. 5-30.)

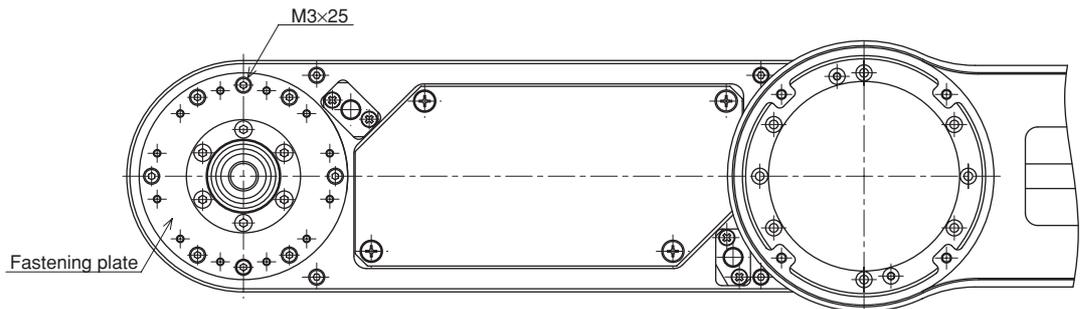
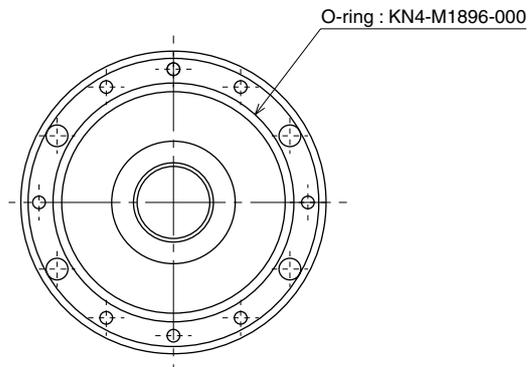


Fig. 5-30

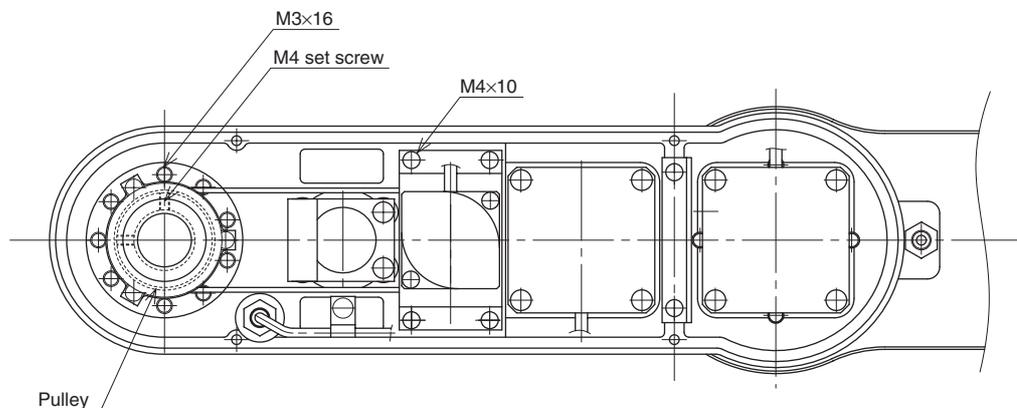
**CAUTION**

An O-ring is fitted to the fastening plate, so be careful not to let it drop into the peripheral unit. (See Fig. 5-31.)



**Fig. 5-31**

- 10) Remove the bolts (M4×10L, 4 pieces) securing the R-axis motor plate at the top of the Y-axis arm. (See Fig. 5-32.)
- 11) Loosen the pulley set screw (M4, 2 pieces) and remove the pulley from the wave generator. (See Fig. 5-32.)
- 12) Remove the harmonic drive installation bolts (M3×16L, 9 pieces) and pull out the harmonic drive from the bottom of the Y-axis arm. (See Fig. 5-32.)



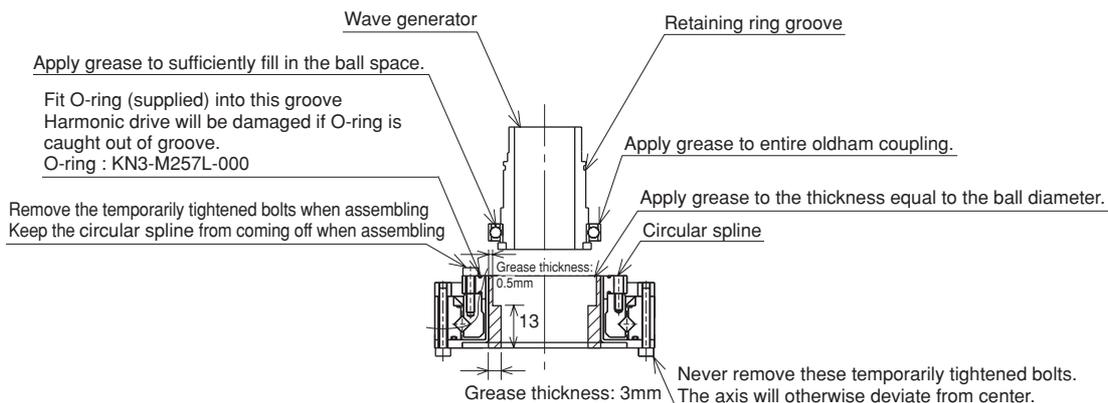
**Fig. 5-32**

**CAUTION**

An O-ring is fitted to the harmonic drive, so be careful not to let it drop into the peripheral unit.

- 13) Remove the retaining ring for the wave generator and pull out the wave generator from the bottom of the Y-axis arm.

- 14) Apply harmonic grease to the new wave generator. See Fig. 5-33 for applying grease properly.



**Fig. 5-33**

- 15) Insert the new wave generator into the Y-axis arm from the bottom, and secure it with the retaining ring. The chamfered side of the retaining ring should face downwards.
- 16) Apply the remaining harmonic grease to the circular spline.  
See Fig. 5-33 for applying grease properly.
- 17) Remove the four bolts temporarily tightened to the new harmonic drive.

**CAUTION**

Remove only the four bolts shown in Fig. 5-33 at this point. Never remove the bolts on the opposite side. If they are removed, the harmonic drive axis may deviate from the center causing trouble.

- 18) Fit an O-ring (supplied with the harmonic drive) coated with harmonic grease into the O-ring groove on the new harmonic drive. (See Fig. 5-33.)  
Apply small amounts of "Screw Lock" to the bolts (M3×16L, 9 pieces) and tighten them to secure the harmonic drive to the Y-axis arm from the top of the Y-axis arm. (See Fig. 5-32.)

**CAUTION**

Do not allow the O-ring to get caught out of the groove during reassembly. A problem will occur if the robot is operated with the O-ring left caught out of the groove.

When reassembling the harmonic drive, be careful to keep the circular spline from coming off. If it comes off, the harmonic drive axis will deviate from the center causing trouble.

- 19) Apply small amounts of "Screw Lock" to the M4 set screws (2 pieces) and tighten them to secure the pulley to the wave generator. (See Fig. 5-32.)
- 20) Fit the timing belt onto the wave generator pulley and motor pulley, and then secure the motor plate. (See Fig. 5-32.)

**CAUTION**

It is necessary to apply correct tension to the timing belt during reassembly. Refer to "8 Adjusting the Timing Belt Tension" in Chapter 4.

- 21) Fit a new O-ring into the O-ring groove on the fastening plate and also replace the edge seal with new one. Then secure the fastening plate to the harmonic drive with the bolts (M3×25L, 8 pieces) coated with small amounts of "Screw Lock". (See Fig. 5-30 and Fig. 5-34.) At this point, be careful to keep the spline shaft from coming off the spline nut.

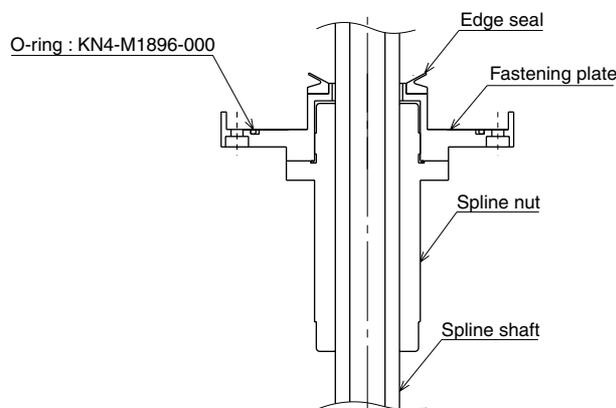
**CAUTION**

The harmonic drive service life may shorten if the edge seal effect is insufficient, so carefully reassemble the parts.

- 22) Tighten the bolts (M3×10L, 12 pieces) to secure the dog ring to the fastening plate.
- 23) Insert the bearing mount plate and bearing onto the spline from the top, and tighten the U-nut to secure the bearing. (Utilize the  $\phi 7$  through-hole when tightening the U-nut like you did to loosen it.) (See Fig. 5-29.)
- 24) Insert the spline and bearing through the holder and secure them with the bolts you removed earlier (M5×16L, 4 pieces). (See Fig. 5-28.)
- 25) Reattach the Y-axis arm upper cover.
- 26) Go outside the safeguard enclosure.
- 27) Check that no one is inside the safeguard enclosure, and then turn on the controller.

**CAUTION**

After the Harmonic drive is replaced, the absolute reset must be performed, and the point data must be reset. Refer to "Chapter 4 Adjustment" to adjust it.



**Fig. 5-34**

- 28) Turn the R-axis arm as much as possible (at least 10 degrees or more), and perform aging at 5% speed for 30 minutes and then at 20% speed for 30 minutes.

## 5-2-3 YK700X, YK800X, YK1000X

The following steps describe procedures and precautions when replacing the harmonic drives of the YK700X, YK800X and YK1000X. (The illustrations show the YK700X). For the bolt tightening torques in this work, refer to Table 5-2.

### 1. X-axis

1) Prepare the following tools and items.

- Harmonic grease 4B No.2 (45g)
- Waste cloth (rag)
- Phillips-head screwdriver
- Hex wrench set
- Screw Lock (thread sealant)
- Ratchet handle
- Hexagonal socket set
- Extension bar
- Torque-limiting wrench
- Replacement parts (See table below.)

Replacement parts			
Parts name	Type No.	YAMAHA Parts No.	Note
Harmonic drive	SHF-32-80	KN5-M2110-001	YK700X, YK800X
	SHF-32-100	KN5-M2110-101	YK1000X
O-ring	S115(JIS)	KN5-M2159-000	Top of harmonic drive
	Cross section diameter: 1.78mm Inner diameter: 78.97mm	KN5-M2144-000	Base (robot pedestal)
	Cross section diameter: 1.78mm Inner diameter: 69.57mm	KN5-M2143-000	Motor
	Cross section diameter: 1.50mm Inner diameter: 87.50mm	KN5-M2199-000	Supplied with harmonic drive

- 2) Turn off the controller.
- 3) Place a sign indicating that the robot is being inspected, to keep others from operating the controller switch.
- 4) Enter the safeguard enclosure.
- 5) Remove the base (robot pedestal) front and rear covers and the X-axis arm upper cover.  
Refer to "7 Removing the Robot Covers" in Chapter 4 for removing the covers.
- 6) Disconnect the connectors on the X-axis motor power cable XM and resolver cable XP.

- 7) Remove the bolts (M6×20L, 4 pieces) securing the motor by using the ratchet handle, M6 hexagonal socket, socket adapter and extension bar. (See Fig. 5-35.)

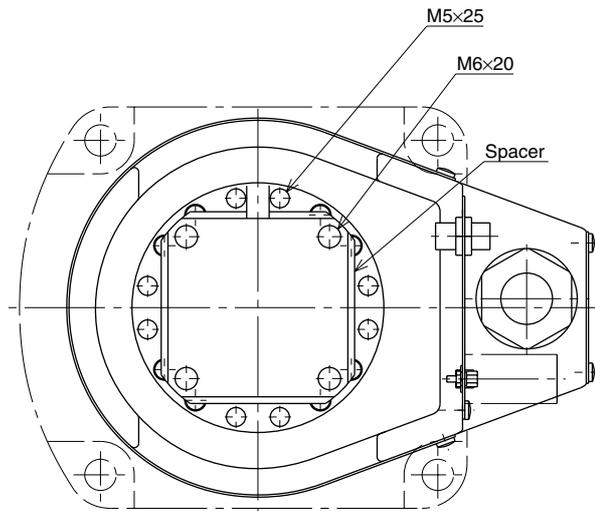


Fig. 5-35

- 8) Slowly pull out the motor while holding it slantways. (See Fig. 5-36.) If it is difficult to remove the motor, slowly rotate the X-axis arm and again try removing the motor.

**CAUTION**

Carefully remove the motor so as not to let hands or fingers get pinched between the motor and the base.

An O-ring is fitted to the motor and the spacer, so be careful not to let it drop into the peripheral unit.

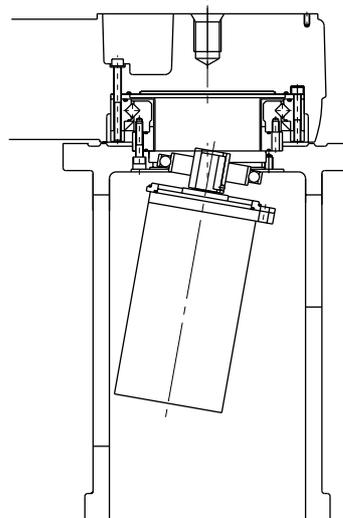


Fig. 5-36

- 9) Remove the wave generator from the motor shaft. The wave generator is secured with an M4 set screw and key. (See Fig. 5-40.)

**⚠ WARNING**

When you remove the X-axis arm installation bolts (M5×55L, 8 pieces) in the next step, the X-axis arm may come off causing a hazardous situation. Be especially careful to keep the arm from falling when a heavy tool is attached to the arm tip.

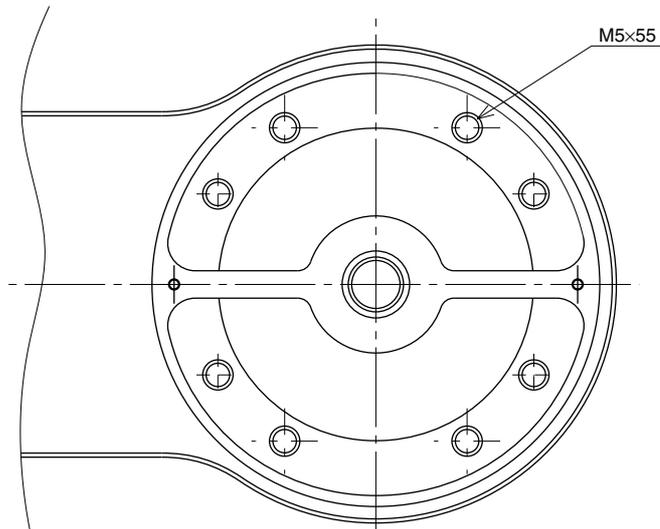
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**⚠ WARNING**

Removing the X-axis arm is dangerous for just one person. Always use two or more people, or remove the Y-axis arm in advance. Refer to "2. Y-axis" of "5-2-3" for removing the Y-axis arm.

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- 10) Remove the X-axis arm installation bolts (M5×55L, 8 pieces). (See Fig. 5-37.)

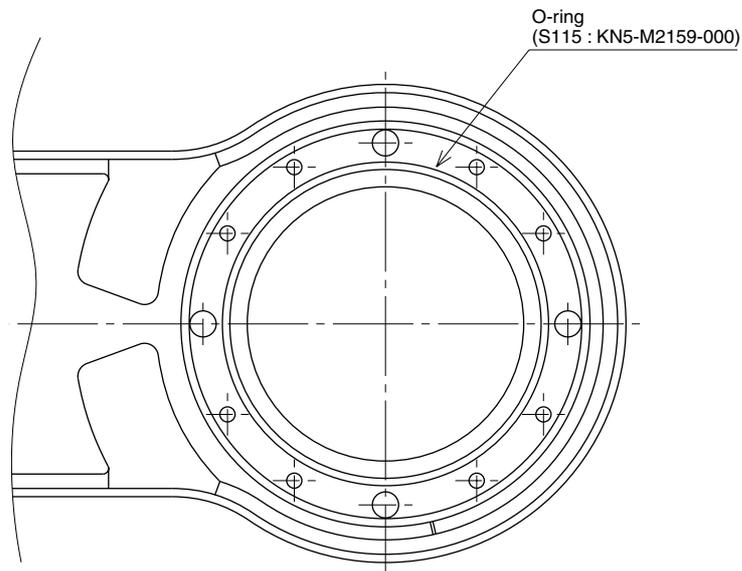


**Fig. 5-37**

- 11) Remove the X-axis arm and place it where it will not obstruct the work.

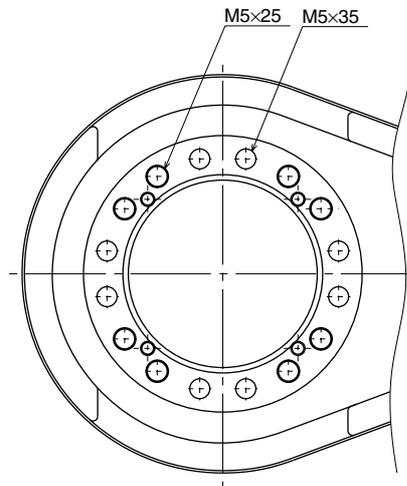
**CAUTION**

An O-ring is fitted to the X-axis arm, so be careful not to let it drop into the peripheral unit. (See Fig. 5-38.)



**Fig. 5-38**

- 12) Remove the bolts (M5×25L 8 pieces and M5×35L 8 pieces) securing the X-axis harmonic drive. (See Fig. 5-39.)



**Fig. 5-39**

- 13) Remove the X-axis harmonic drive from the top of the base.

**CAUTION**

An O-ring is fitted to the X-axis harmonic drive, so be careful not to let it drop into the base or peripheral unit.

- 14) Fit an O-ring (supplied with the harmonic drive) coated with harmonic grease into the O-ring groove on the new harmonic drive. (See Fig. 5-40.)  
Apply small amounts of "Screw Lock" to the bolts (M5×25L 8 pieces and M5×35L 8 pieces) and tighten them to secure the harmonic drive from the backside of the base. (See Fig. 5-39.)

**CAUTION**

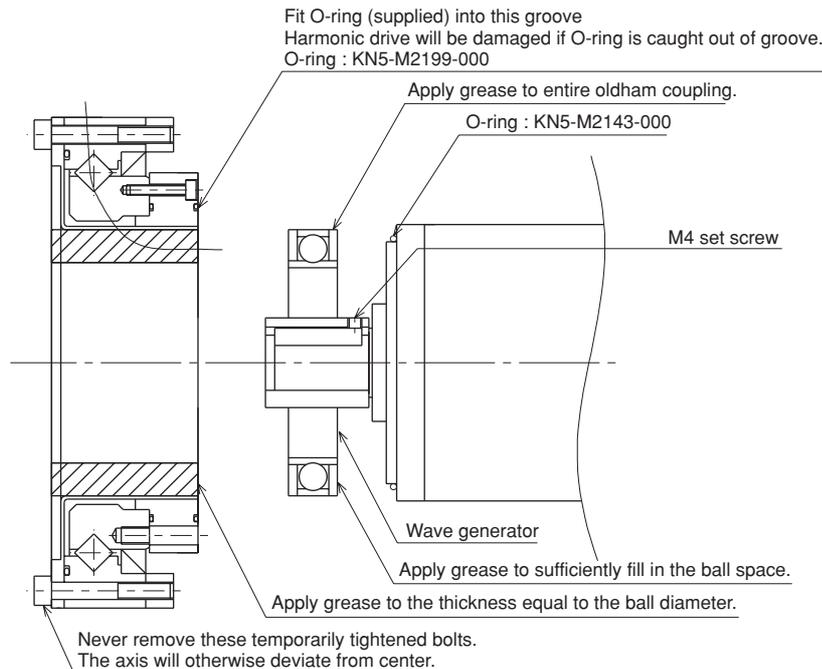
Do not allow the O-ring to get caught out of the groove during reassembly. A problem will occur if the robot is operated with the O-ring left caught out of the groove.

- 15) Apply harmonic grease to the new wave generator and flexspline.  
See Fig. 5-40 for applying grease properly.
- 16) Fit a new O-ring into the O-ring groove on the X-axis arm and secure it to the harmonic drive. Then apply small amounts of "Screw Lock" to the bolts (M5×55L, 8 pieces) you removed earlier and tighten them uniformly to secure the X-axis arm. (See Fig. 5-37 and Fig. 5-38.)

**CAUTION**

Do not allow the O-ring to get caught out of the groove during reassembly. A problem will occur if the robot is operated with the O-ring left caught out of the groove.

- 17) Fit the wave generator onto the motor shaft, and fully insert it against the motor. Then, apply small amounts of "Screw Lock" to the M4 set screw (1 piece) you removed earlier and tighten it to secure the wave generator onto the motor shaft. (See Fig. 5-40.)



**Fig. 5-40**

- 18) Fit a new O-ring to the motor and temporarily fasten the motor and spacer to the base with the bolts (M6×20L, 4 pieces) you removed earlier. Insert a new O-ring between the spacer and the base at this point.  
Insert the motor with the wave generator into the harmonic drive while holding the motor slantways. If it is difficult to insert the motor, try inserting it again while slowly rotating the X-axis arm. (See Fig. 5-36.)

**⚠ CAUTION**

Do not allow the O-ring to get caught out of the groove during reassembly. A problem will occur if the robot is operated with the O-ring left caught out of the groove.

---

- 19) Uniformly tighten the four bolts (M6×20L) temporarily fastened in the previous step while moving the X-axis by hand slowly left and right through 45°. If any jamming or catching is felt while moving the axis at this time, then reassemble from the beginning.
- 20) Reattach the connectors on the X-axis motor power cable XM and resolver cable XP.
- 21) Reattach the base (robot pedestal) front and rear covers and the X-axis arm upper cover.
- 22) Go outside the safeguard enclosure.
- 23) Check that no one is inside the safeguard enclosure, and then turn on the controller.

**⚠ CAUTION**

After the Harmonic drive is replaced, an absolute reset must be performed, and the standard coordinate and point data must be reset. Refer to "Chapter 4 Adjustment" to adjust it.

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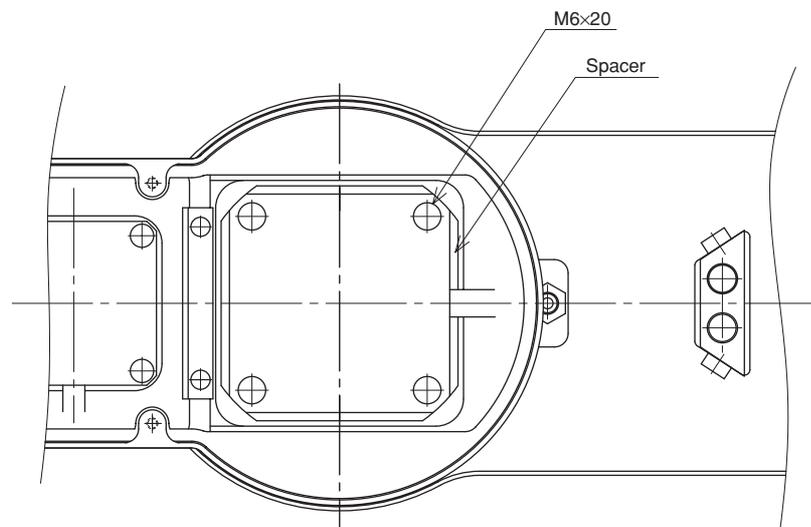
- 24) Turn the X-axis arm as much as possible (at least 10 degrees or more), and perform aging at 5% speed for 30 minutes and then at 20% speed for 30 minutes.

**2. Y-axis**

- 1) Prepare the following tools and items.
  - Harmonic grease 4B No.2 (24g)
  - Waste cloth (rag)
  - Phillips-head screwdriver
  - Hex wrench set
  - Screw Lock (thread sealant)
  - Torque-limiting wrench
  - Replacement parts (See table below.)

Replacement parts			
Parts name	Type No.	YAMAHA Parts No.	Note
Harmonic drive	SHF-25-80	KN4-M2110-001	
O-ring	S90(JIS)	KN4-M2143-000	Lower part of harmonic drive
	Cross section diameter: 1.78mm × Inner diameter: 69.57mm	KN5-M2143-000	For motor
	Cross section diameter: 1.30mm × Inner diameter: 66.50mm	KN5-M257L-000	Supplied with harmonic drive

- 2) Turn off the controller.
- 3) Place a sign indicating that the robot is being inspected, to keep others from operating the controller switch.
- 4) Enter the safeguard enclosure.
- 5) Remove the Y-axis arm upper cover. Place the cover on the robot base (pedestal) side with the machine harness still connected.  
Refer to "7 Removing the Robot Covers" in Chapter 4 for removing the covers.
- 6) Disconnect the connectors on the Y-axis motor power cable YM and resolver cable YP.
- 7) Remove the Y-axis motor installation bolts (M6×20L, 4 pieces) and then remove the Y-axis motor by swaying it gently right and left. (See Fig. 5-41.)



**Fig. 5-41**

**⚠ CAUTION**

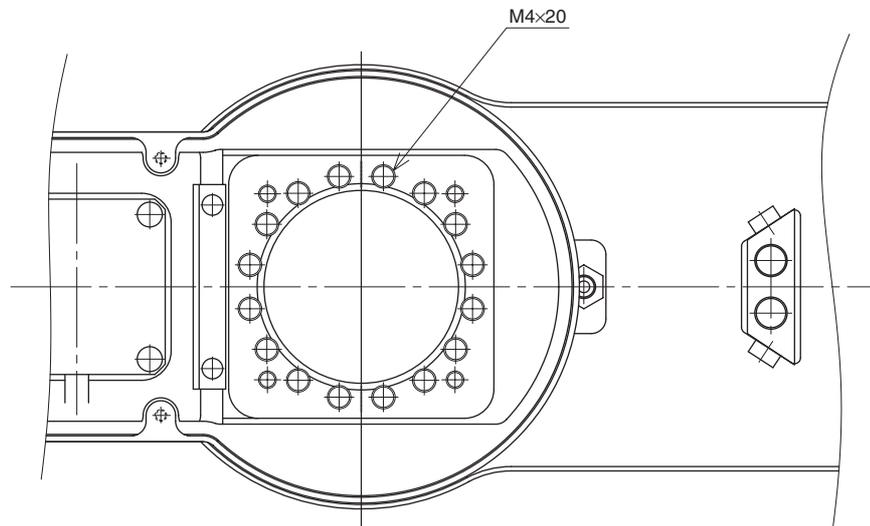
An O-ring is fitted to the motor, so be careful not to let it drop into the peripheral unit.

- 8) Remove the wave generator from the motor shaft. The wave generator is secured with an M4 set screws. (See Fig. 5-45.)

**⚠ WARNING**

When you remove the Y-axis arm installation bolts (M4×20L, 16 pieces) in the next step, the Y-axis arm may come off causing a hazardous situation. Be especially careful to keep the arm from falling when a heavy tool is attached to the arm tip.

- 9) Remove the Y-axis arm installation bolts (M4×20L, 16 pieces). (See Fig. 5-42.)

**Fig. 5-42**

- 10) Remove the Y-axis arm and place it where it will not obstruct the work.

**⚠ CAUTION**

An O-ring is fitted to the upper surface of the harmonic drive, so be careful not to let it drop into the peripheral unit.

- 11) Remove the Y-axis harmonic drive installation bolts (M4×45L, 8 pieces). (See Fig. 5-43.)

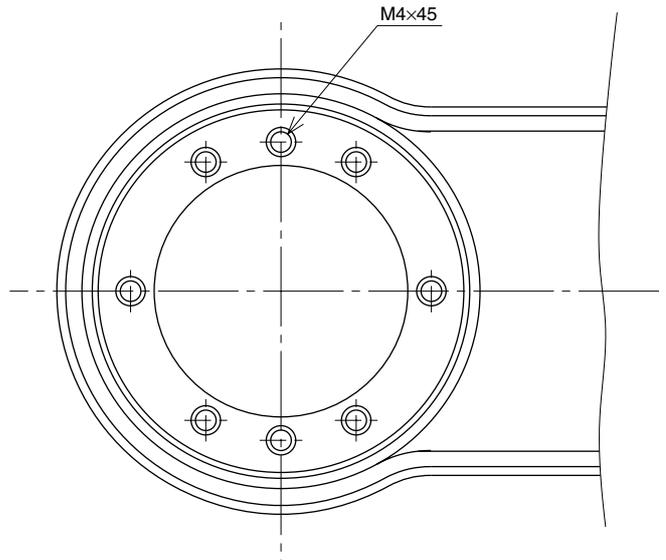


Fig. 5-43

- 12) Remove the Y-axis harmonic drive from the top of the X-axis arm.

**CAUTION**

An O-ring is fitted to the upper surface of the X-axis, so be careful not to let it drop into the peripheral unit. (See Fig. 5-44.)

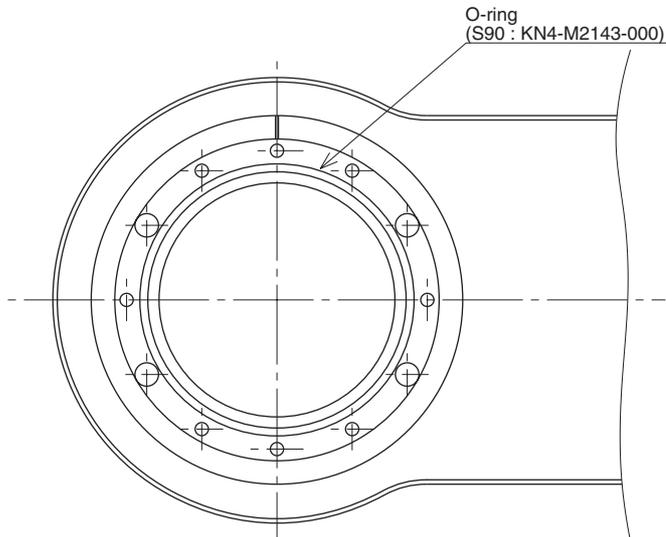


Fig. 5-44

- 13) Fit a new O-ring coated with harmonic grease into the O-ring groove on the X-axis arm. (See Fig. 5-44.)

- 14) Place the new harmonic drive on the X-axis arm, and secure it with the bolts (M4×45L, 8 pieces) you removed earlier. Apply small amounts of "Screw Lock" to the bolts and tighten them uniformly to secure the harmonic drive from the backside. (See Fig. 5-43.)

**CAUTION**

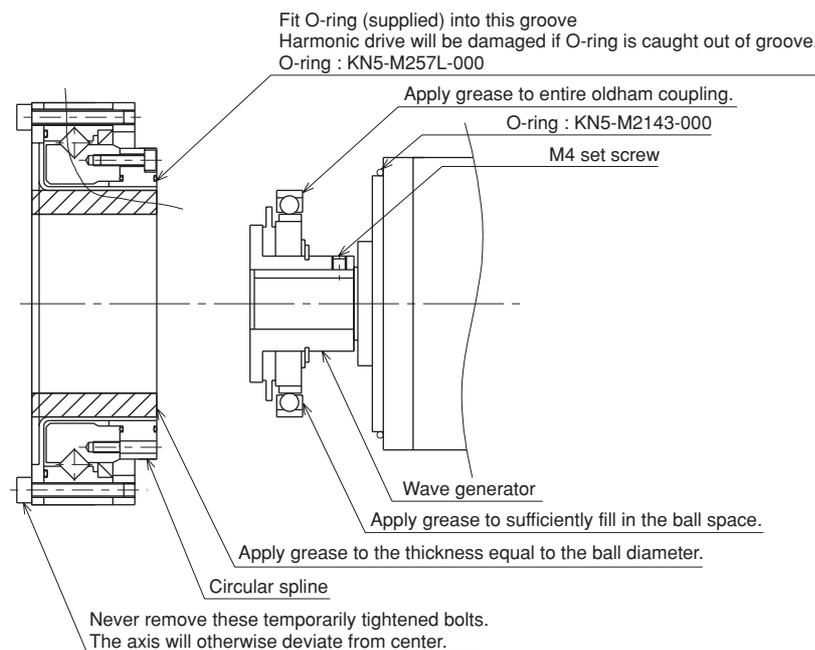
Do not allow the O-ring to get caught out of the groove during reassembly. A problem will occur if the robot is operated with the O-ring left caught out of the groove.

- 15) Fit an O-ring (supplied with the harmonic drive) coated with harmonic grease into the O-ring groove on the new harmonic drive. (See Fig. 5-45.)
- 16) Secure the Y-axis arm to the harmonic drive with the bolts (M4×20L, 16 pieces) you removed earlier. Apply small amounts of "Screw Lock" to the bolts and tighten them uniformly to secure the Y-axis arm. (See Fig. 5-42.)

**CAUTION**

Do not allow the O-ring to get caught out of the groove during reassembly. A problem will occur if the robot is operated with the O-ring left caught out of the groove.

- 17) Apply harmonic grease to the new wave generator and flexspline.  
See Fig. 5-45 for applying grease properly.
- 18) Fit the wave generator onto the motor shaft, and fully insert it against the motor. Then, apply small amounts of "Screw Lock" to the M4 set screw (1 piece) you removed earlier and tighten it to secure the wave generator. (See Fig. 5-45.)



**Fig. 5-45**

- 19) Fit a new O-ring to the motor and tighten the bolts (M6×20L, 4 pieces) you removed earlier to temporarily secure the motor to the Y-axis arm. (See Fig. 5-41.)

Insert a new O-ring between the spacer and the Y-axis arm at this point.

**⚠ CAUTION**

Do not allow the O-ring to get caught out of the groove during reassembly. A problem will occur if the robot is operated with the O-ring left caught out of groove.

---

- 20) Uniformly tighten the four bolts (M6×20L) temporarily fastened in the previous step while moving the Y-axis by hand slowly left and right through 45°. If any jamming or catching is felt while moving the axis at this time, then reassemble from the beginning.
- 21) Reattach the connectors on the Y-axis motor power cable YM and resolver cable YP.
- 22) Reattach the Y-axis arm upper cover.
- 23) Go outside the safeguard enclosure.
- 24) Check that no one is inside the safeguard enclosure, and then turn on the controller.

**⚠ CAUTION**

After the Harmonic drive is replaced, an absolute reset must be performed, and the standard coordinate and point data must be reset. Refer to "Chapter 4 Adjustment" to adjust it.

---

- 25) Turn the Y-axis arm as much as possible (at least 10 degrees or more), and perform aging at 5% speed for 30 minutes and then at 20% speed for 30 minutes.

### 3. R-axis

- 1) Prepare the following tools and items.
  - Harmonic grease 4B No.2 (9g)
  - Waste cloth (rag)
  - Phillips-head screwdriver
  - Hex wrench set
  - Screw Lock (thread sealant)
  - Torque-limiting wrench
  - Hook wrench
  - Replacement parts (See table below.)

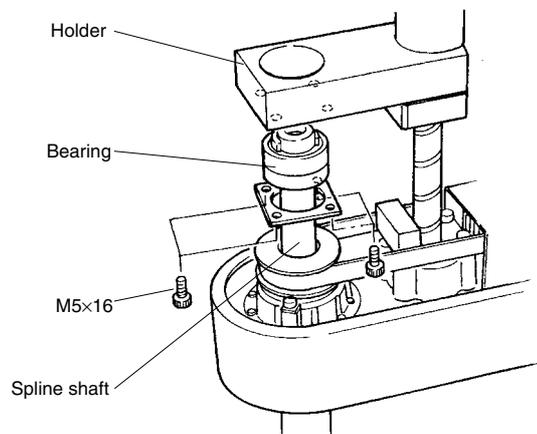
Replacement parts			
Parts name	Type No.	YAMAHA Parts No.	Note
Harmonic drive	SHF-20-50	KN5-M1821-001	
O-ring	S71(JIS)	KN3-M2159-000	Lower part of harmonic drive
	Cross section diameter: 0.99mm × Inner diameter: 53.28mm	KN3-M2144-000	Supplied with harmonic drive
Edge seal	VR28A	KN5-M1886-000	

- 2) Turn off the controller.
- 3) Place a sign indicating that the robot is being inspected, to keep others from operating the controller switch.
- 4) Enter the safeguard enclosure.
- 5) Remove the Y-axis arm upper cover. Place the cover on the robot base (pedestal) side with the machine harness still connected.  
Refer to "7 Removing the Robot Covers" in Chapter 4 for removing the covers.

**⚠ WARNING**

The Z-axis will slide down when the spline mounting bolts (M5×16L, 4 pieces) are removed in the next step, causing a hazardous situation. Prop the Z-axis with a support stand before loosening these bolts.

- 6) Remove the bolts (M5×16L, 4 pieces) securing the bearing to the upper end of the spline and remove the spline and bearing from the holder. (See Fig. 5-46.)



**Fig. 5-46**

- 7) While placing a steel rod or similar tool through the 8mm diameter hole at the lower part of the spline, loosen the U-nut at the top of the spline with the hook wrench, and remove the bearing and bearing mount plate. (See Fig. 5-47.)

Use a round steel rod with a diameter slightly smaller than 8mm. Avoid using a square rod because the spline might be damaged by the edge of the rod.

At this time, be careful to keep the spline shaft from coming off the spline nut.

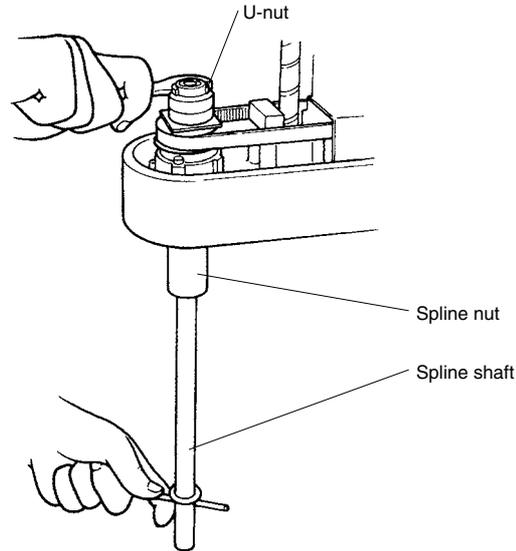


Fig. 5-47

- 8) Remove the bolts (M3×10L, 12 pieces) on the lower side of the Y-axis arm, and remove the R-axis dog ring from the fastening plate.
- 9) Remove the bolts (M3×30L, 8 pieces) on the underside of the Y-axis arm and remove the plate fastening the spline and the harmonic drive. (See Fig. 5-48.)

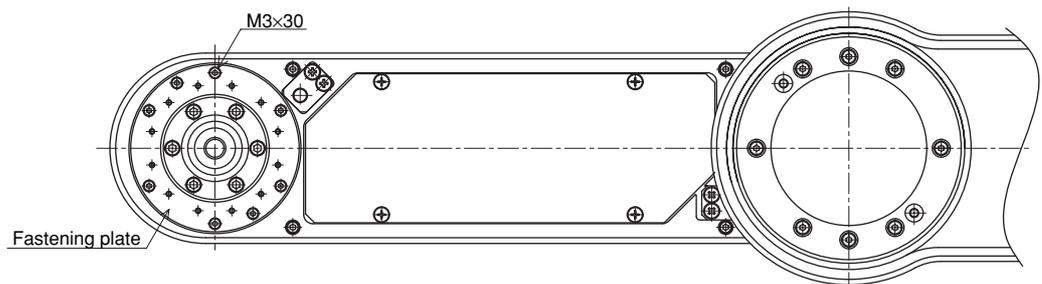
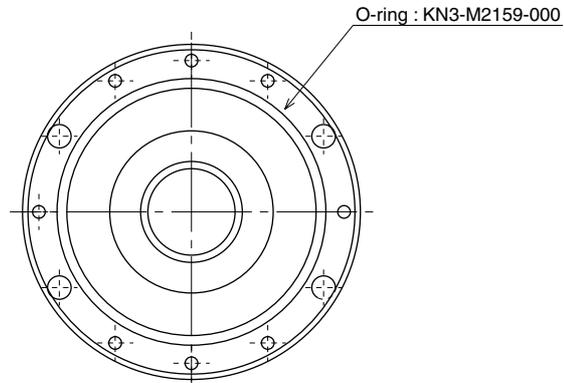


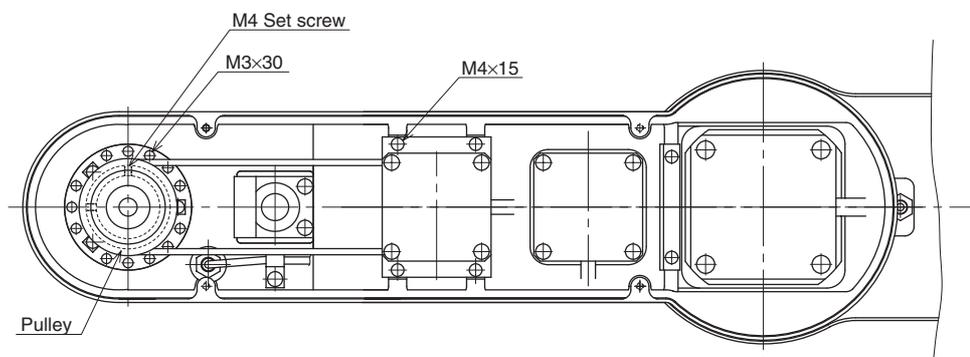
Fig. 5-48

**CAUTION**

An O-ring is fitted to the fastening plate, so be careful not to let it drop into the peripheral unit. (See Fig. 5-49.)

**Fig. 5-49**

- 10) Remove the bolts (M4×15L, 4 pieces) securing the R-axis motor plate at the top of the Y-axis arm. (See Fig. 5-50.)
- 11) Loosen the pulley set screw (M4, 2 pieces) and remove the pulley from the wave generator. (See Fig. 5-50.)
- 12) Remove the harmonic drive installation bolts (M3×30L, 13 pieces) and pull out the harmonic drive from the bottom of the Y-axis arm. (See Fig. 5-50.)

**Fig. 5-50****CAUTION**

An O-ring is fitted to the harmonic drive, so be careful not to let it drop into the peripheral unit.

- 13) Remove the retaining ring for the wave generator and pull out the wave generator from the bottom of the Y-axis arm.

- 14) Apply harmonic grease to the new wave generator. See Fig. 5-51 for applying grease properly.

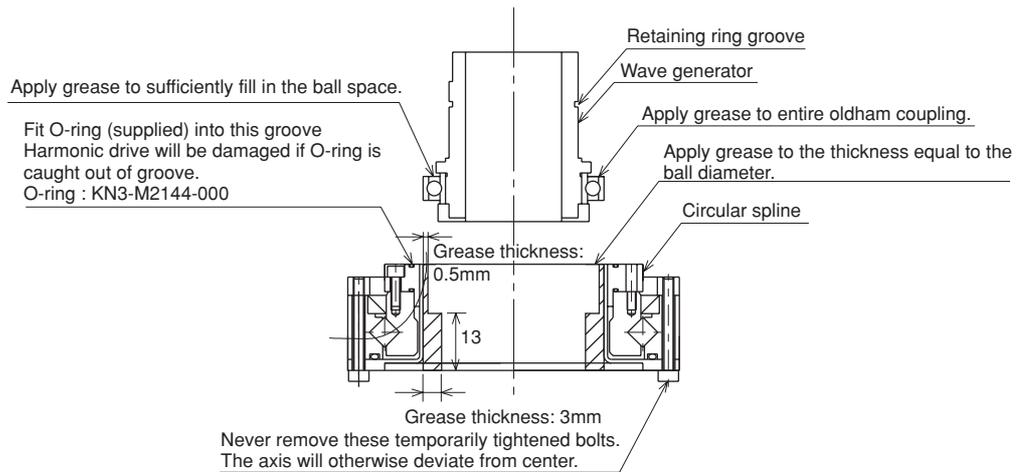


Fig. 5-51

- 15) Insert the new wave generator into the Y-axis arm from the bottom, and secure it with the retaining ring. The chamfered side of the retaining ring should face downwards.
- 16) Apply the remaining harmonic grease to the circular spline. See Fig. 5-51 for applying grease properly.
- 17) Fit an O-ring (supplied with the harmonic drive) coated with harmonic grease into the O-ring groove on the new harmonic drive. (See Fig. 5-51.) Apply small amounts of "Screw Lock" to the bolts (M3×30L, 13 pieces) and tighten them to secure the harmonic drive to the Y-axis arm from the top of the Y-axis arm. (See Fig. 5-50.)

**CAUTION**

Do not allow the O-ring to get caught out of the groove during reassembly. A problem will occur if the robot is operated with the O-ring left caught out of the groove.

- 18) Apply small amounts of "Screw Lock" to the M4 set screws (2 pieces) and tighten them to secure the pulley to the wave generator. (See Fig. 5-50.)
- 19) Fit the timing belt onto the wave generator pulley and motor pulley, and then secure the motor plate. (See Fig. 5-50.)

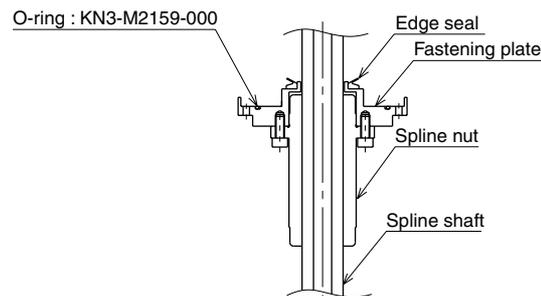
**CAUTION**

It is necessary to apply correct tension to the timing belt during reassembly. Refer to "8 Adjusting the Timing Belt Tension" in Chapter 4.

- 20) Fit a new O-ring into the O-ring groove on the fastening plate and also replace the edge seal with new one. Then secure the fastening plate to the harmonic drive with the bolts (M3×30L, 8 pieces) coated with small amounts of "Screw Lock". (See Fig. 5-48 and Fig. 5-52.) At this point, be careful to keep the spline shaft from coming off the spline nut.

**CAUTION**

The harmonic drive service life may shorten if the edge seal effect is insufficient, so carefully reassemble the parts.



**Fig. 5-52**

- 21) Tighten the bolts (M3×10L, 12 pieces) to secure the dog ring to the fastening plate.
- 22) Insert the bearing mount plate and bearing onto the spline from the top, and tighten the U-nut to secure the bearing. (Utilize the  $\phi 8$  through-hole when tightening the U-nut like you did to loosen it.) (See Fig. 5-47.)
- 23) Insert the spline and bearing through the holder and secure them with the bolts you removed earlier (M5×16L, 4 pieces). (See Fig. 5-46.)
- 24) Reattach the Y-axis arm upper cover.
- 25) Go outside the safeguard enclosure.
- 26) Check that no one is inside the safeguard enclosure, and then turn on the controller.

**CAUTION**

After the Harmonic drive is replaced, the absolute reset must be performed, and the point data must be reset. Refer to "Chapter 4 Adjustment" to adjust it.

- 27) Turn the R-axis arm as much as possible (at least 10 degrees or more), and perform aging at 5% speed for 30 minutes and then at 20% speed for 30 minutes.

5-2-4 YK1200X

The YK1200X uses a harmonic drive only for the R-axis. The following steps describe procedures and precautions when replacing this harmonic drive. For the bolt tightening torques in this work, refer to Table 5-2.

- 1) Prepare the following tools and items.
  - Harmonic grease 4B No.2 (20g)
  - Waste cloth (rag)
  - Phillips-head screwdriver
  - Hex wrench set
  - Screw Lock (thread sealant)
  - Torque-limiting wrench
  - Hook wrench
  - Replacement parts (See table below.)

Replacement parts			
Parts name	Type No.	YAMAHA Parts No.	Note
Harmonic drive	SHF-25-50	KN6-M1821-001	
O-ring	S90(JIS)	KN4-M2143-000	Lower part of harmonic drive
	Cross section diameter: 1.30mm Inner diameter: 66.50mm	KN4-M257L-000	Supplied with harmonic drive
	Cross section diameter: 1.25mm Inner diameter: 37.50mm	KN6-M1896-010	Wave generator support bearing section
Edge seal	VR32A	KN6-M1886-000	

- 2) Turn off the controller.
- 3) Place a sign indicating that the robot is being inspected, to keep others from operating the controller switch.
- 4) Enter the safeguard enclosure.
- 5) Remove the Y-axis arm front cover.  
Refer to "7 Removing the Robot Covers" in Chapter 4 for removing the covers.
- 6) Remove the bolts (M5×20L, 4 pieces) and then separate the spline support shaft (2 pieces) from the shaft fastening plate. (See Fig. 5-53.)

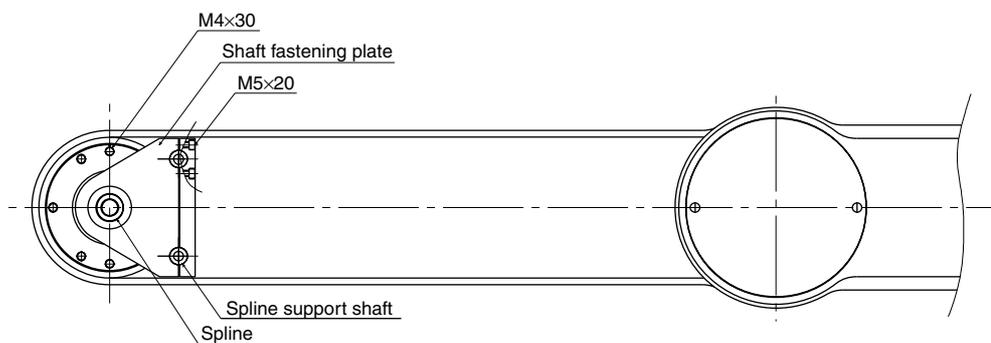


Fig. 5-53

- 7) Remove the bolts (M6×20L, 4 pieces) securing the bearing to the upper end of the spline and remove the bearing mount plate. (See Fig. 5-54.)

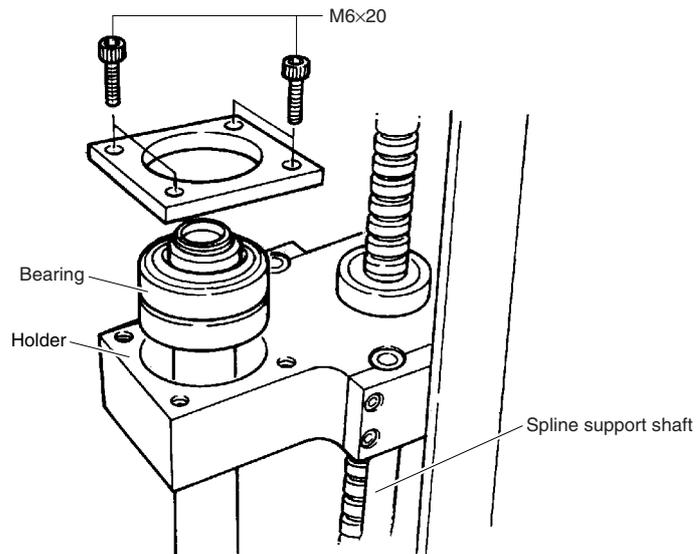


Fig. 5-54

**⚠ WARNING**

The Z-axis will slide down when the U-nut is removed in the next step, causing a hazardous situation. Prop the Z-axis with a support stand before loosening the U-nut.

- 8) While holding a steel rod or similar tool through the 10mm diameter hole as shown, use the hook spanner to remove the U-nut on the spline shaft and then remove the bearing. (See Fig. 5-55.)

Use a round steel rod with a diameter slightly smaller than 10mm. Avoid using a square rod because the spline might be damaged by the edge of the rod.

Be careful at this point to keep the spline shaft from coming off the spline.

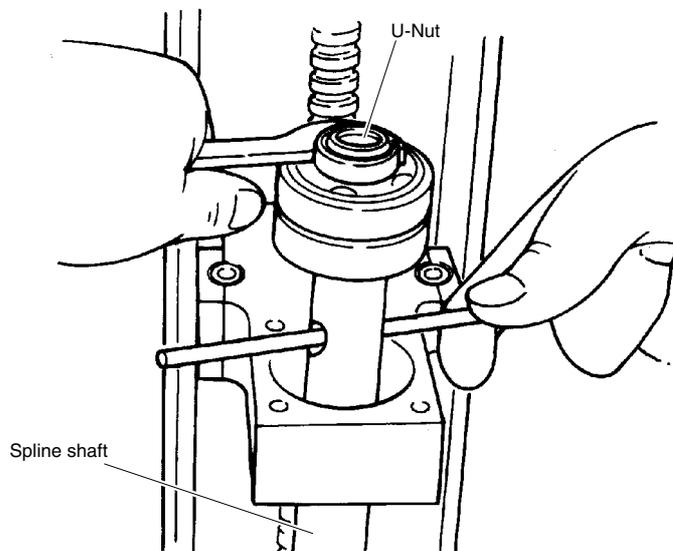


Fig. 5-55

- 9) Remove the bolts (M4×14L, 2 pieces) on the underside of the Y-axis arm and remove the R-axis dog ring from the fastening plate.
- 10) Remove the bolts (M4×30L, 8 pieces) on the underside of the Y-axis arm and remove the plate fastening the spline and the harmonic drive. (See Fig. 5-53.)

**CAUTION**

An O-ring is fitted to the fastening plate, so be careful not to let it drop into the peripheral unit. (See Fig. 5-56.)

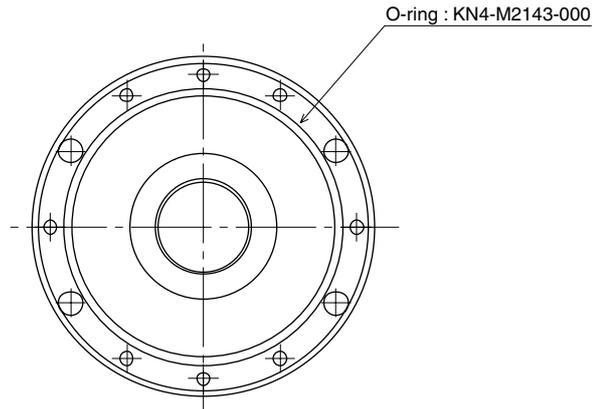


Fig. 5-56

- 11) Remove the bolts (M6×20L, 4 pieces) securing the R-axis motor plate at the top of the Y-axis arm. (See Fig. 5-57.)
- 12) Loosen the pulley bolts (M3×30L, 4 pieces) and remove the pulley fastened to the wave generator. (See Fig. 5-57.)
- 13) Remove the harmonic drive installation bolts (M4×45L, 12 pieces) and pull out the harmonic drive from the bottom of the Y-axis arm. (See Fig. 5-57.)

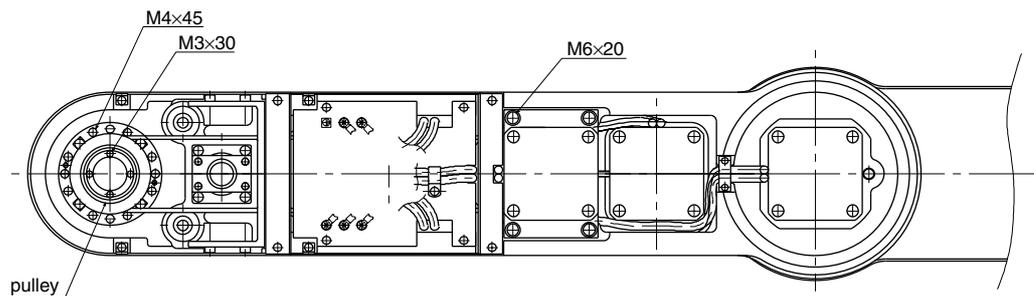


Fig. 5-57

**CAUTION**

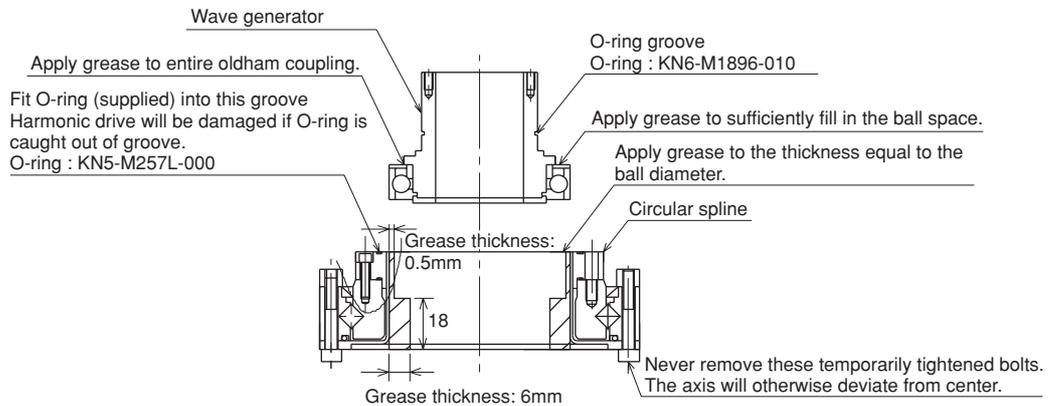
An O-ring is fitted to the harmonic drive, so be careful not to let it drop into the peripheral unit.

- 14) Pull out the wave generator from the bottom of the Y-axis arm.

**CAUTION**

An O-ring is fitted to the wave generator, so be careful not to drop it into the peripheral unit.

- 15) Apply harmonic grease to the new wave generator. See Fig. 5-58 for applying grease properly.



**Fig. 5-58**

- 16) Fit the O-ring coated with harmonic grease into the O-ring groove on the new wave generator (wave generator support bearing section), and then insert the wave generator into position from the bottom of the Y-axis arm.

**CAUTION**

Do not allow the O-ring to get caught out of the groove during reassembly. A problem will occur if the robot is operated with the O-ring left caught out of the groove.

- 17) Apply the remaining harmonic grease to the circular spline.  
See Fig. 5-58 for applying grease properly.
- 18) Fit an O-ring (supplied with the harmonic drive) coated with harmonic grease into the O-ring groove on the new harmonic drive. (See Fig. 5-58.)  
Apply small amounts of "Screw Lock" to the bolts (M4×45L, 12 pieces) and tighten them to secure the harmonic drive to the Y-axis arm from the top of the Y-axis arm. (See Fig. 5-57.)

**CAUTION**

Do not allow the O-ring to get caught out of the groove during reassembly. A problem will occur if the robot is operated with the O-ring left caught out of the groove.

- 19) Apply small amounts of "Screw Lock" to the bolts (M3×30L, 4 pieces) and tighten them to secure the pulley to the wave generator. (See Fig. 5-57.)
- 20) Fit the timing belt onto the wave generator pulley and motor pulley, and then secure the motor plate. (See Fig. 5-57.)

**CAUTION**

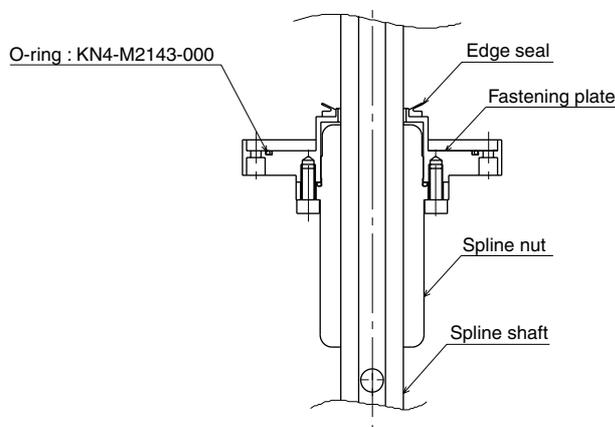
When securing the timing belt, the belt tension must be adjusted properly. See "8. Adjusting the Timing Belt Tension" in Chapter 4 for how to adjust the belt tension.

- 21) Fit a new O-ring into the O-ring groove on the fastening plate and also replace the edge seal with new one. Then, secure the fastening plate to the harmonic drive with the bolts (M4×30L, 8 pieces) coated with small amounts of "Screw Lock". (See Figs. 5-53 and 5-59.)

At this point, be careful to keep the spline shaft from coming off the spline nut.

**CAUTION**

The harmonic drive service life may shorten if the edge seal effect is insufficient, so carefully reassemble the parts.



**Fig. 5-59**

- 22) Secure the dog ring to the fastening plate with the bolts (M4×14L, 2 pieces).
- 23) Insert the spline shaft into the holder, fit the bearing onto the spline and tighten the U-nut to secure the bearing. (Utilize the  $\phi 10$  through-hole when tightening the U-nut like you did to loosen it.) (See Fig. 5-55.)
- 24) Put the bearing into the holder and tighten the bolts (M6×20L, 4 pieces) to secure the bearing mount plate to the holder (See Fig. 5-54.)
- 25) Install the spline support shafts (2 pieces) to the fastening plate, apply a small amount of "Screw Lock" to the bolts (M5×20L, 4 pieces) and tighten. (See Fig. 5-53.)
- 26) Attach the Y-axis arm front cover.
- 27) Go outside the safeguard enclosure.
- 28) Check that no one is inside the safeguard enclosure, and then turn on the controller.
- 29) Turn the R-axis arm as much as possible (at least 10 degrees or more), and perform aging at 5% speed for 30 minutes and then at 20% speed for 30 minutes.

**5-2-5 YK550X with high-speed R-axis specifications: R-axis**

The YK550X with high-speed R-axis specifications uses harmonic grease 4B No.2 only for the R-axis.

For information on how to replace the speed reduction gear, refer to "6-4 Replacing the R-axis harmonic grease".

## 6 Replacing the Harmonic Grease (YK550X)

The YK550X uses a harmonic drive as the speed reduction gear for the X, Y and R axes. Harmonic grease HC-1A (Harmonic Drive Systems Inc.) is used to lubricate the harmonic drive. When this grease deteriorates with operating time, the service life of the harmonic drive may shorten. Use the guideline explained below to determine the replacement period and replace the grease periodically.

### 6-1 Replacement period

The harmonic grease replacement period is determined by the total number of turns of the wave generator used in the harmonic drive. It is recommended to replace the harmonic grease when the total number of turns has reached  $1.5 \times 10^8$  (at ambient operating temperatures of 0°C to +40°C). This means that the replacement period will differ depending on the following operating conditions. If the robot operation duty ratio is high or the robot is operated in environments at higher temperatures, the grease should be replaced earlier.

(Operating conditions)

- n : Number of axis movements per minute
- q : Average turn per axis movement
- N : Speed ratio
- h : Operation time per day
- D : Operation days per year

For example, when the robot is used under the following conditions, the replacement period can be calculated as follows.

- n : 10
- q : 1/4 turn
- N : 50
- h : 24 hours per day
- D : 240 days per year

$$\begin{aligned} \text{Replacement period} &= 1.5 \times 10^8 / (n \times 60 \times h \times D \times N \times q) \\ &= 1.5 \times 10^8 / (10 \times 60 \times 24 \times 240 \times 50 \times 1/4) = 3.47 \text{ years} \end{aligned}$$

Axis	Speed Ratio
X, Y, R	50

## 6-2

**Basic replacement procedure for harmonic grease and precautions (Y-axis)**

Basic procedures and precautions for replacing the harmonic grease are described below using the Y-axis of the YK550X as an example. Use basically the same procedure when replacing the grease the X-axis and R-axis.

**⚠ WARNING**

The motor and speed reduction gear casing are extremely hot after automatic operation, so burns may occur if these are touched. Before touching these parts, turn off the controller, wait for a while and check that the temperature has cooled.

**⚠ WARNING**

Precautions when handling harmonic grease, cleaning oil:

- Inflammation may occur if they get in the eyes.  
Before handling them, wear your safety goggles to ensure they will not come in contact with the eyes.
- Inflammation may occur if they come into contact with skin. Be sure to wear protective gloves to prevent contact with skin.
- Do not take orally or eat. (Eating will cause diarrhea and vomiting.)
- Hands and fingers might be cut when opening the container, so use protective gloves.
- Keep out of the reach of children.
- Do not heat them or place near an open flame since this could lead to sparks and fires.

Emergency Treatment:

- If they get in the eyes, wash liberally with pure water for about 15 minutes and consult a physician for treatment.
- If they come in contact with the skin, wash away completely with soap and water.
- If taken internally, do not induce vomiting but promptly consult a physician for treatment.

**⚠ WARNING**

Disposing of harmonic grease, cleaning oil and the container:

- Proper disposal is compulsory under federal, state and local regulations. Take appropriate measures in compliance with legal regulations.
- Do not pressurize the empty container. Pressurizing may cause the container to rupture.
- Do not attempt to weld, heat up, drill holes or cut this container. This might cause the container to explode and the remaining materials inside it to ignite.

### **⚠ WARNING**

When removing the wave generator from the motor shaft or reinstalling it back onto the motor shaft, use caution to avoid as much as possible, applying a thrust load to the motor shaft. If a load is applied, the resolver may be damaged resulting in a hazardous situation of the robot malfunction.

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### **⚠ CAUTION**

The harmonic drive service life may decline drastically if the grease recommended by YAMAHA is not used.

---

### **⚠ CAUTION**

Harmonic drive

- Do not apply strong shocks or impacts to these parts such as with a hammer. Also, do not scratch, scar or dent these parts by dropping, etc. Such actions will damage the harmonic drive.
  - The specified performance cannot be maintained if any part of the harmonic drive is used in a damaged state. This damage or wear may also lead to trouble with the harmonic drive.
- 

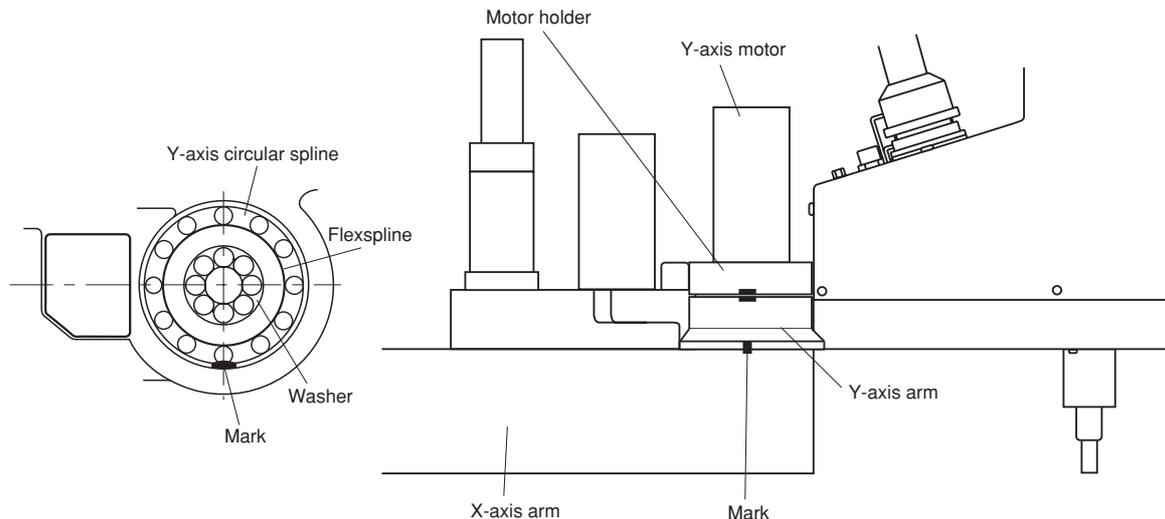
### **⚠ CAUTION**

Deviations in position may occur due to replacement of the harmonic grease. This means that the machine reference adjustment, standard coordinate setting and point data settings are required after replacing the grease.

---

- 1) Prepare the following tools and items necessary for replacing the grease.
  - Harmonic grease HC-IA (20g)
  - Waste cloth
  - Phillips screwdriver
  - Cleaning oil (kerosene, etc.)
  - Magic marker
  - Air gun
  - Hex wrench set
  - Screw lock
  - Ratchet handle (insertion angle 6.35mm, 9.5mm)
  - Hexagonal socket set (insertion angle 6.35mm, 9.5mm)
  - Torque wrench (insertion angle 6.35mm, 9.5mm)
  - Extension bar (insertion angle 9.5mm, length 75mm)
- 2) Turn off the the controller.
- 3) Place a sign indicating that the robot is being inspected, to keep others from operating the controller switch.

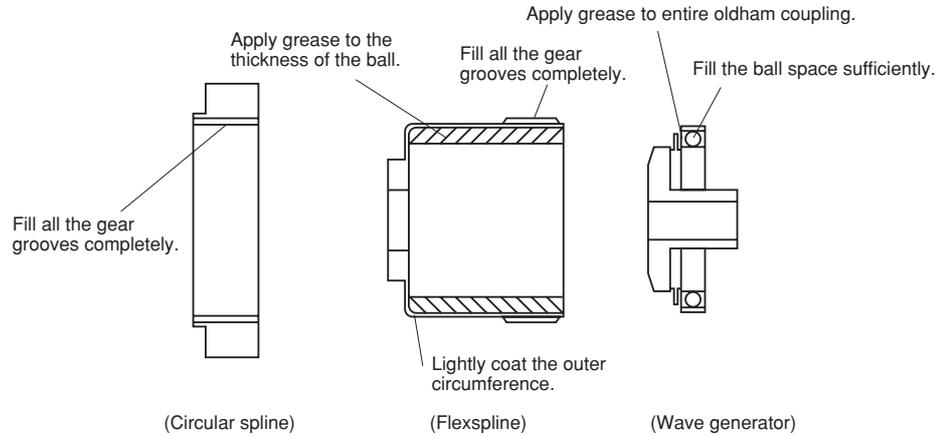
- 4) Enter the safeguard enclosure.
- 5) To make reassembly easier, put marks on the motor holder, circular spline, Y-axis arm and X-axis arm to indicate their relational positions before proceeding to the next step, as shown in Fig. 5-60. The circular spline can be seen after removing the motor holder.
- 6) Remove the four M4 bolts securing the motor holder.
- 7) Slowly pull out the motor along with the motor holder, while swaying the motor slightly left and right. At this time, make every effort to avoid rotating the motor shaft.
- 8) Remove the M6 set screw from the motor holder. (See Fig. 5-62.)
- 9) Align the key with the M6 hole, and insert the 2mm hex wrench into the M6 hole to loosen the internal M4 set screw. Then, remove the wave generator from the motor shaft.



**Fig. 5-60 Harmonic drive grease replacement section and position markings**

- 10) Remove the eight M4 bolts securing the circular spline and slowly pull out the circular spline to remove it. Use the puller taps if difficult to remove the circular spline.
- 11) Finally, remove the eight M6 bolts securing the flexspline and washer on the inner side of the circular spline, and remove the flexspline and washer. If the bolts are hard to see due to grease, remove the grease to make the job easier. Use the puller taps on the bottom if difficult to remove these parts.

- 12) Remove the old grease from the washer, flexspline, circular spline and wave generator with a waste cloth, and then clean further with cleaning oil and by blow from an air gun. The harmonic drive components are precision parts so be careful not to drop them.



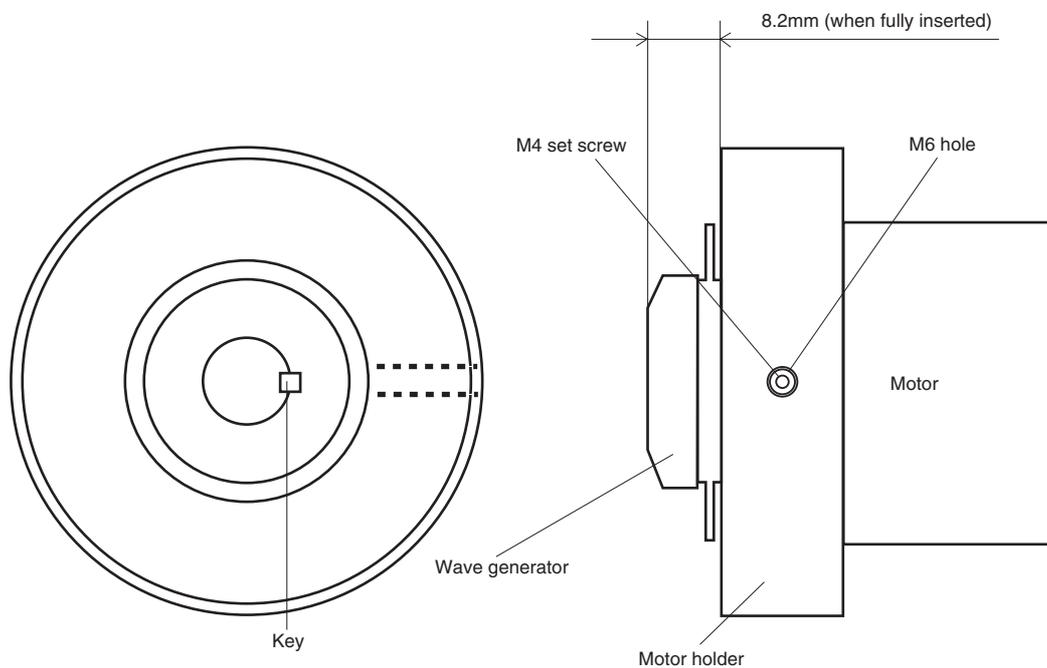
**Fig. 5-61 Applying grease**

- 13) Apply the harmonic grease to the wave generator, circular spline, and flexspline. See Fig. 5-61 for the basics on applying the grease. Do not apply grease to the washer.
- 14) Install the circular spline onto the Y-axis arm. Tighten the eight M4 bolts while aligning with the marks you previously made. Take care not to let foreign matter such as dirt or grit become mixed with the grease or parts during installation. See below for the tightening torque of each bolt.

Tightening torque	
M3 bolt	2.0Nm (20kgf·cm)
M4 bolt	4.5Nm (46kgf·cm)
M5 bolt	9.0Nm (92kgf·cm)
M6 bolt	15.3Nm (156kgf·cm)
M8 bolt	37Nm (380kgf·cm)

- 15) While aligning the Y-axis arm and X-axis arm with their marks, gently insert the flexspline into the circular spline. Then put the washers in place and tighten the eight M6 bolts on the inner side of the circular spline, in order from the diagonally opposite positions.
- 16) Insert the wave generator onto the motor shaft so it makes tight contact with the motor holder as shown in Fig. 5-62, then apply small amounts of "Screw Lock" (thread sealant) to the M4 set screw and tighten to secure the wave generator. At this time, make every effort to avoid rotating the motor shaft.
- 17) While aligning the Y-axis arm mark with the motor holder mark, gently insert the wave generator into the circular spline by moving it slightly left and right.

- 18) Tighten the four M4 bolts on the motor holder gradually while gently moving the Y-axis arm by hand 45 degrees left and right. If you feel any hang-ups or abnormalities, take apart and reassemble again.
- 19) Go outside the safeguard enclosure.
- 20) Check that no one is inside the safeguard enclosure and then turn on the controller.
- 21) Turn the Y-axis arm as much as possible (at least 10 degrees or more), and perform aging at 5% speed for 30 minutes and then at 20% speed for 30 minutes.
- 22) Perform absolute reset and adjust the Y-axis machine reference. Also set the reference coordinates and point data.



**Fig. 5-62 Wave generator installation position**

## 6-3 Replacing the X-axis harmonic grease

The following steps explain the procedures for replacing the X-axis harmonic grease of the YK550X, which differ from the procedures detailed in Section 6-2. Before starting the replacement job, be sure to read the warning, caution and procedures described in Section 6-2.

### **⚠ WARNING**

The motor and speed reduction gear casing are extremely hot after automatic operation, so burns may occur if these are touched. Cool the X-axis motor for a while with the fan and then turn off the controller. Check that the temperature has cooled before touching these parts.

### **⚠ WARNING**

- Bodily injury may occur from coming into contact with the X-axis cooling fan while it is rotating.
- When removing the cover on the base (pedestal), first turn off the controller and make sure the fan has stopped.

- 1) Prepare the following tools and items.
  - Harmonic grease HC-IA (45g)
  - Waste cloth
  - Phillips screwdriver
  - Cleaning oil (kerosene, etc.)
  - Torque wrench (insertion angle 6.35mm, 9.5mm)
  - Magic marker
  - Air gun
  - Hex wrench set
  - Screw lock
  - Ratchet handle (insertion angle 6.35mm, 9.5mm)
  - Hexagonal socket set (insertion angle 6.35mm, 9.5mm)
  - Extension bar (insertion angle 6.35mm, length 150mm)
  - Extension bar (insertion angle 9.5mm, length 75mm)
  - Socket adapter (9.5mm , 6.35mm  )
- 2) Turn off the controller.
- 3) Place a sign indicating the robot is being inspected, to keep others from operating the controller switch.
- 4) Enter the safeguard enclosure.
- 5) Remove the front and rear covers shown in the figure of the base, and also remove the rear cover shown in Fig. 5-63 (a).
- 6) Unplug the connectors of the X-axis motor power wire XM and the resolver wire XP.
- 7) Mark the relative positions beforehand of the motor holder, circular spline, base (pedestal) and X-axis arm with a magic marker, in order to make the reassembly job easier. The circular spline can be seen when the motor holder is removed. (See Fig. 5-63 (b), (d).)

- 8) Remove the four M5 bolts for the motor holder, using the ratchet handle, hexagonal socket, extension bar, socket adapter and hex wrench. (See Fig. 5-63 (c).)

9)

**⚠ WARNING**

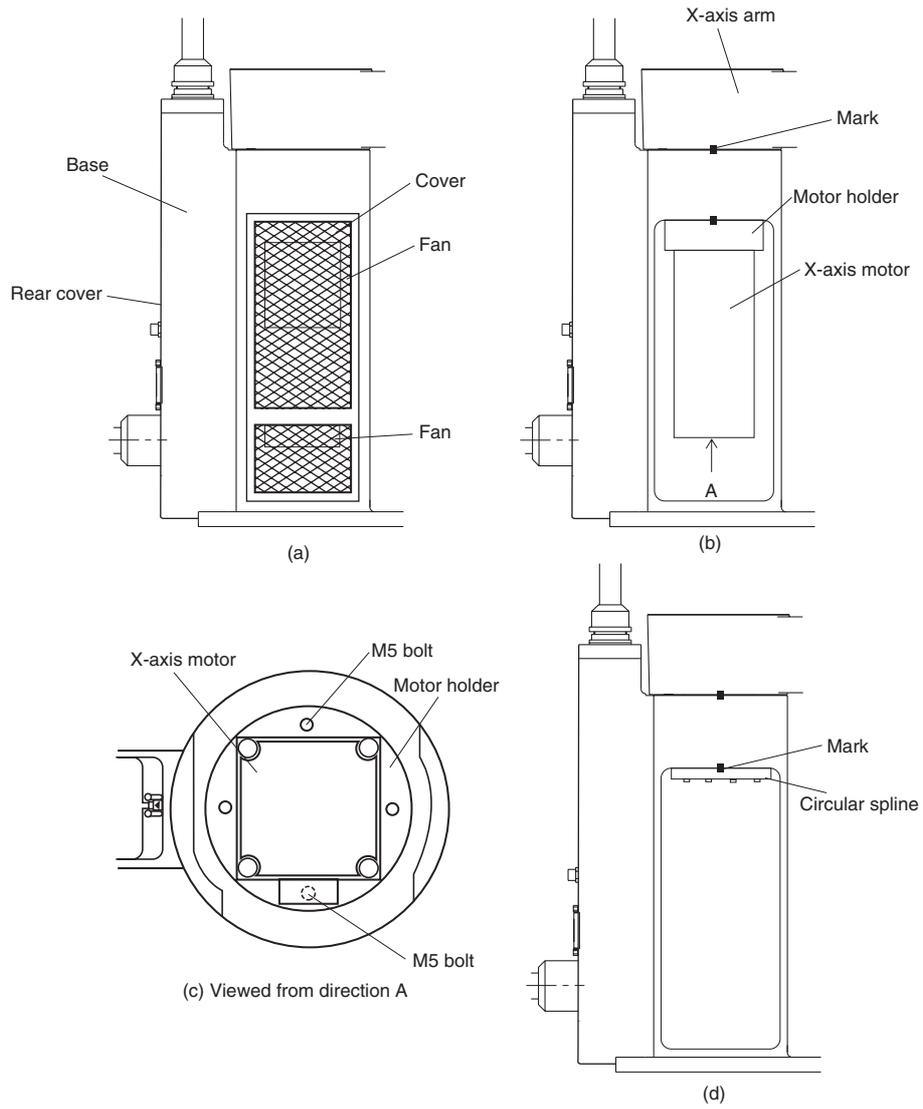
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Carefully remove the motor so as not to let hands or fingers get pinched between the motor and the base.

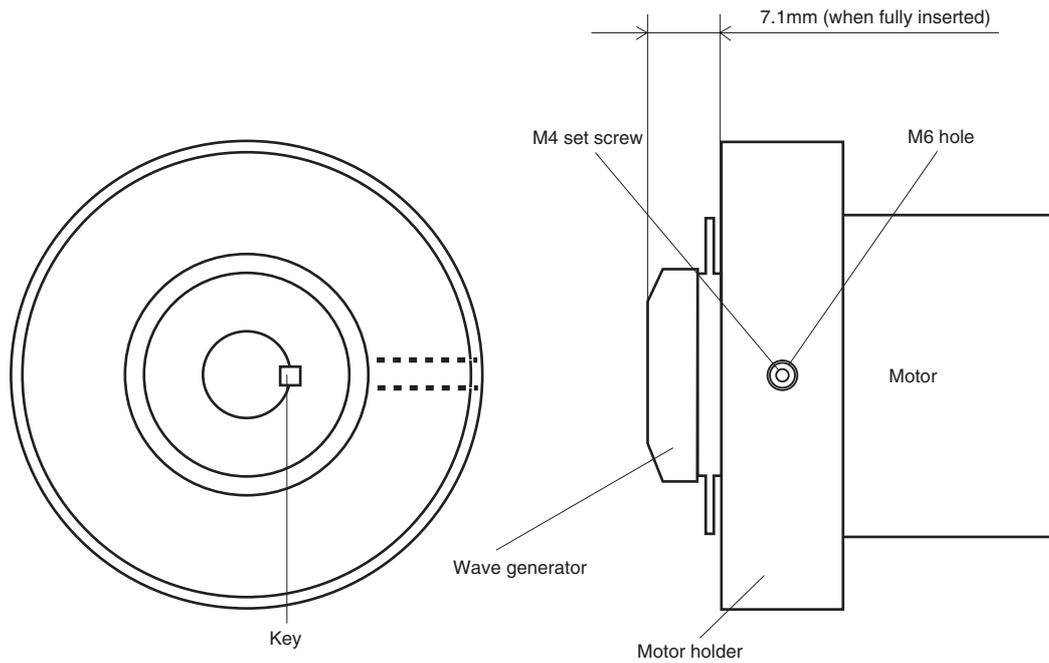
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Remove the motor along with the motor holder, by pulling it gently right and left. Make every effort to avoid rotating the motor shaft at this time.

- 10) Remove the M6 set screw from the motor holder. (See Fig. 5-64.)
- 11) Align the key with the M6 hole, and insert the 2mm hex wrench into the M6 hole to loosen the internal M4 set screw. Then, remove the wave generator from the motor shaft.
- 12) From this step, use the same procedure explained from step 10) in Section 6-2.  
In reassembly, insert the wave generator all the way onto the motor shaft, so that it is in the position as shown in Fig. 5-64. Then, apply small amounts of "Screw Lock" to the M4 set screw and tighten to secure the wave generator.



**Fig. 5-63 Harmonic drive grease replacement section and position markings**



**Fig. 5-64 Wave generator installation position**

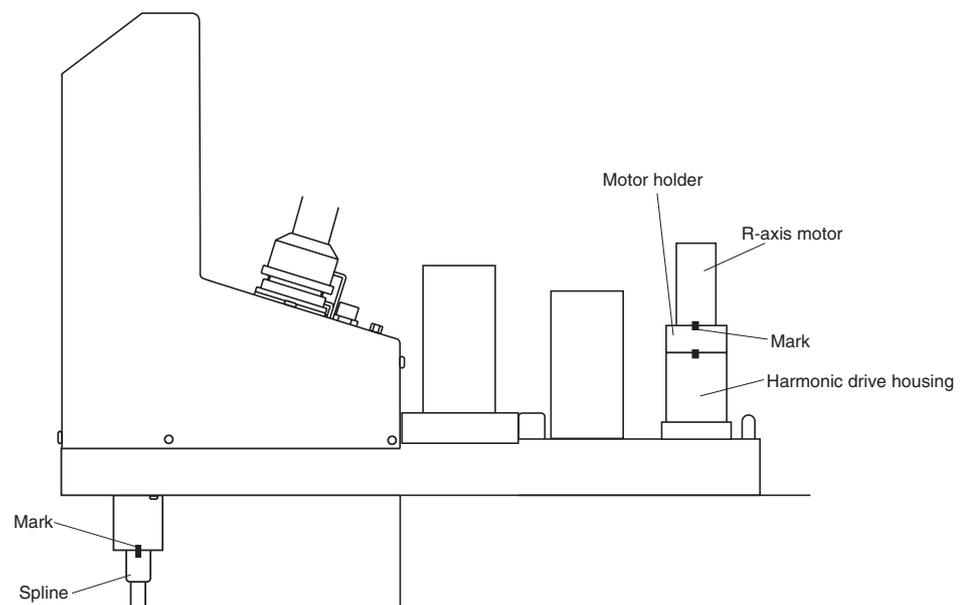
## 6-4

**Replacing the R-axis harmonic grease**

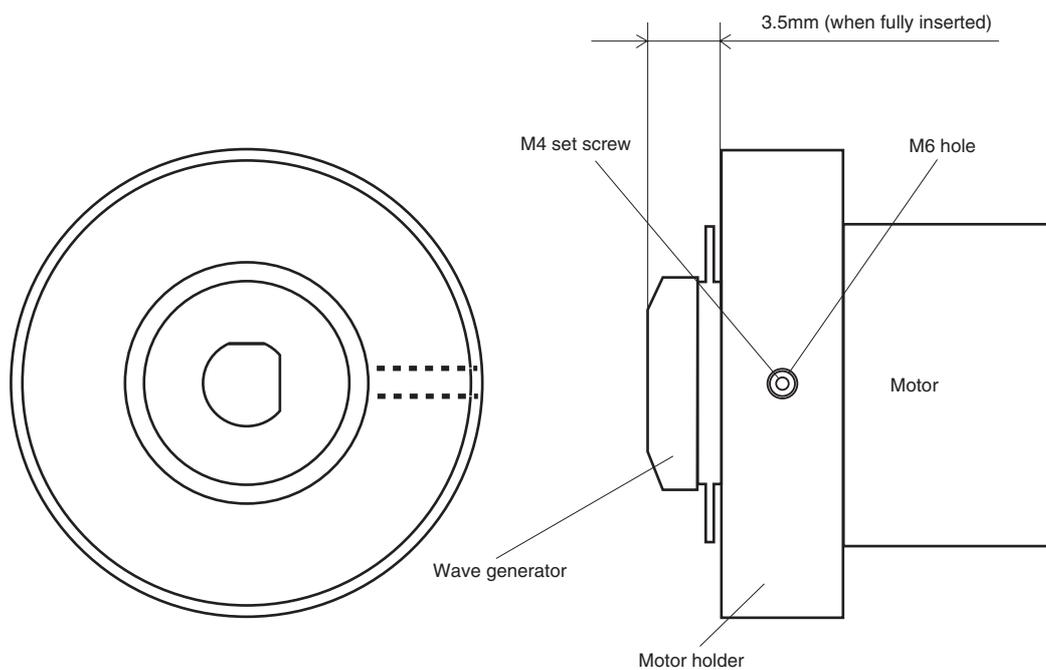
The following steps explain the procedures for replacing the R-axis harmonic grease of the YK550X, which only differ from the procedures described in Section 6-2. Before starting the replacement job, be sure to read the warning, caution and procedures described in Section 6-2.

In the case of the YK550X with high-speed R-axis specifications, grease replacement is not required because harmonic grease 4B No. 2 is used. When the harmonic drive replacement period has expired, which can be calculated from the factors explained in "5-1 Replacement period", replace the harmonic drive while referring to the procedures described in this section. Always use harmonic grease 4B No. 2.

- 1) Prepare the following tools and items.
  - Harmonic grease (standard R-axis specifications: HC-1A, high-speed R-axis specifications: 4B No. 2) (4.2g)
  - Waste cloth
  - Phillips screwdriver
  - Cleaning oil (kerosene, etc.)
  - Torque wrench (insertion angle 6.35mm)
  - Magic marker
  - Ratchet handle (insertion angle 6.35mm)
  - Hexagonal socket set (insertion angle 6.35mm)
  - Extension bar (insertion angle 6.35mm, length 50mm)
  - T wrench (for M5)
- 2) Turn off the controller.
- 3) Place a sign indicating the robot is being inspected, to keep others from operating the controller switch.
- 4) Enter the safeguard enclosure.
- 5) Use the same procedure explained in steps 5) and later, in section 6-2. Insert the wave generator onto the motor shaft so it makes tight contact with the motor holder as shown in Fig. 5-66, then apply small amounts of "Screw Lock" (thread sealant) to the two M3 set screws and tighten them to secure the wave generator.



**Fig. 5-65 Harmonic drive grease replacement section and position markings**



**Fig. 5-66 Wave generator installation position**

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## 7 Replacing the Grease for RV Speed Reduction Gears (YK1200X)

The YK1200X uses RV speed reduction gears for the X and Y axes. If grease for RV speed reduction gears deteriorates, this may shorten the service life of RV speed reduction gears. Replace the grease periodically as explained below.

---

### 7-1 Replacement period

The grease replacement period is typically 20,000 hours of operation. However, if the robot operation duty ratio is higher or the robot is operated in environments at higher or lower temperatures, the grease should be replaced earlier.

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### 7-2 Recommended grease

Use the following grease.

Daphne Eponex grease EP-0 (Idemitsu Kosan) or equivalent

Replenishment grease amount (for new RV speed reduction gears)

X-axis speed reduction gear      514 cc

Y-axis speed reduction gear      192 cc

**⚠ CAUTION**

The RV speed reduction gear service life may shorten if the grease recommended by YAMAHA is not used.

---

## 7-3 Replacement procedure

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### **⚠ WARNING**

The motor and speed reduction gear casing are extremely hot after automatic operation, so burns may occur if these are touched. Before touching these parts, turn off the controller, wait for a while and check that the temperature has cooled.

---

### **⚠ WARNING**

Precautions when handling grease:

- Inflammation may occur if this gets in the eyes.  
Before handling the grease, wear your safety goggles to ensure the grease will not come in contact with the eyes.
- Inflammation may occur if the grease comes into contact with skin. Be sure to wear protective gloves to prevent contact with skin.
- Do not take orally or eat. (Eating will cause diarrhea and vomiting.)
- Hands and fingers might be cut when opening the container, so use protective gloves.
- Keep out of the reach of children.
- Do not heat the grease or place near an open flame since this could lead to sparks and fires.

Emergency Treatment:

- If this grease gets in the eyes, wash liberally with pure water for about 15 minutes and consult a physician for treatment.
  - If this grease comes in contact with the skin, wash away completely with soap and water.
  - If taken internally, do not induce vomiting but promptly consult a physician for treatment.
- 

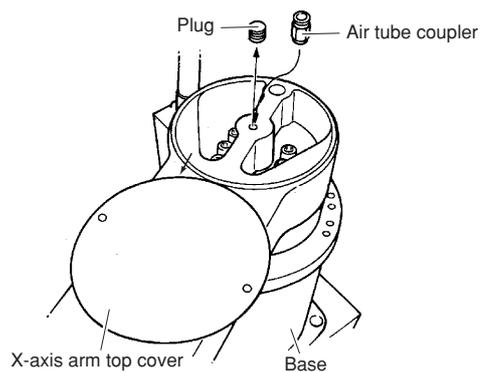
### **⚠ CAUTION**

Disposing of grease and the container:

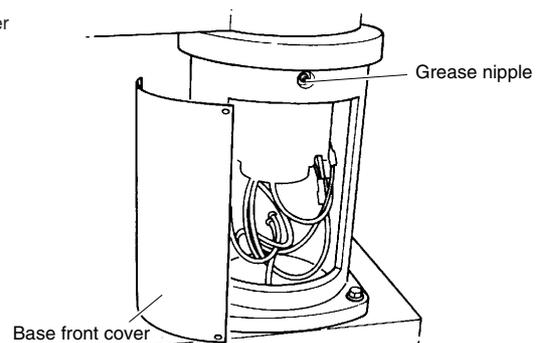
- Proper disposal is compulsory under federal, state and local regulations. Take appropriate measures in compliance with legal regulations.
  - Do not pressurize the empty container. Pressurizing may cause the container to rupture.
  - Do not attempt to weld, heat up, drill holes or cut this container. This might cause the container to explode and the remaining materials inside it to ignite.
-

## 7-3-1 Replacing the X-axis grease (first product to products manufactured in September 2009)

- 1) Prepare the following tools and items.
  - Daphne Eponex grease EP-0
  - Hex wrench set
  - Air tube coupler (PT1/8)
  - Air tube
  - Rag
  - Grease gun
- 2) Turn off the controller.
- 3) Place a sign indicating that the robot is being inspected, to keep others from operating the controller switch.
- 4) Enter the safeguard enclosure.
- 5) Remove the base (robot pedestal) front cover and the X-axis arm top cover. Refer to "7 Removing the Robot Covers" in Chapter 4 for removing the covers.
- 6) Remove the plug on the top of the X-axis arm. (See Fig. 5-67.)
- 7) To remove the old grease from the X-axis, attach the air coupler (PT1/8) into the screw hole where the plug was fitted and connect the air tube to the air coupler. The old grease inside the X-axis will be squeezed out by replenishing new grease with a grease gun as explained in the next steps.
- 8) Using the grease gun, pump the specified grease into the grease nipple located on the front of the robot base. (See Fig. 5-68.)
- 9) After replenishing the grease, move the X-axis arm by hand back and forth a few times (about 90 degrees) and then remove excess grease.
- 10) Remove the air coupler and then reattach the plug, X-axis top cover and base front cover.
- 11) Go outside the safeguard enclosure.
- 12) Check that no one is inside the safeguard enclosure, and then turn on the controller.



**Fig. 5-67**



**Fig. 5-68**

### 7-3-2 Replacing the X-axis grease (products manufactured from October 2009 onward)

- 1) Prepare the following tools and items.
  - Daphne Eponex grease EP-0
  - Air tube coupler (PT1/8)
  - Grease nipple (A-MT6×1, supplied with the robot)
  - Rag
  - Hex wrench set
  - Air tube
  - Grease gun
  - Sealing tape (NITOFロン PIPESEAL, etc.)
- 2) Turn off the controller.
- 3) Place a sign indicating that the robot is being inspected, to keep others from operating the controller switch.
- 4) Enter the safeguard enclosure.
- 5) Remove the base (robot pedestal) front cover and the X-axis arm top cover. Refer to "7 Removing the Robot Covers" in Chapter 4 for removing the covers.
- 6) Remove the plug on the top of the X-axis arm. (See Fig. 5-69.)
- 7) To remove the old grease from the X-axis, attach the air coupler (PT1/8) into the screw hole where the plug was fitted and connect the air tube to the air coupler. The old grease inside the X-axis will be squeezed out by replenishing new grease with a grease gun as explained in the next steps.
- 8) Remove the plug on the front (section A) of the robot base and attach the grease nipple (A-MT6×1) there. (See Fig. 5-70.)  
Keep the removed plug, as it will be used after replenishing grease.
- 9) Using the grease gun, supply the specified grease into the grease nipple until the old grease is squeezed out from the upper tube.
- 10) When the old grease no longer comes out of the tube, remove the grease nipple attached to the front (section A) of the robot base, and fit the plug into place. When fitting the plug, wrap sealing tape around it to prevent grease from leaking out.
- 11) After replenishing the grease, move the X-axis arm by hand back and forth a few times (about 90 degrees) and then remove excess grease.
- 12) Remove the air coupler, then fit the plug into place on the top of the X-axis arm and reattach the base front cover. When fitting the plug, wrap sealing tape around it to prevent grease from leaking out.
- 13) Go outside the safeguard enclosure.
- 14) Check that no one is inside the safeguard enclosure, and then turn on the controller.

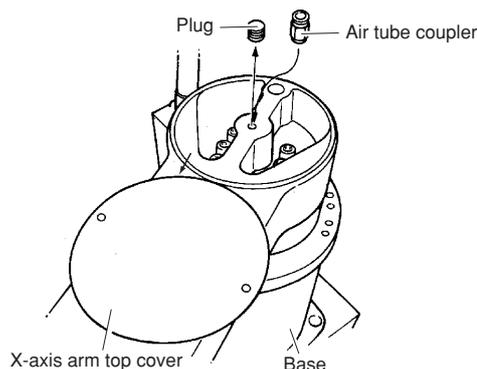


Fig. 5-69

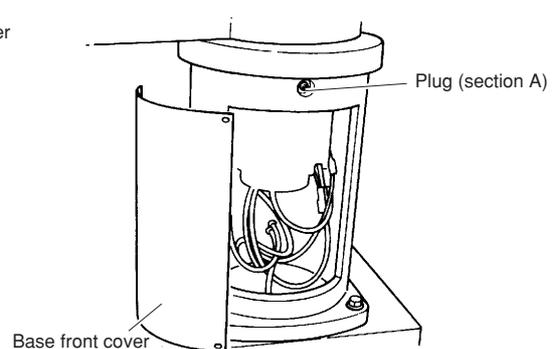


Fig. 5-70

## 7-3-3

### Replacing the Y-axis grease (first product to products manufactured in September 2009)

- 1) Prepare the following tools and items.
  - Daphne Eponex grease EP-0
  - Hex wrench set
  - Air tube coupler (PT1/8)
  - Air tube
  - Rag
  - Grease gun
- 2) Turn off the controller.
- 3) Place a sign indicating that the robot is being inspected, to keep others from operating the controller switch.
- 4) Enter the safeguard enclosure.
- 5) Remove the X-axis arm under cover.  
Refer to "7 Removing the Robot Covers" in Chapter 4 for removing the covers.
- 6) Remove the plug on the top of the Y-axis arm. (See Fig. 5-71.)
- 7) To remove the old grease from the Y-axis, attach the air coupler (PT1/8) into the screw hole where the plug was fitted and connect the air tube to the air coupler. The old grease inside the Y-axis will be squeezed out by replenishing new grease with a grease gun as explained in the next steps.
- 8) Using the grease gun, pump the specified grease into the grease nipple located on the bottom of the X-axis arm. (See Fig. 5-72.)
- 9) After replenishing the grease, move the Y-axis arm by hand back and forth a few times (about 90 degrees) and then remove excess grease.
- 10) Remove the air coupler and then reattach the plug and X-axis arm under cover.
- 11) Go outside the safeguard enclosure.
- 12) Check that no one is inside the safeguard enclosure, and then turn on the controller.

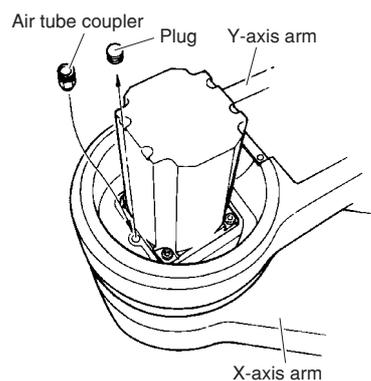


Fig. 5-71

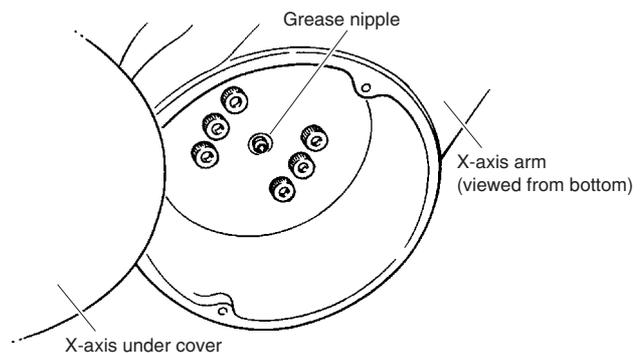


Fig. 5-72

### 7-3-4 Replacing the Y-axis grease (products manufactured from October 2009 onward)

- 1) Prepare the following tools and items.
  - Daphne Eponex grease EP-0
  - Hex wrench set
  - Air tube coupler (PT1/8)
  - Air tube
  - Grease nipple (A-MT8×1)
  - Grease gun
  - Rag
  - Sealing tape (NITOFYLON PIPESEAL, etc.)
- 2) Turn off the controller.
- 3) Place a sign indicating that the robot is being inspected, to keep others from operating the controller switch.
- 4) Enter the safeguard enclosure.
- 5) Remove the X-axis arm under cover.  
Refer to "7 Removing the Robot Covers" in Chapter 4 for removing the covers.
- 6) Remove the plug on the top of the Y-axis arm. (See Fig. 5-73.)
- 7) To remove the old grease from the Y-axis, attach the air coupler (PT1/8) into the screw hole where the plug was fitted and connect the air tube to the air coupler. The old grease inside the Y-axis will be squeezed out by replenishing new grease with a grease gun as explained in the next steps.
- 8) Remove the plug on the underside (section A) of the X-axis arm and attach the grease nipple (A-MT8×1) there. (See Fig. 5-74.)  
Keep the removed plug, as it will be used after replenishing grease.
- 9) Using the grease gun, supply the specified grease into the grease nipple until the old grease is squeezed out from the upper tube.
- 10) When the old grease no longer comes out of the tube, remove the grease nipple attached to the underside (section A) of the X-axis arm, and fit the plug into place. When fitting the plug, wrap sealing tape around it to prevent grease from leaking out.
- 11) After replenishing the grease, move the Y-axis arm by hand back and forth a few times (about 90 degrees) and then remove excess grease.
- 12) Remove the air coupler, then fit the plug into place on the top of the Y-axis arm and reattach the X-axis arm under cover. When fitting the plug, wrap sealing tape around it to prevent grease from leaking out.
- 13) Go outside the safeguard enclosure.
- 14) Check that no one is inside the safeguard enclosure, and then turn on the controller.

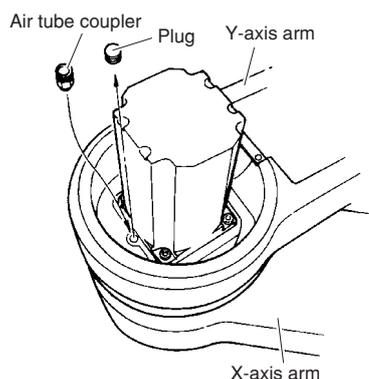


Fig. 5-73

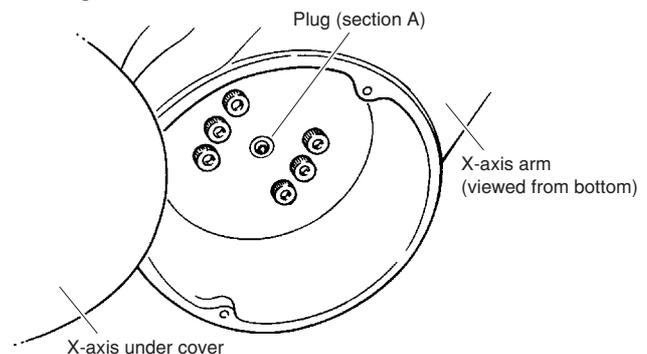
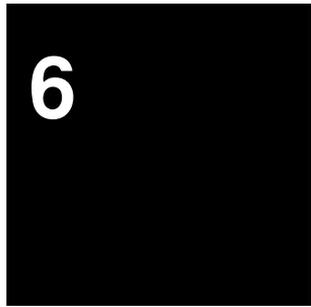


Fig. 5-74

# CHAPTER 6



## Increasing the robot operating speed

1 Increasing the robot operating speed .....6-1

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# MEMO

# 1 Increasing the robot operating speed

The robot operating speed can be increased by the following methods.  
Use these methods as needed when programming.

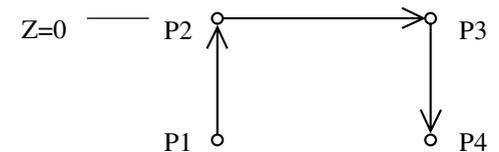
## (1) Increasing speed by arch motion

[Also refer to:] Robot controller user's manual  
("Axis parameters" – "Arch position" in Chapter 4)  
Programming manual  
(ARCH statement in "11. Command statements".)

### ① Gate motion

From point P1 to P4 via P2 and P3:

MOVE P, P2  
MOVE P, P3  
MOVE P, P4



### ② Arch motion: Using default arch position: (2000 pulses)

From point P1 to P2:

MOVE P, P2, Z=0

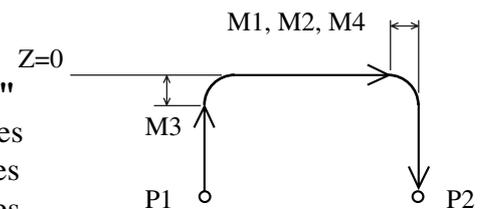
"Axis parameters" – "Arch position"

M1 (X-axis arch position) = 2000 pulses

M2 (Y-axis arch position) = 2000 pulses

M3 (Z-axis arch position) = 2000 pulses

M4 (R-axis arch position) = 2000 pulses



When the Z-axis moves upward from P1 and enters the M3 arch position range (2000 pulses prior to Z=0), the X, Y and R axes begin to move. When these 3 axes enter the M1, M2 and M4 arch position range (2000 pulses prior to P2), the Z-axis moves downward to P2. Compared with the gate motion ①, this arch motion shortens the cycle time approximately 20% by moving the robot arm along an arc.

③ **Arch motion: Making the arch position value larger**

In the arch motion ②, making the arch position value larger can further shorten the cycle time. Since the robot arm moves along a larger arc, use caution to avoid obstacles if they are located near the arm movement path.

The arch position parameter can be set for each axis.

④ **Arch motion: changing the arch positions in the program**

From point P1 to P2 and then to P3:

ARCH (1) = 10000 ... X-axis arch position (pulses) Arch position can be set for each axis.

ARCH (2) = 20000 ... Y-axis arch position (pulses)

ARCH (3) = 20000 ... Z-axis arch position (pulses)

ARCH (4) = 20000 ... R-axis arch position (pulses)

MOVE P, P2, Z=0

ARCH (1) = 2000

ARCH (2) = 2000

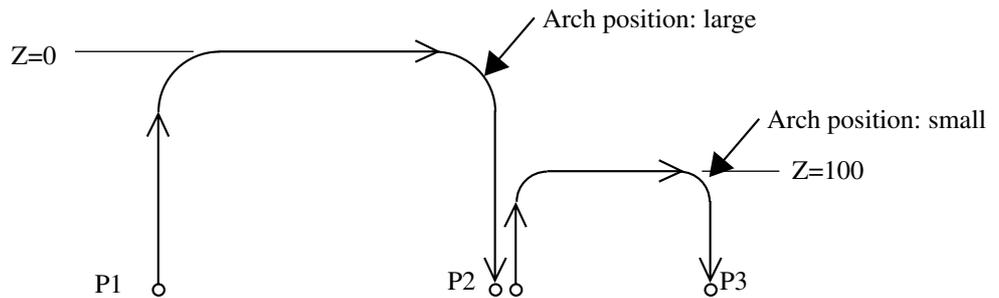
ARCH (3) = 2000

ARCH (4) = 2000

MOVE P, P3, Z=100

If the same arch position value (pulses) is used for all axes, you can write as "ARCH 2000".

Since the arch positions can be changed in the program, optimizing the arch positions can further shorten the cycle time.



**(2) Increasing the speed with the WEIGHT statement**

[Also refer to:] Robot controller user's manual  
 ("Robot parameters" – "Axis tip weight" in Chapter 4)  
 Programming manual  
 (WEIGHT statement in "11. Command statements".)

[Example]

From P1 when chuck is open:

WEIGHT 5 ..... Changes the axis tip weight parameter to 5kg (no workpiece).

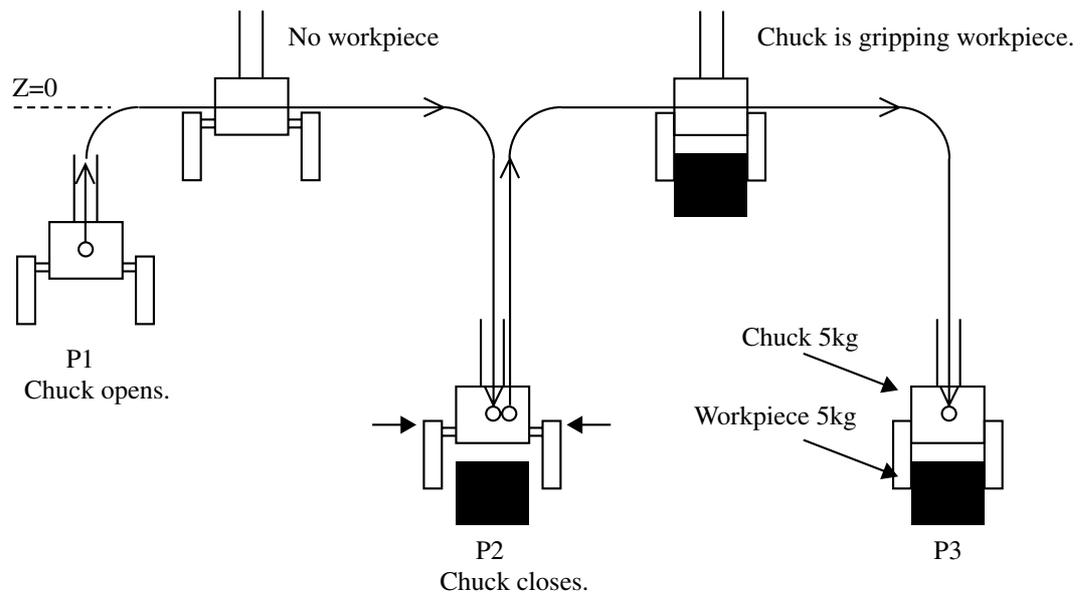
MOVE P, P2, Z=0

DO3 (0) = 1 ..... Chuck closes.

WEIGHT 10 ..... Changes the axis tip weight parameter to 10kg (with workpiece).

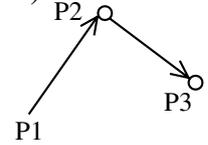
MOVE P, P3, Z=0

In the above program, the acceleration can be set to a higher level by reducing the axis tip weight parameter to 5kg while the chuck does not grip any workpiece, and then set to a lower level by changing the axis tip weight parameter to 10kg. Compared to programs using an axis tip weight parameter left set at 10kg, this method shortens the cycle time since the acceleration is increased.



**(3) Increasing the speed by the tolerance parameter**

[Also refer to:] Robot controller user's manual  
("Axis parameters" – "Tolerance" in Chapter 4)  
Programming manual  
(TOLE statement in "11. Command statements".)



[Example]

From P1 to P3 via P2

TOLE (1) = 2048 ... X-axis tolerance (pulses) : Increases the tolerance.

TOLE (2) = 2048 ... Y-axis tolerance (pulses)

TOLE (3) = 2048 ... Z-axis tolerance (pulses)

TOLE (4) = 2048 ... R-axis tolerance (pulses)

MOVE P, P2

TOLE (1) = 80 ..... Returns the tolerance to the default value.

TOLE (2) = 80

TOLE (3) = 80

TOLE (4) = 80

MOVE, P, P3

Tolerance can be set for each axis.  
If the same tolerance is used for all axes, you can write as "TOLE 2048".

If the same tolerance is used for all axes, you can write as "TOLE 80".

When P2 is an escape point and does not need to be accurately positioned, setting the tolerance parameter to a larger value allows the robot arm to pass through P2 quickly. The larger the tolerance value for the positioning time, the shorter the cycle time will be.

The maximum value of the tolerance parameter is 2048 (pulses) and the default is 80 (pulses).

**(4) Increasing the speed by the OUT effective position parameter**

[Also refer to:] Robot controller user's manual  
 ("Axis parameters" – "Out effective Position" in Chapter 4)  
 Programming manual  
 (OUTPOS statement in "11. Command statements".)

[Example]

From P1 when chuck is open:

OUTPOS (1) = 10000 ... X-axis OUT effective position (pulses) : Increases the OUT effective position.

OUTPOS (2) = 10000 ... Y-axis OUT effective position (pulses)

OUTPOS (3) = 10000 ... Z-axis OUT effective position (pulses)

OUTPOS (4) = 10000 ... R-axis OUT effective position (pulses)

MOVE P, P2, Z=0

DO3 (0) = 1 ..... Chuck closes.

OUTPOS (1) = 2000 ..... Returns the OUT effective position to the default value.

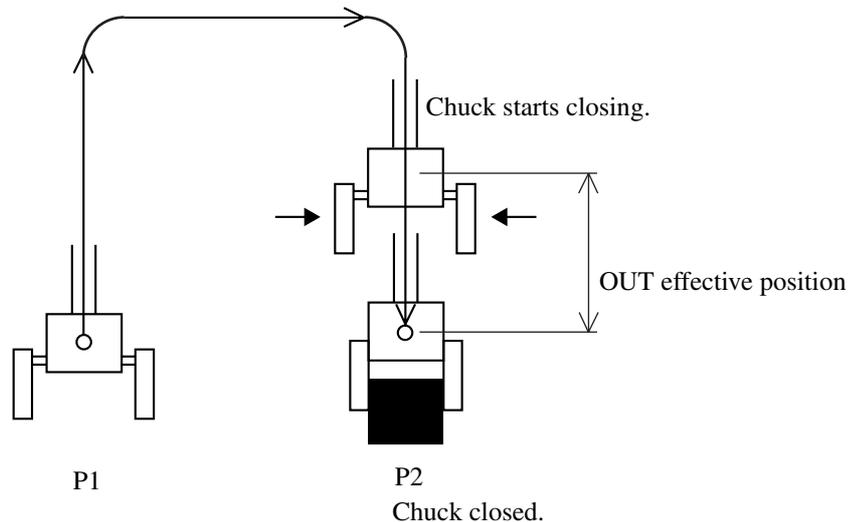
OUTPOS (2) = 2000

OUTPOS (3) = 2000

OUTPOS (4) = 2000

The OUT effective position can be set for each axis. If the same OUT effective position is used for all axes, you can write as "OUTPOS 10000".

If the same OUT effective position is used for all axes, you can write as "OUTPOS 2000".



When all of the X, Y, Z and R axes enter the OUT effective position (10000 pulses prior to P2), the chuck starts closing.

By setting the OUT effective position larger, the chuck starts closing while the robot arm is still moving at an earlier point, so that the chuck can grip the workpiece more quickly.

The default value of the OUT effective position is 2000 (pulses).

[Reference]

**Relation between X, Y, R-axis rotating angle, Z-axis movement distance and pulse values**

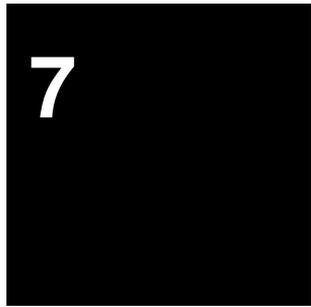
The arch position, tolerance and OUT effective position parameters are set in pulses.

For the relation between X, Y, R-axis rotating angle, Z-axis movement distance and pulse values, refer to the tables listed under item (4) in "4. Setting the soft limits". (Chapter 4 in this manual)

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# MEMO

# CHAPTER 7



## Specifications

1	Manipulator .....	7-1
1-1	Basic specification .....	7-1
1-2	External view and dimensions .....	7-4
1-3	Robot inner wiring diagram .....	7-30
1-4	Wiring table .....	7-33

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# MEMO

# 1 Manipulator

## 1-1 Basic specification

Robot model		YK250X(H)	YK350X(H)	YK400X(H)	
Axis specifications	X-axis	Arm length	125mm	225mm	225mm
		Rotation angle	±115°	±115°	±115°
	Y-axis	Arm length	125mm	125mm	175mm
		Rotation angle	±140°	±140°	±140°
	Z-axis	Stroke	150mm	150mm	150mm
R-axis	Rotation angle	±180°	±180°	±180°	
Motor	X-axis	200W	200W	200W	
	Y-axis	100W	100W	100W	
	Z-axis	100W	100W	100W	
	R-axis	100W	100W	100W	
Maximum speed	XY resultant	4.0m/s	5.0m/s	6.0m/s	
	Z-axis	1.0m/s	1.0m/s	1.0m/s	
	R-axis	1020°/s	1020°/s	1020°/s	
Repeatability *1	XY-axes	±0.01mm	±0.01mm	±0.01mm	
	Z-axis	±0.01mm	±0.01mm	±0.01mm	
	R-axis	±0.005°	±0.005°	±0.005°	
Payload	3kg				
R-axis tolerable moment of inertia *2	0.05kgm <sup>2</sup> (0.5kgfcm <sup>2</sup> )				
User wiring	10cables				
User tubing	φ4×3				
Travel limit	1.Soft limit 2.Mechanical limit (XYZ-axes)				
Robot cable	3.5m (option: 5m, 10m)				
Weight	15kg	15kg	15kg		

\*1 At constant ambient temperature (XY)

\*2 There are limits to acceleration coefficient settings.

## CHAPTER 7 Specifications

Robot model		YK500X	YK600X	YK550X	YK550X with high-speed R-axis specifications	
Axis specifications	X-axis	Arm length	250mm	350mm	300mm	
		Rotation angle	±120°	±120°	±90°	
	Y-axis	Arm length	250mm	250mm	250mm	
		Rotation angle	±145°	±145°	±145°	
	Z-axis	Stroke	200,300mm	200,300mm	200mm	
	R-axis	Rotation angle	±180°	±180°	±180°	
Motor	X-axis	400W	400W	800W		
	Y-axis	200W	200W	200W		
	Z-axis	200W	200W	200W		
	R-axis	100W	100W	100W		
Maximum speed	XY resultant	4.9m/s	5.6m/s	6.7m/s		
	Z-axis	1.7m/s	1.7m/s	2.3m/s		
	R-axis	876°/s	876°/s	540°/s	1700°/s	
Repeatability *1	XY-axes	±0.02mm	±0.02mm	±0.02mm		
	Z-axis	±0.01mm	±0.01mm	±0.01mm		
	R-axis	±0.005°	±0.005°	±0.005°		
Payload	10kg			5kg		
R-axis tolerable moment of inertia *2	0.12kgm <sup>2</sup> (1.2kgfcm <sup>2</sup> )		0.1kgm <sup>2</sup> (1.0kgfcm <sup>2</sup> )	0.05kgm <sup>2</sup> (0.5kgfcm <sup>2</sup> )		
User wiring	20cables			20cables		
User tubing	φ6×3			φ6×2		
Travel limit	1.Soft limit 2.Mechanical limit (XYZ-axes)					
Robot cable	3.5m (option: 5m, 10m)					
Weight	28kg	28kg	46kg			

\*1 At constant ambient temperature (XY)

\*2 There are limits to acceleration coefficient settings.

Robot Model		YK700X	YK800X	YK1000X	YK1200X	
Axis specifications	X-axis	Arm length	350mm	450mm	550mm	6000mm
		Rotation angle	±120°	±120°	±120°	±125°
	Y-axis	Arm length	350mm	350mm	450mm	600mm
		Rotation angle	±145°	±145°	±145°	±150°
	Z-axis	Stroke	200,400mm	200,400mm	200,400mm	400mm
R-axis	Rotation angle	±180°	±180°	±180°	±180°	
Motor	X-axis	800W	800W	800W	900W	
	Y-axis	400W	400W	400W	800W	
	Z-axis	400W	400W	400W	600W	
	R-axis	200W	200W	200W	400W	
Maximum speed	XY resultant	6.7m/s	7.3m/s	8.0m/s	7.4m/s	
	Z-axis	1.7m/s	1.7m/s	1.7m/s	0.75m/s	
	R-axis	600°/s	600°/s	600°/s	600°/s	
Repeatability *1	X,Y-axes	±0.02mm	±0.02mm	±0.02mm	±0.05mm	
	Z-axis	±0.01mm	±0.01mm	±0.01mm	±0.02mm	
	R-axis	±0.005°	±0.005°	±0.005°	±0.005°	
Payload	20kg				50kg	
R-axis tolerable moment of inertia *2	0.32kgm <sup>2</sup> (3.2kgfcm <sup>2</sup> )				2.45kgm <sup>2</sup> (25kgfcm <sup>2</sup> )	
User wiring	20 cables					
User tubing	φ6×3					
Travel limit	1.Soft limit 2.Mechanical limit (XYZ-axes)					
Robot cable	3.5m,option:5m,10m					
Weight	56kg	57kg	58kg	124kg		

\*1 At constant ambient temperature (XY)

\*2 There are limits to acceleration coefficient settings.

### Sound level

Robot model	Equivalent sound level of robot, Laeq (A) (at 10dB or more difference from background sound pressure level )	Position where the noise level is measured
YK250X, YK350X, YK400X	69.8dB	1.0m away from the rear of robot, 1.6m height
YK500X, YK600X	69.7dB	1.0m away from the rear of robot, 1.6m height
YK700X, YK800X, YK1000X	69.4dB	1.0m away from the rear of robot, 1.6m height
YK1200X	75.1dB	1.0m away from the rear of robot, 1.6m height

Note: Sound level may increase when sound reflecting objects are located near the robot.

1-2 External view and dimensions

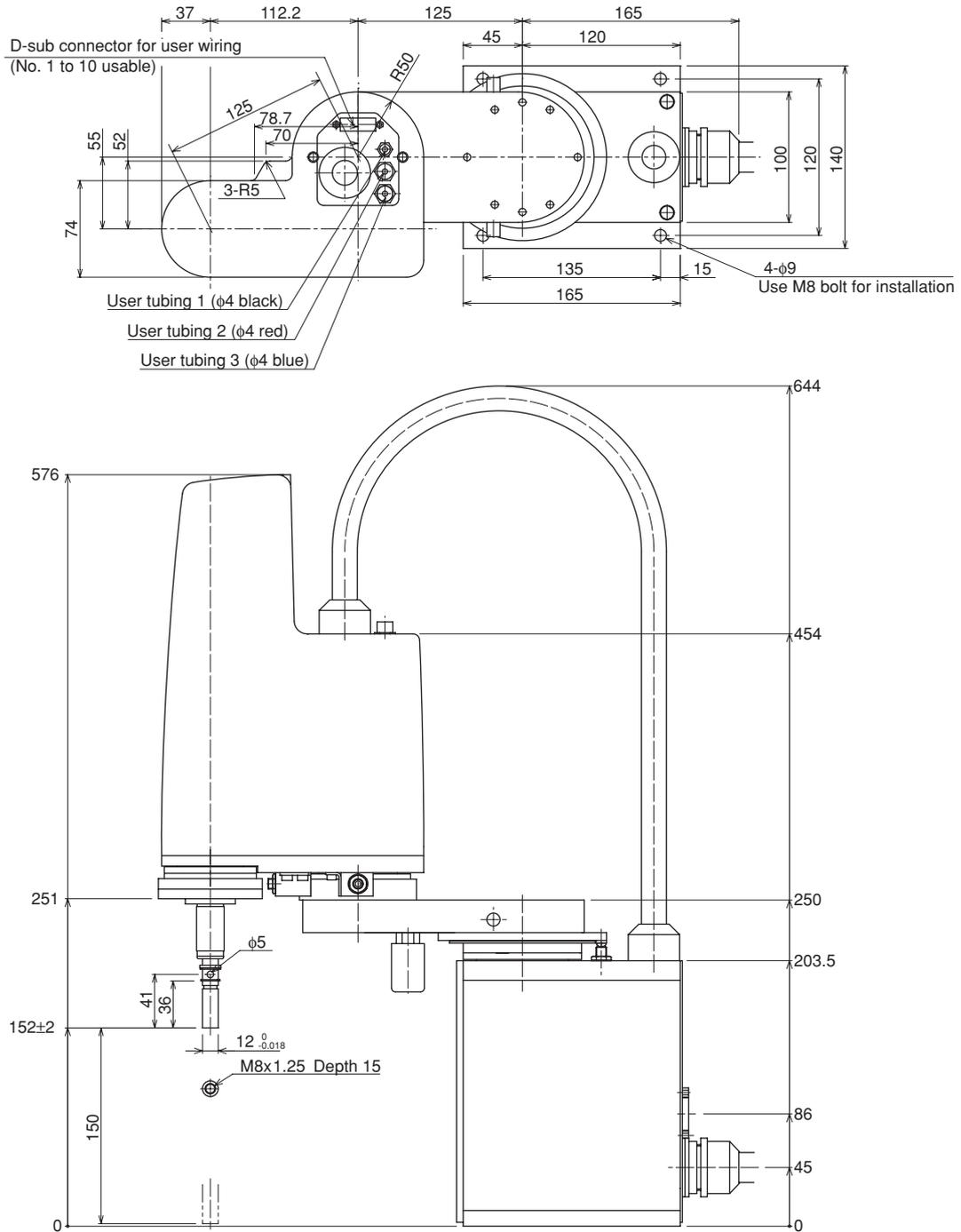
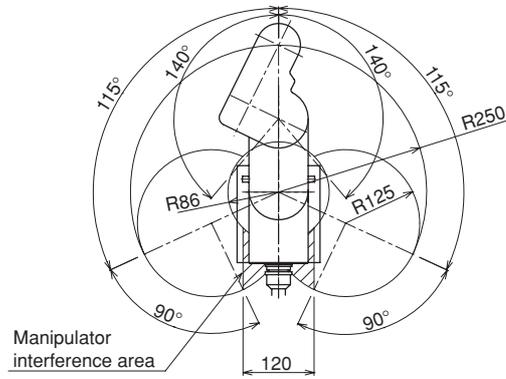
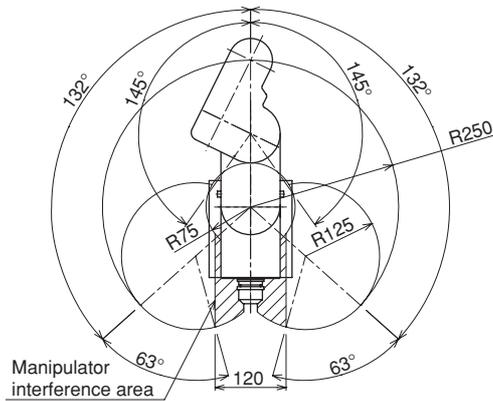


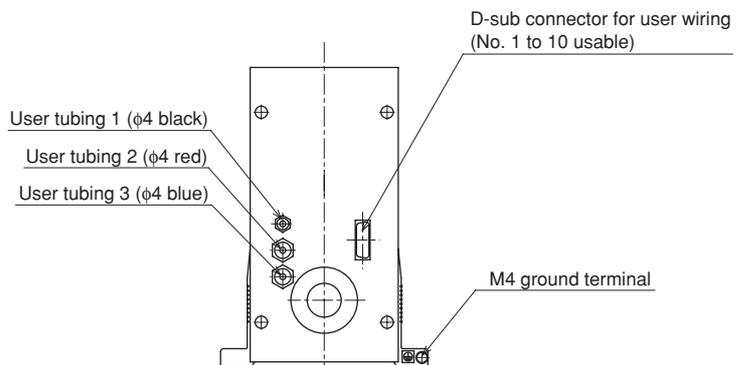
Fig. 7-1 YK250X



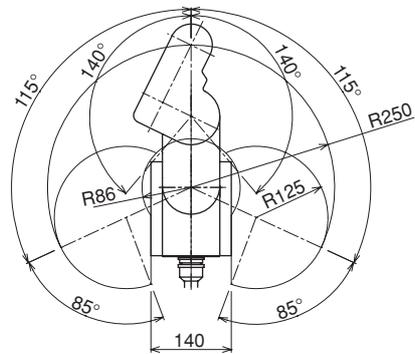
Working envelope (1 : 5)



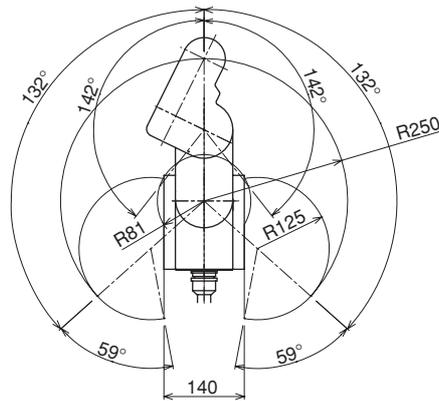
X and Y-axis mechanical stopper positions (1 : 5)



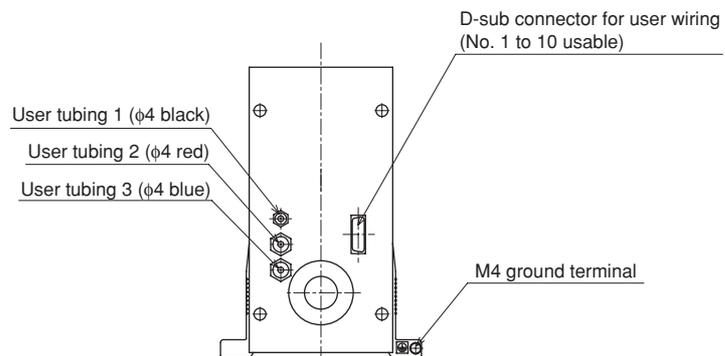




Working envelope (1 : 5)



X and Y-axis mechanical stopper positions (1 : 5)



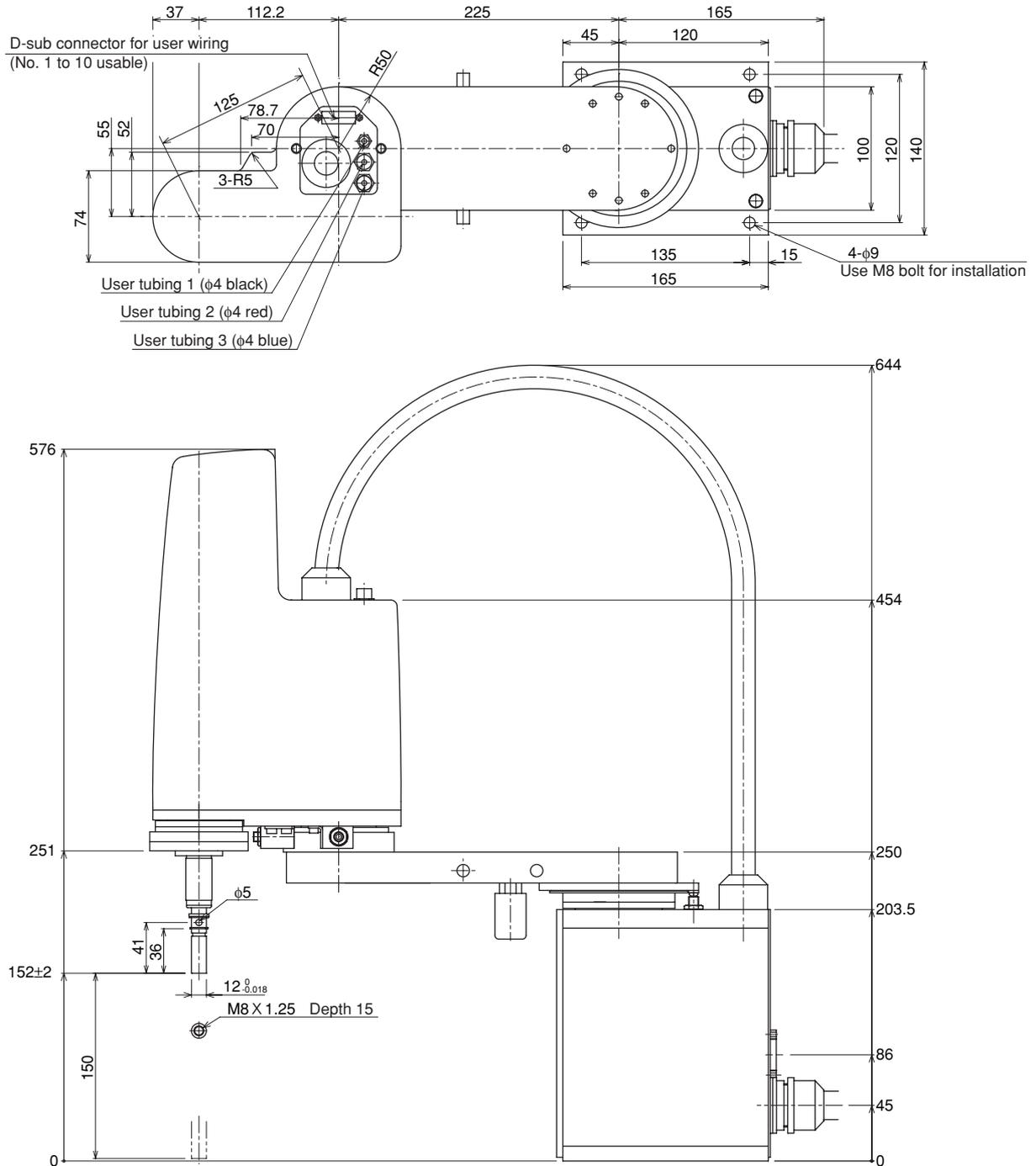
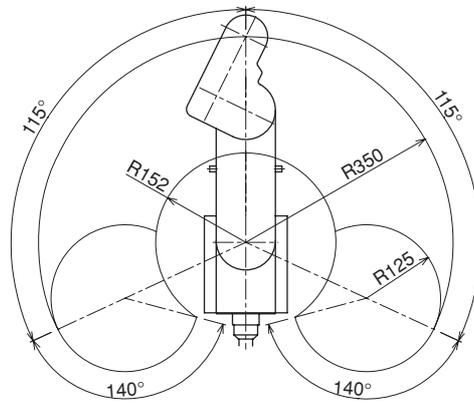
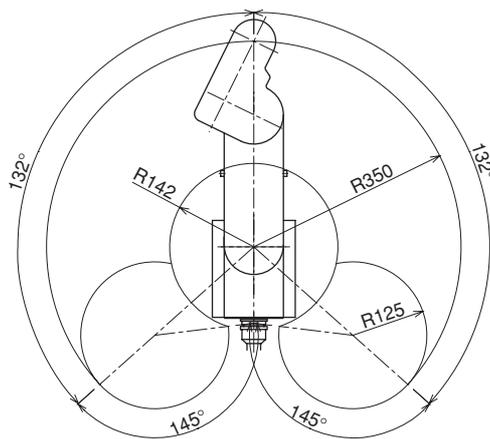


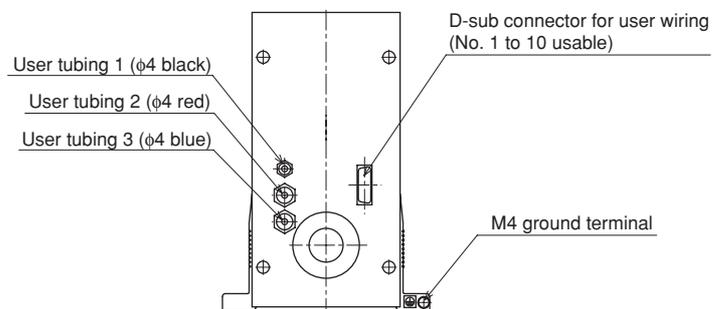
Fig. 7-3 YK350X



Working envelope (1 : 5)



X and Y-axis mechanical stopper positions (1 : 5)



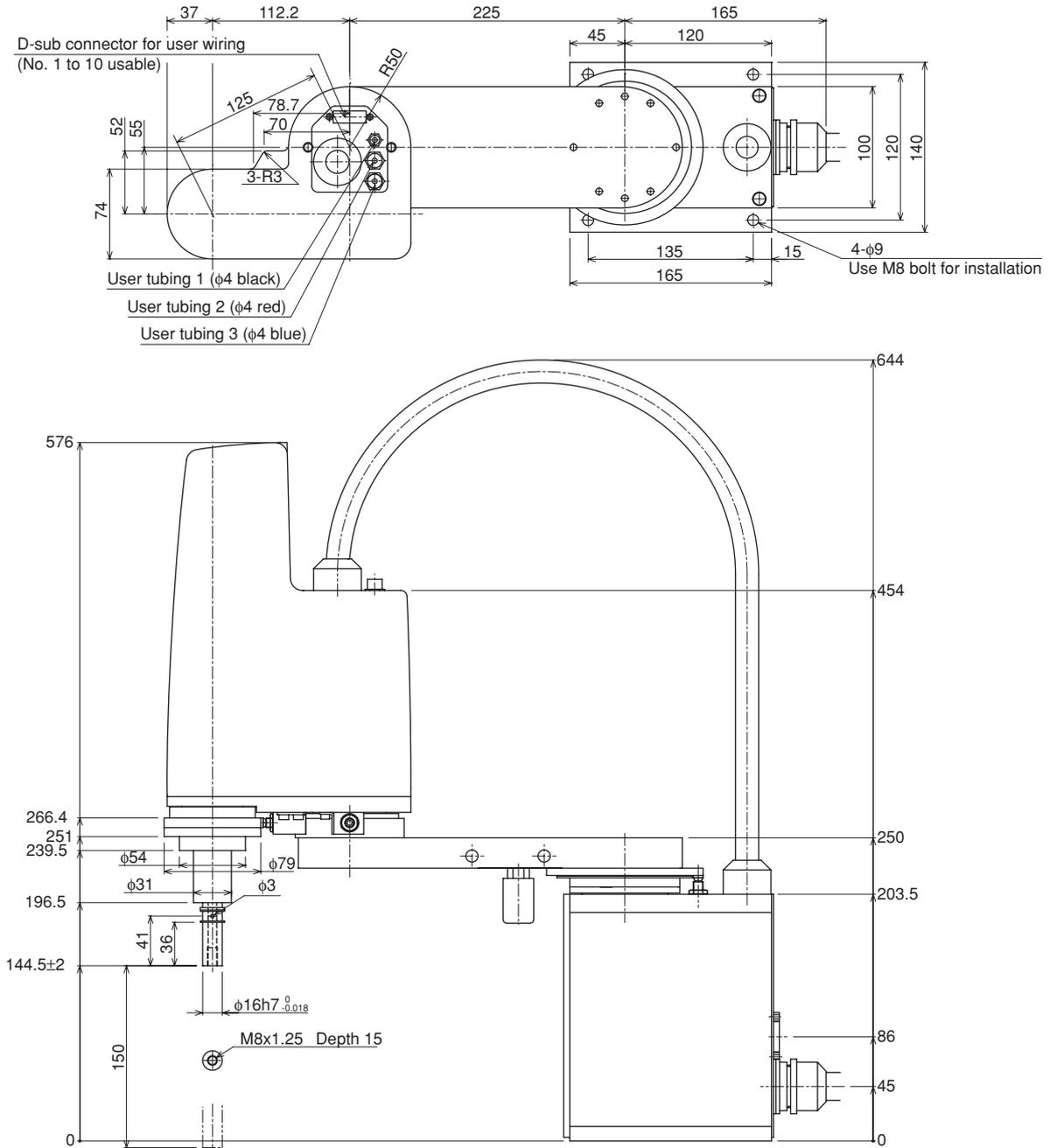
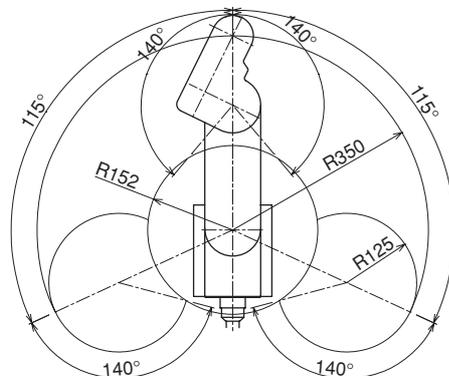
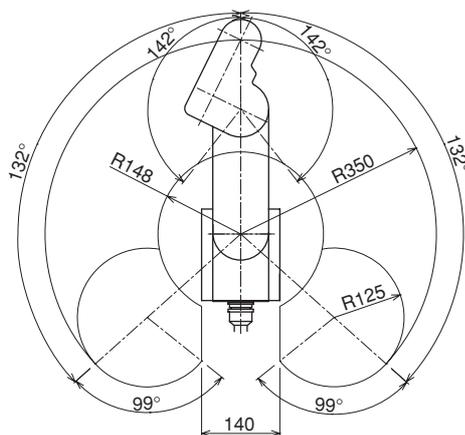


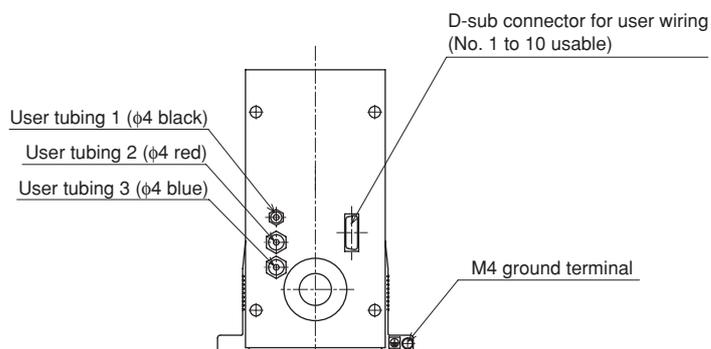
Fig. 7-4 YK350XH



Working envelope (1 : 5)



X and Y-axis mechanical stopper positions (1 : 5)



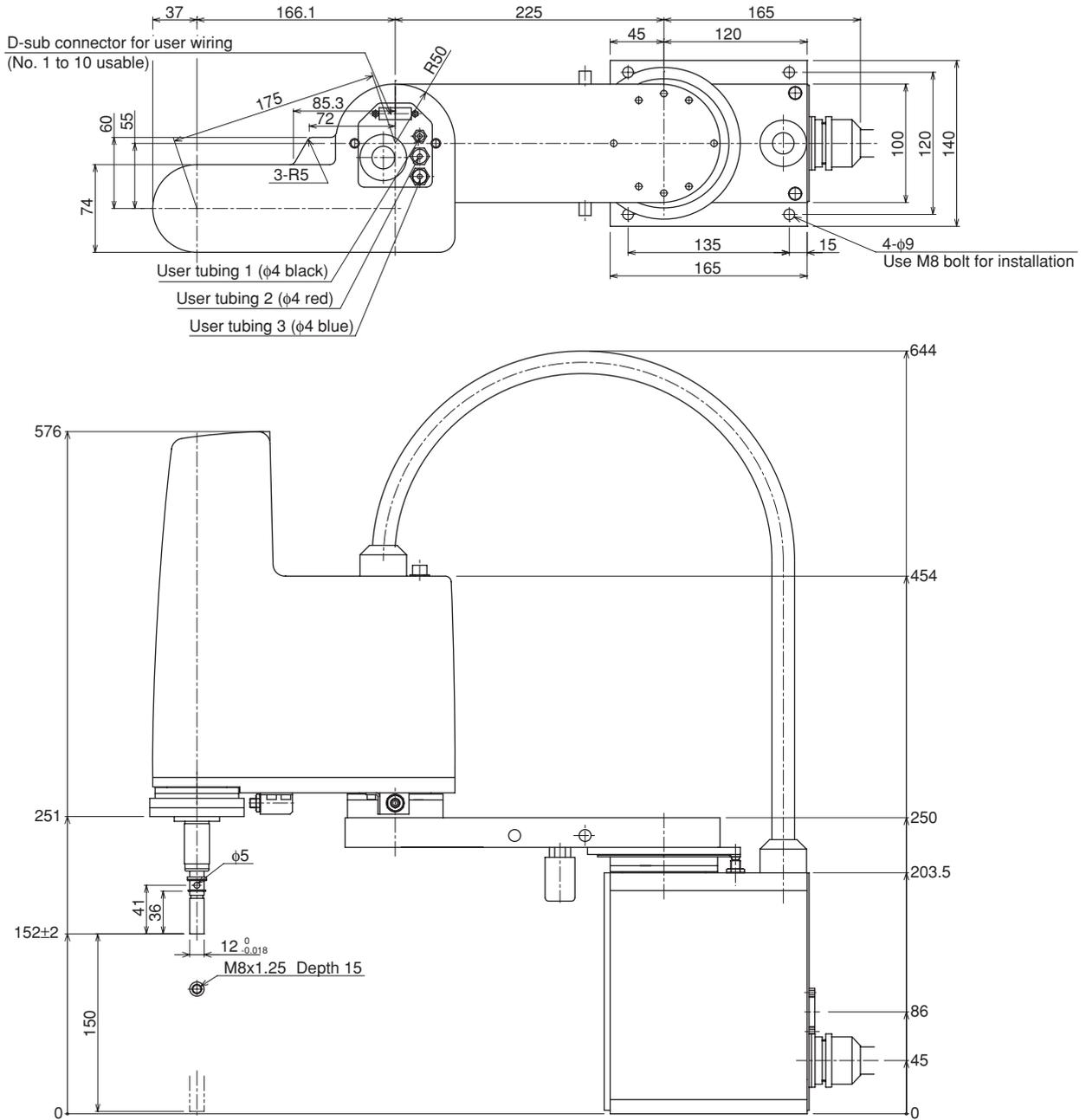
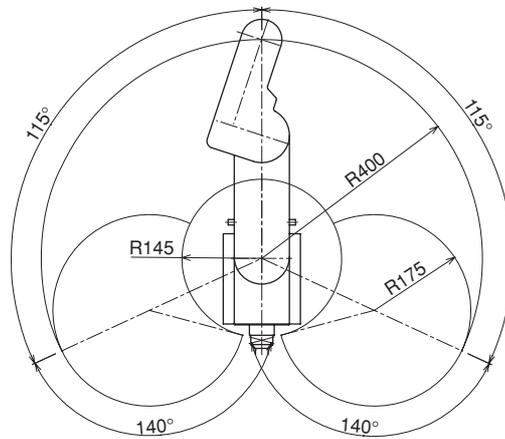
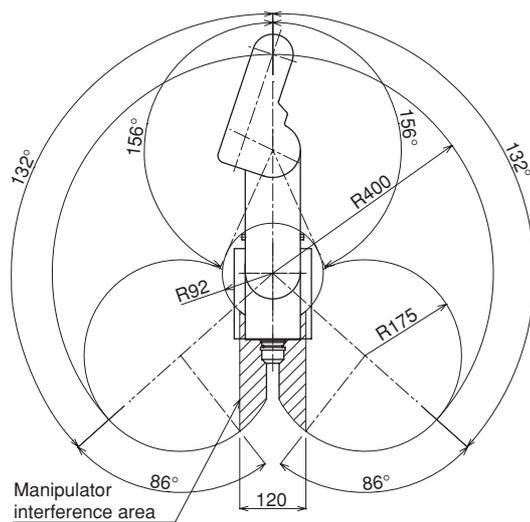


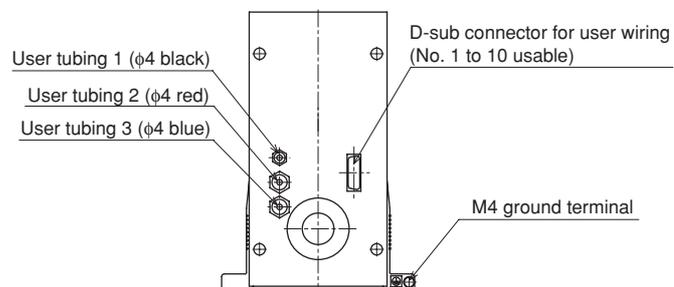
Fig. 7-5 YK400X



Working envelope (1 : 5)



X and Y-axis mechanical stopper positions (1 : 5)



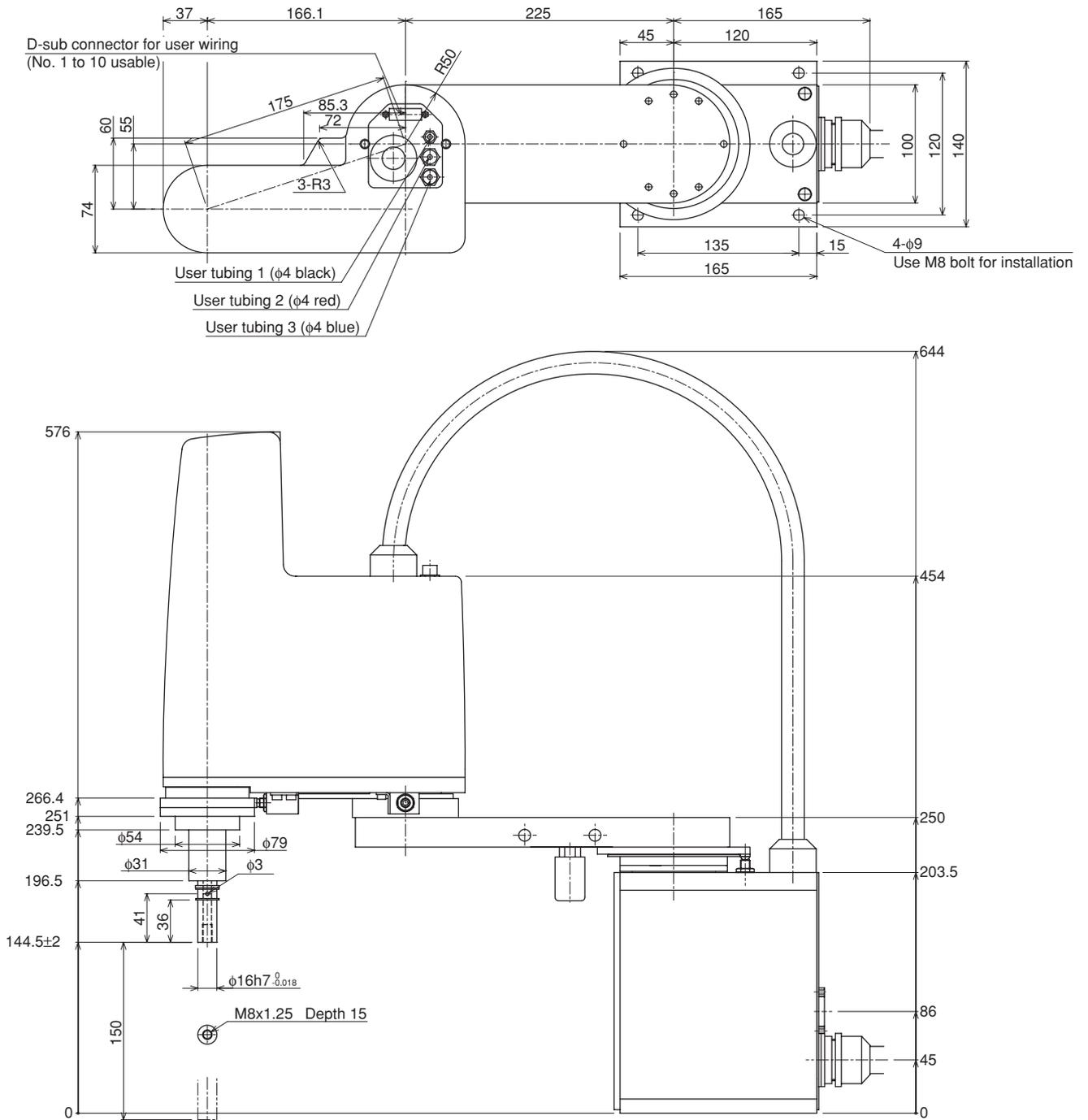
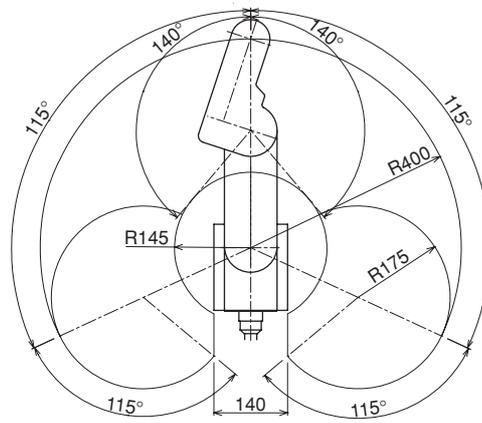
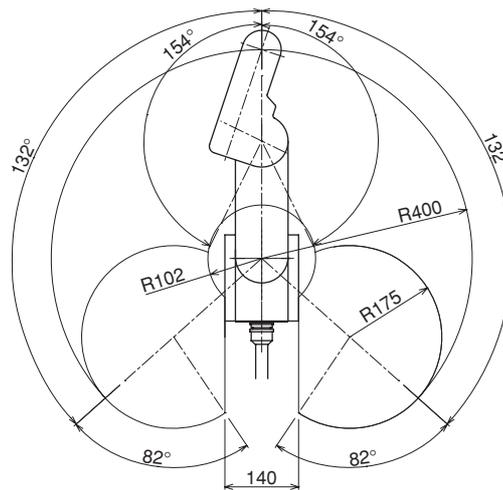


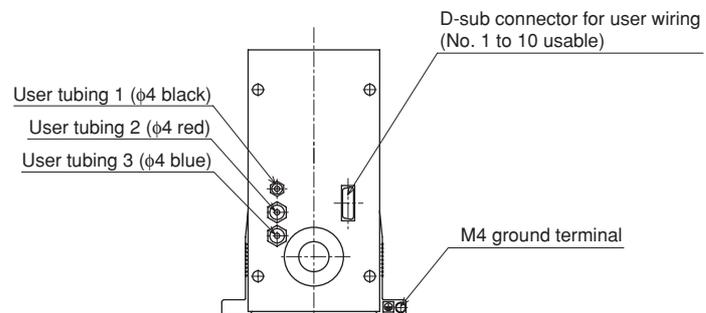
Fig. 7-6 YK400XH

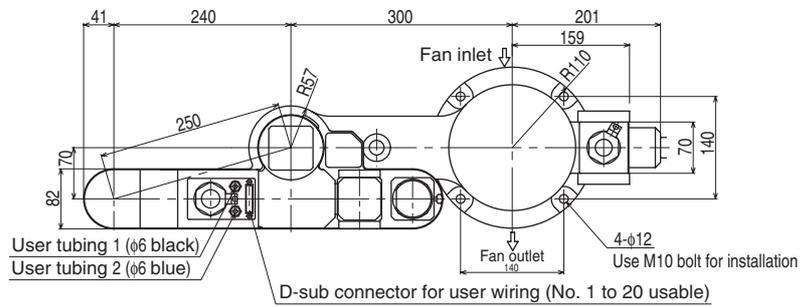


Working envelope (1 : 5)



X and Y-axis mechanical stopper positions (1 : 5)





(When Y-axis maximum working envelope is set to 940mm.)

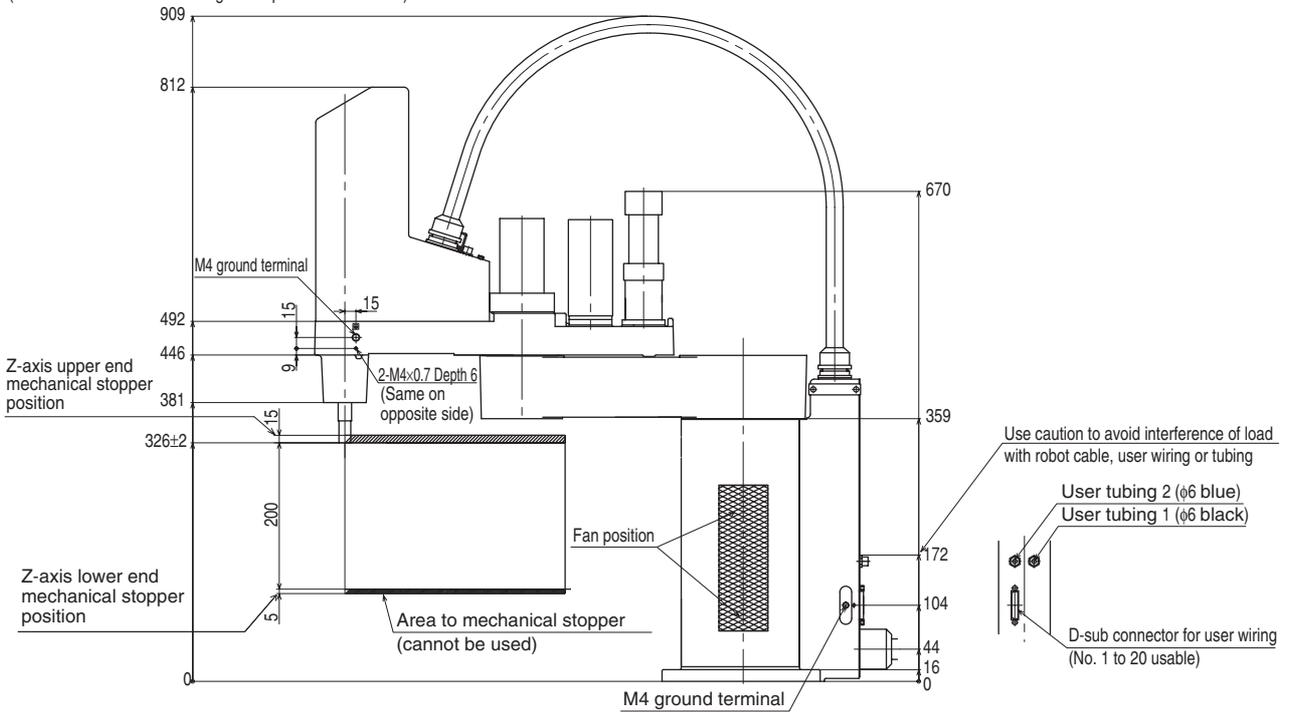
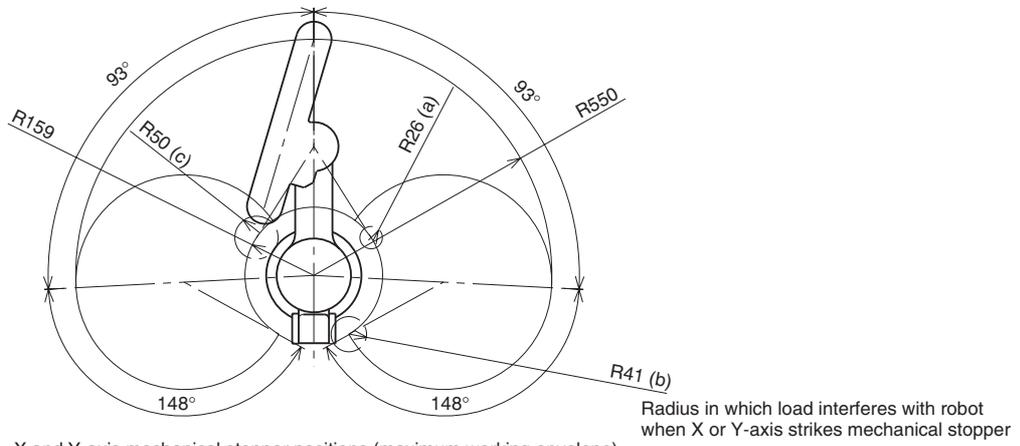
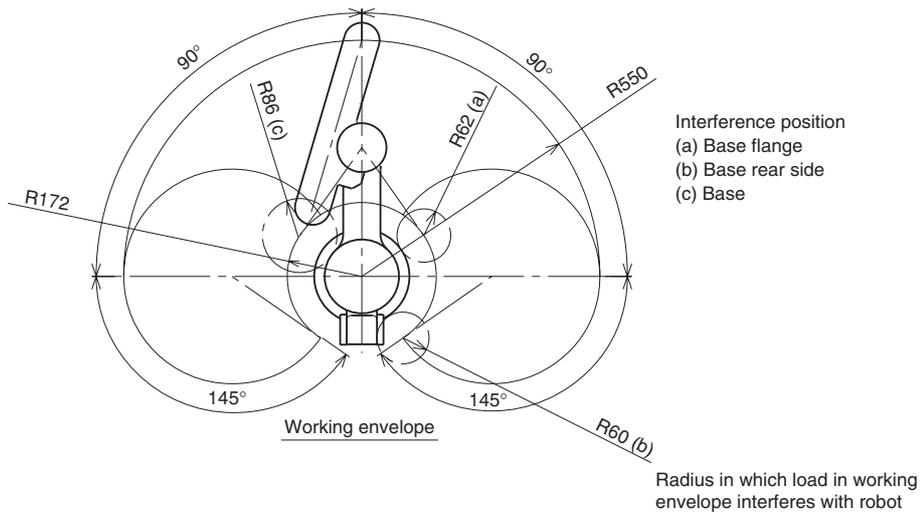
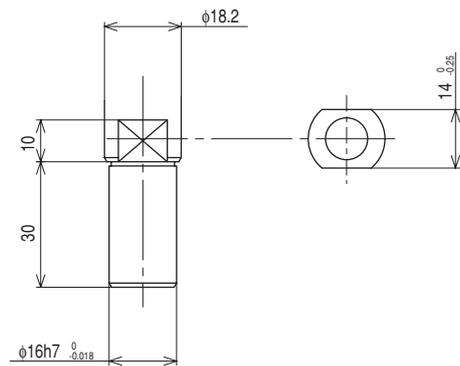


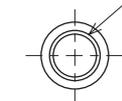
Fig. 7-7 YK550X



\*The area between working envelope and X or Y-axis mechanical stopper position cannot be used.



M12×1.75 Depth 20



Details of manipulator tip

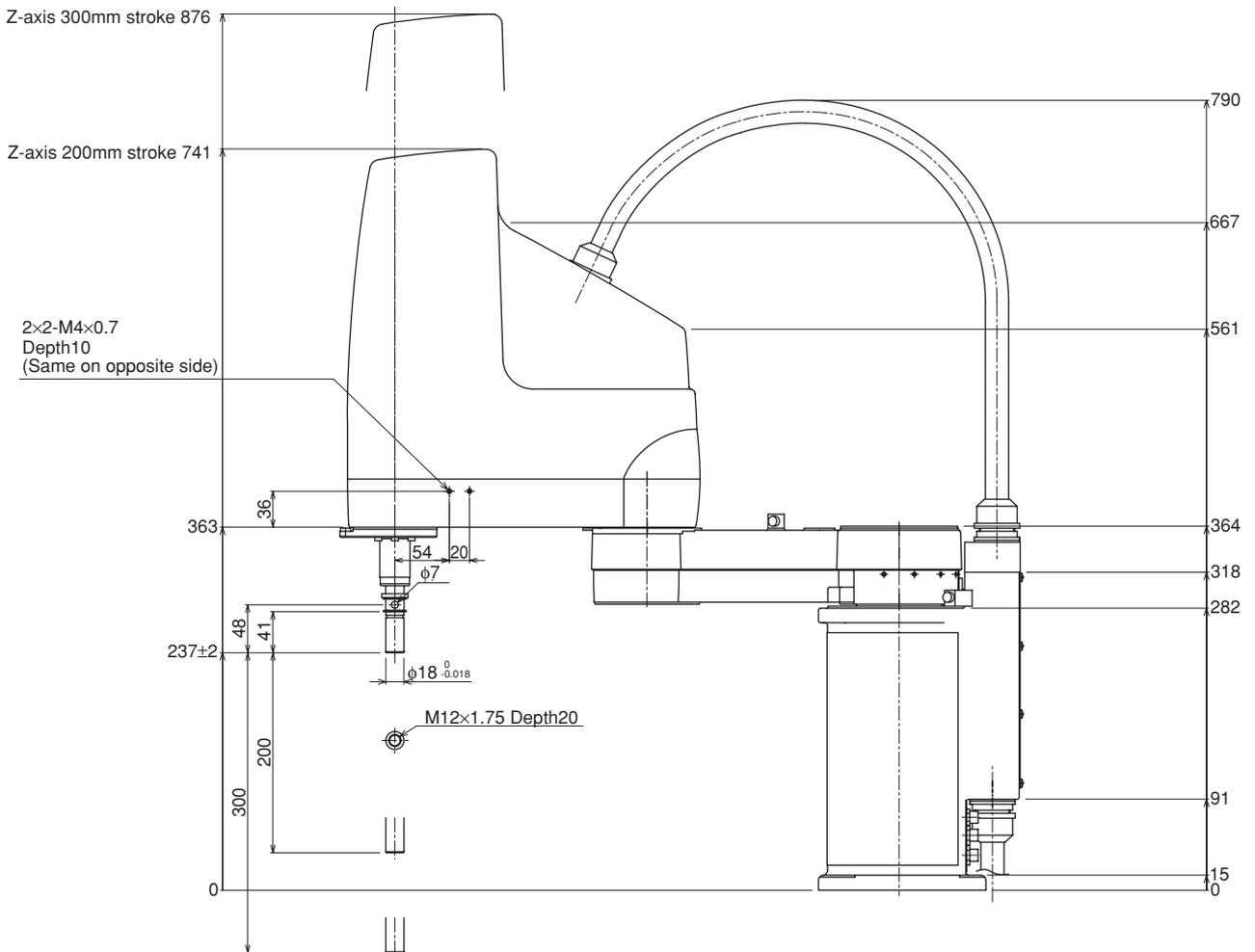
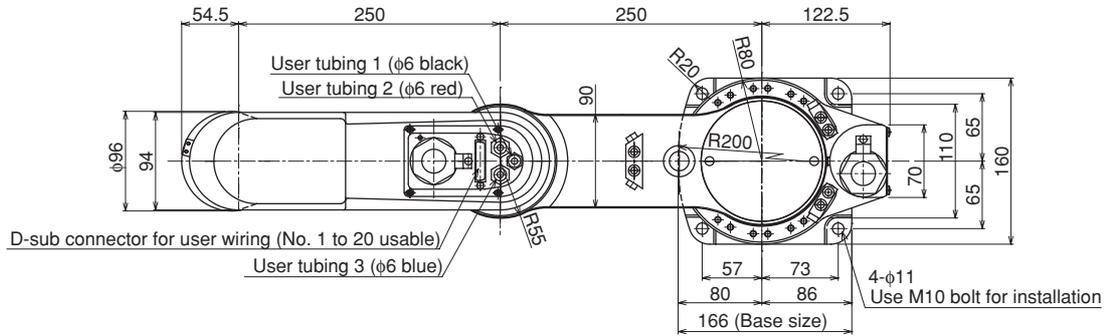
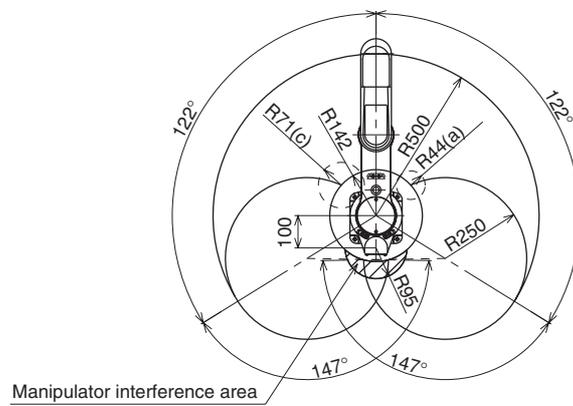
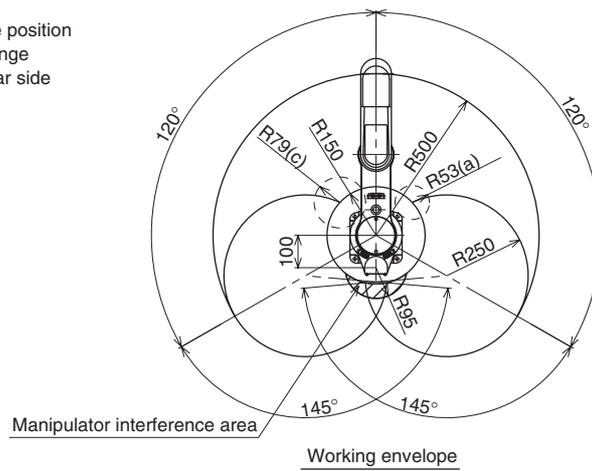
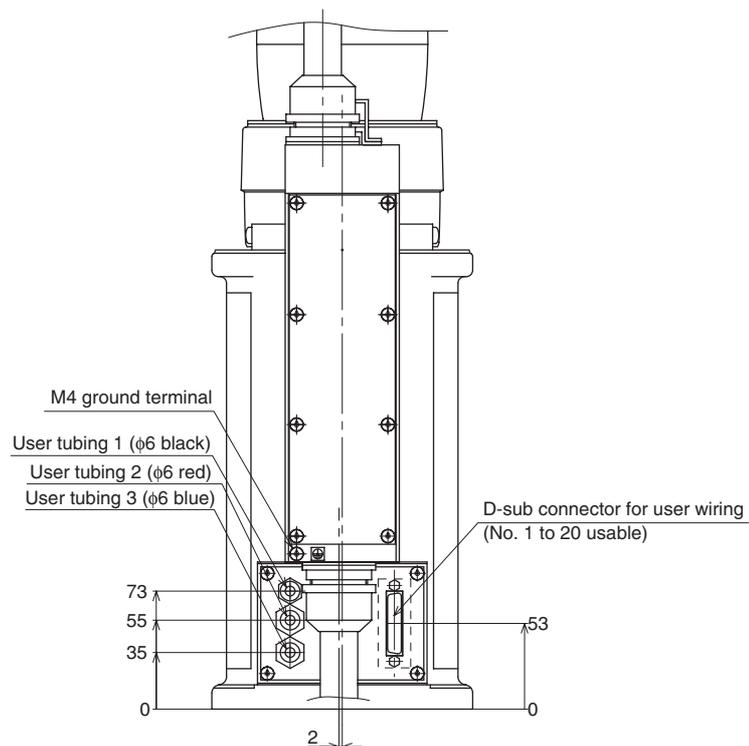


Fig. 7-8 YK500X

Interference position  
 (a) Base flange  
 (b) Base rear side  
 (c) Base



X and Y-axis mechanical stopper positions (maximum working envelope)



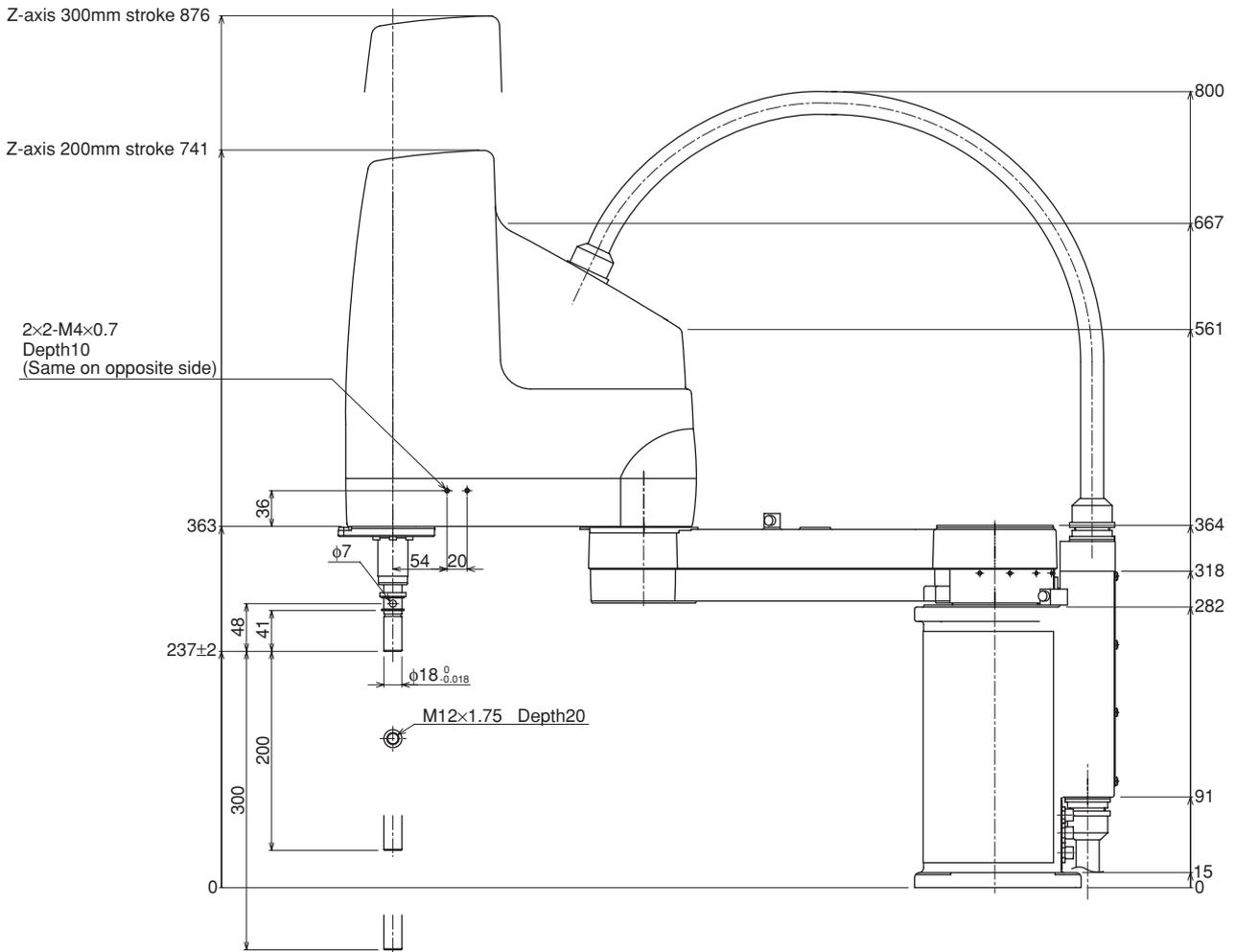
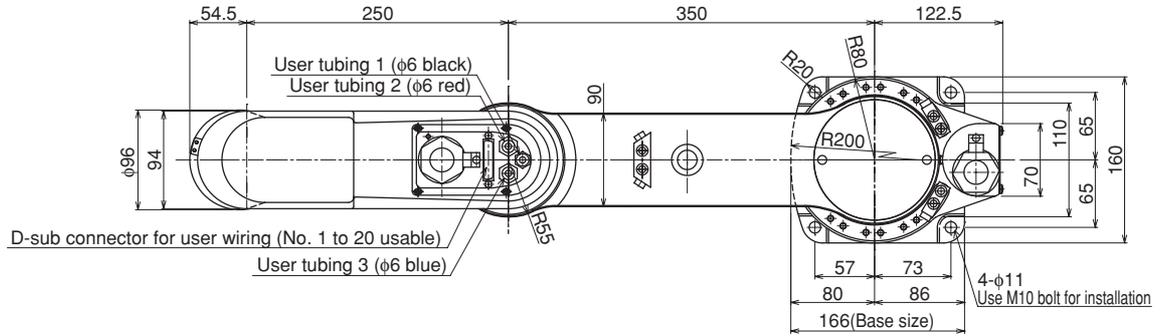
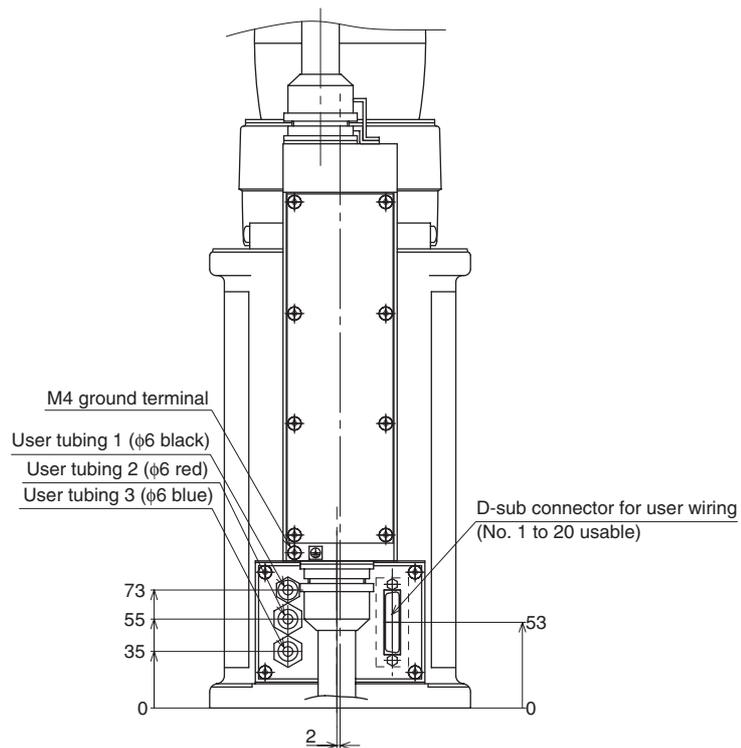
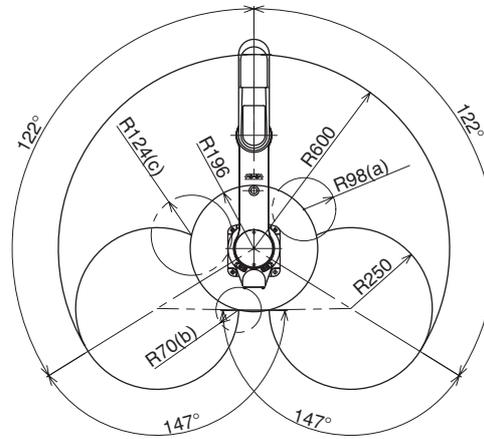
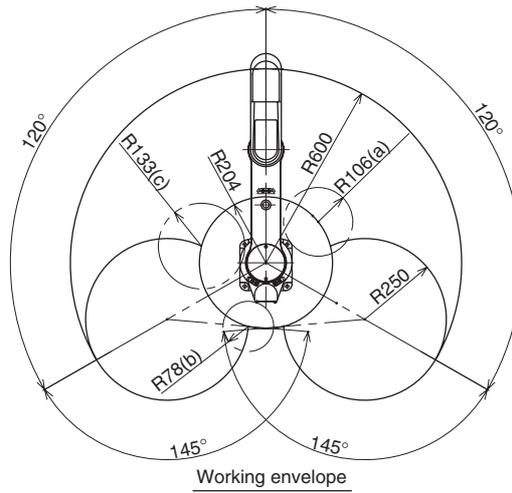


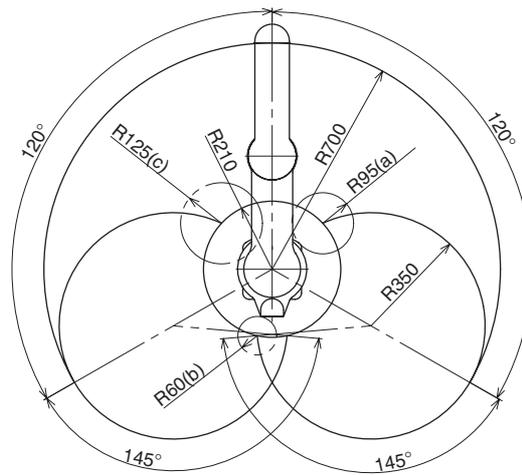
Fig. 7-9 YK600X

Interference position  
 (a) Base flange  
 (b) Base rear side  
 (c) Base

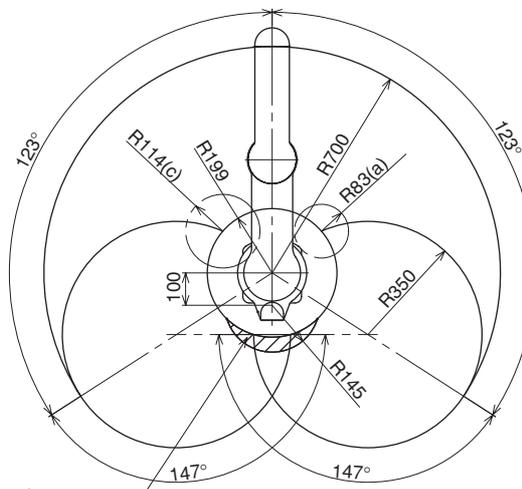




Interference position  
 (a) Base flange  
 (b) Base rear side  
 (c) Base

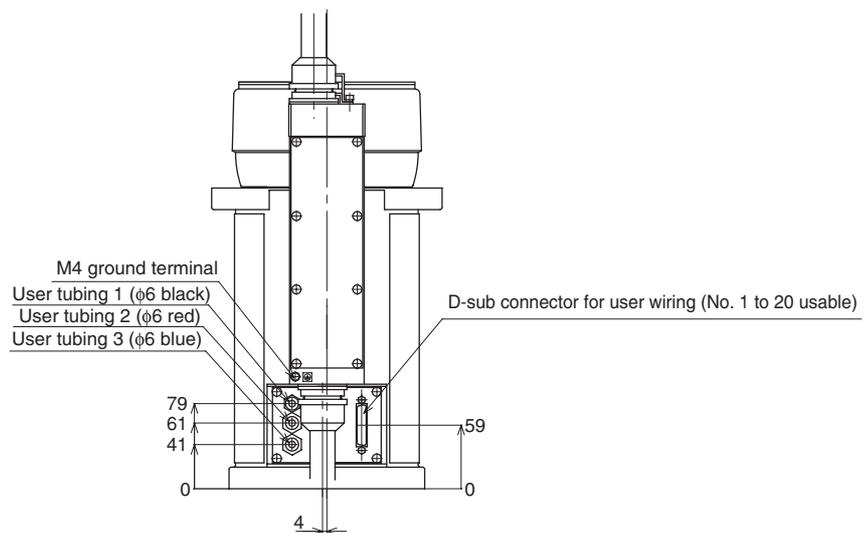


Working envelope



Manipulator interference area

X and Y-axis mechanical stopper positions (maximum working envelope)



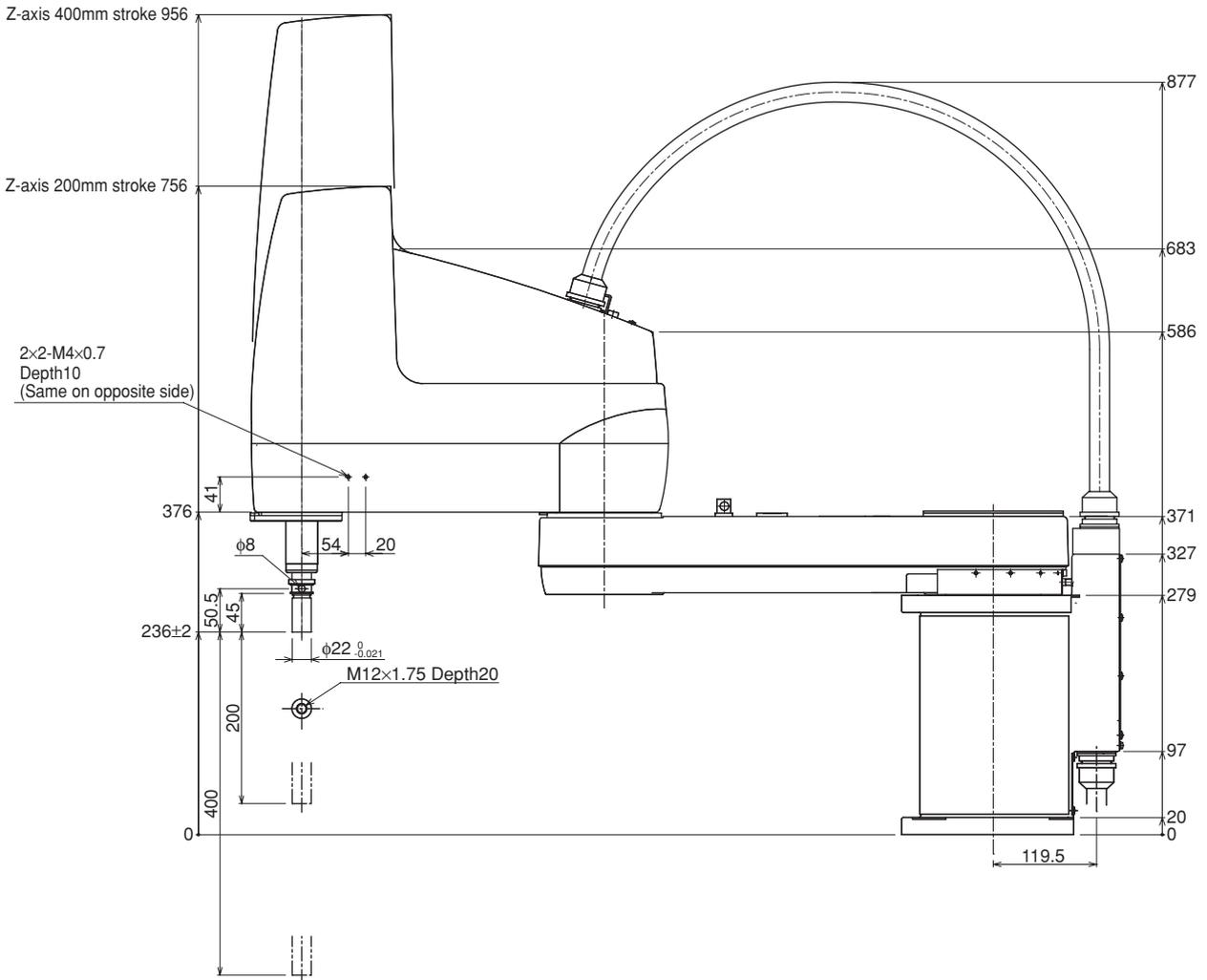
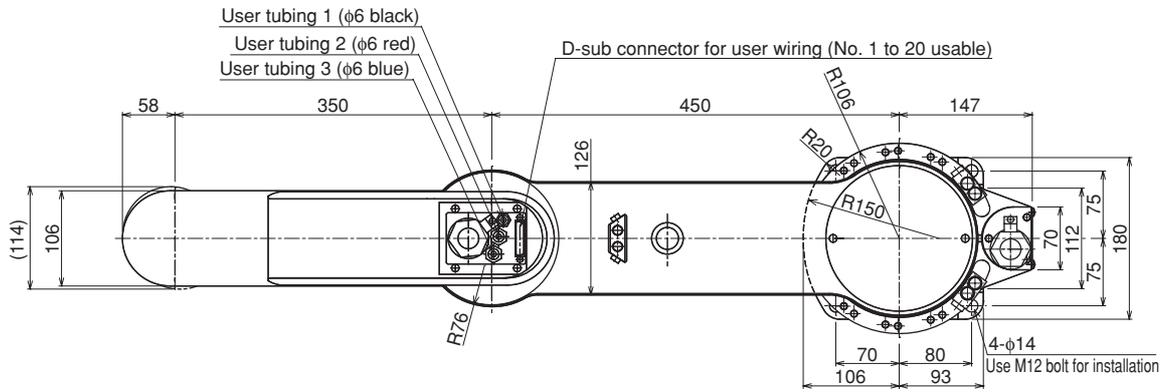
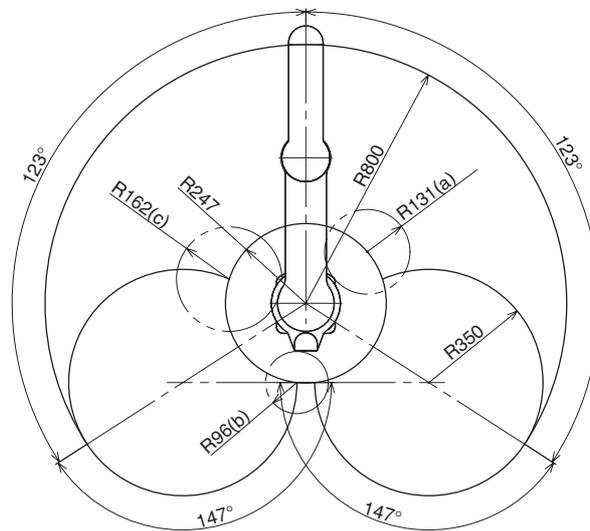
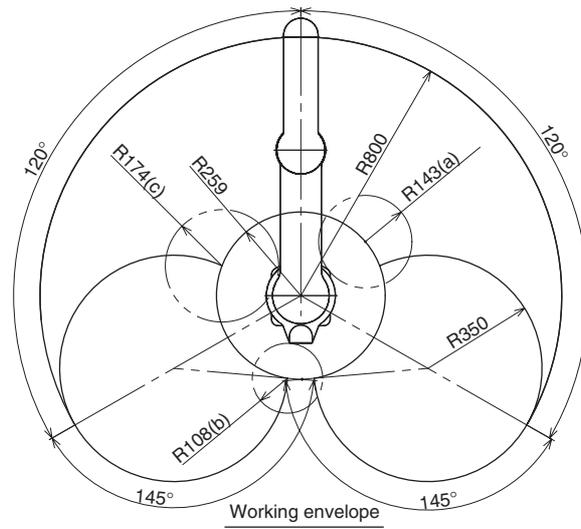
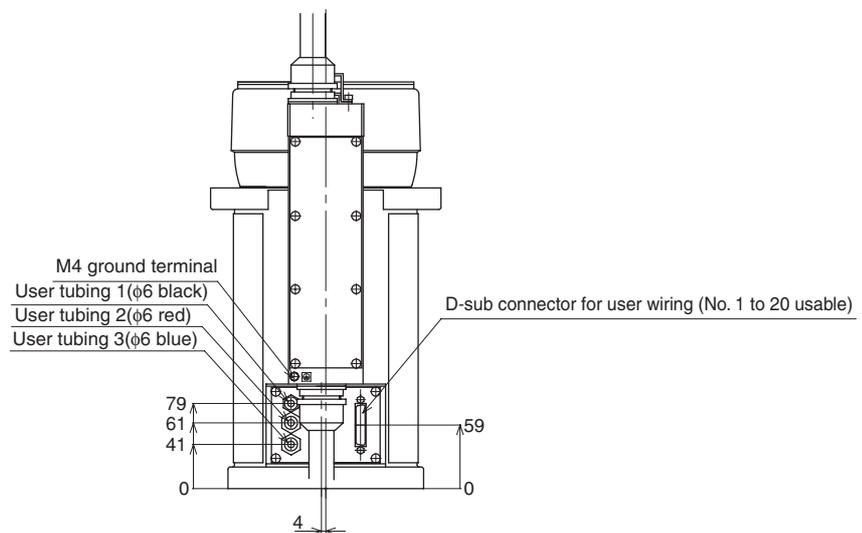


Fig. 7-11 YK800X

Interference position  
 (a) Base flange  
 (b) Base rear side  
 (c) Base

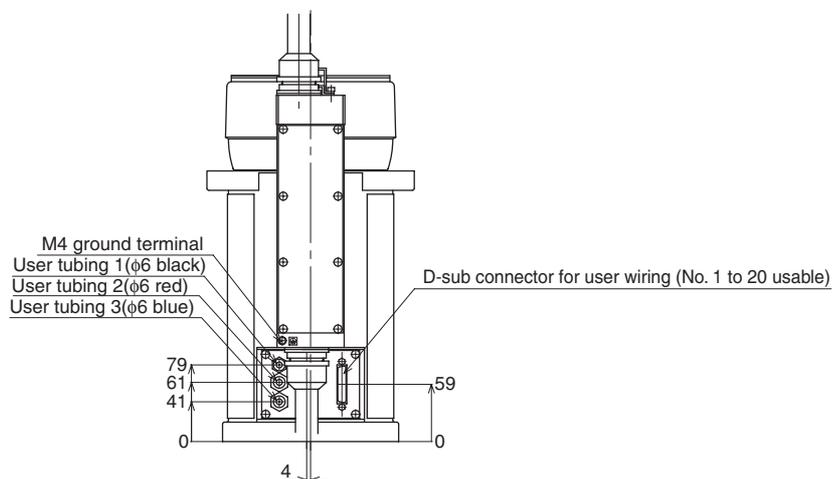
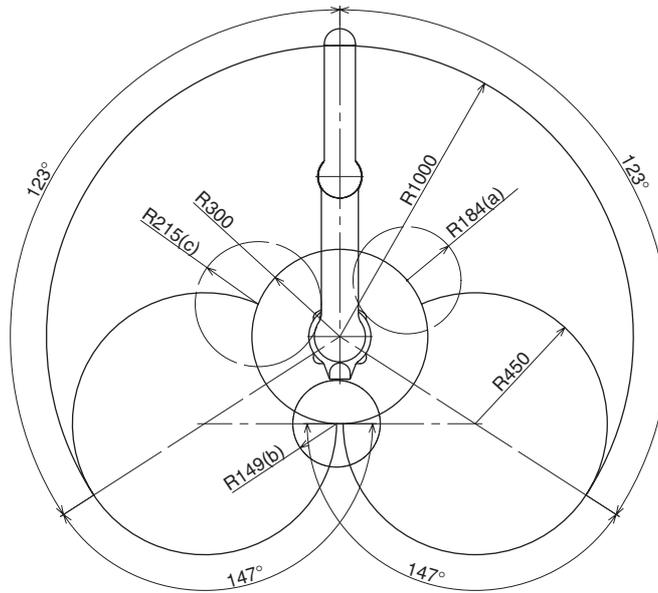
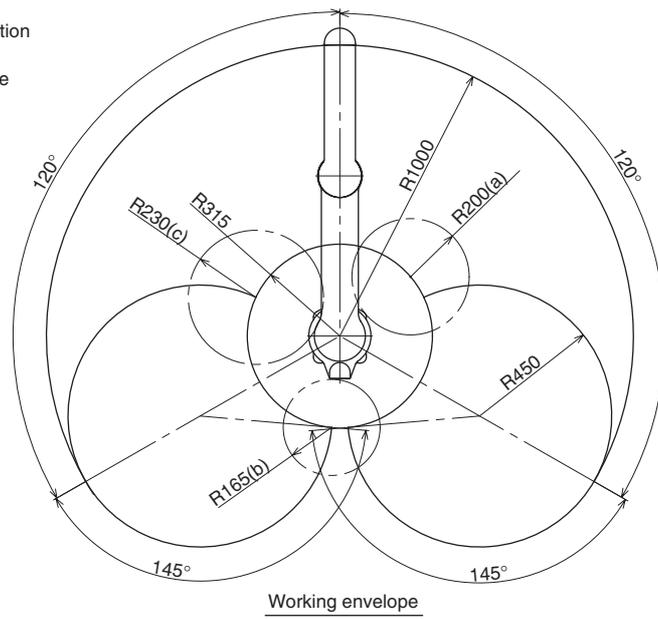


X and Y-axis mechanical stopper positions (maximum working envelope)





Interference position  
 (a) Base flange  
 (b) Base rear side  
 (c) Base



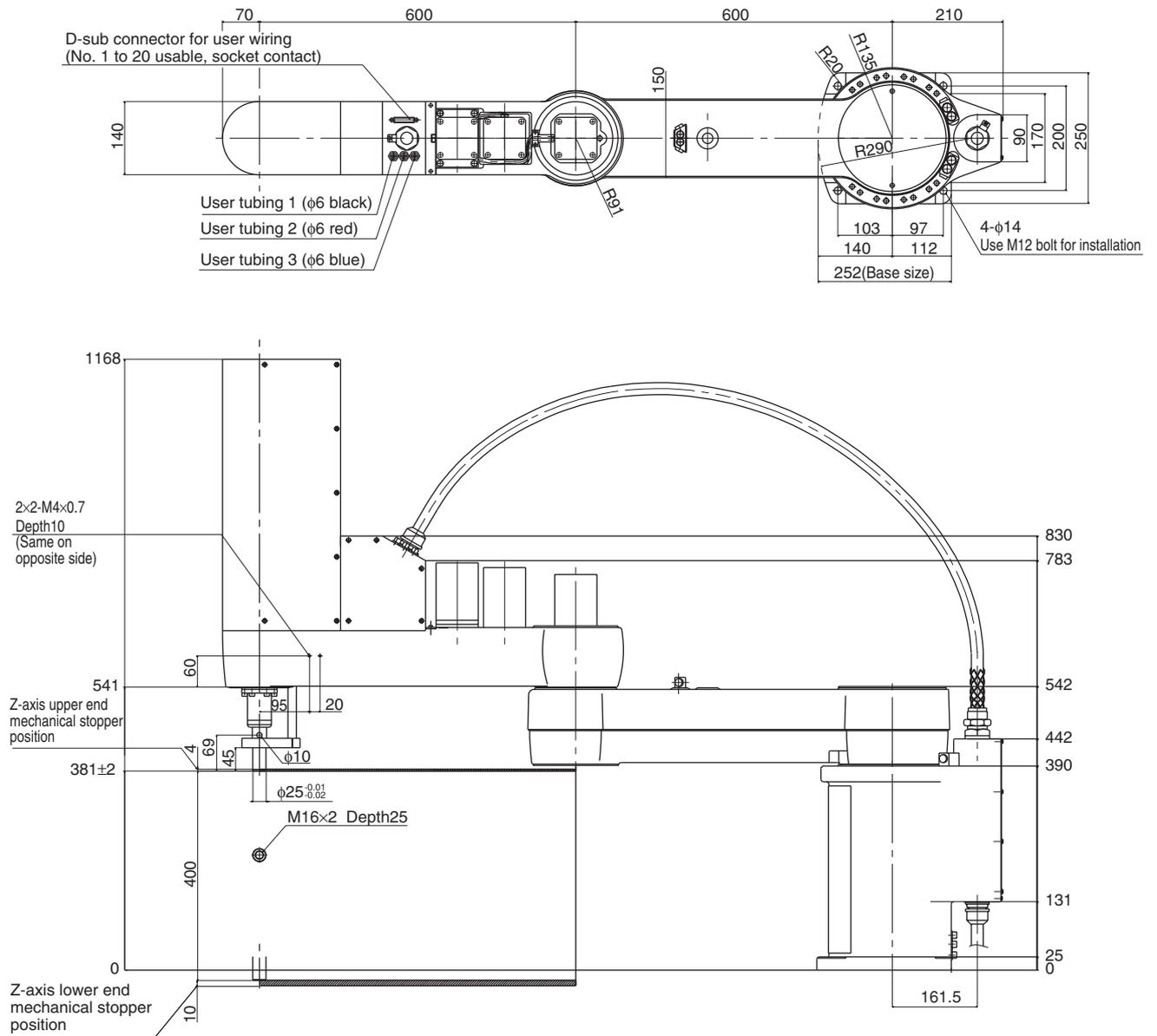
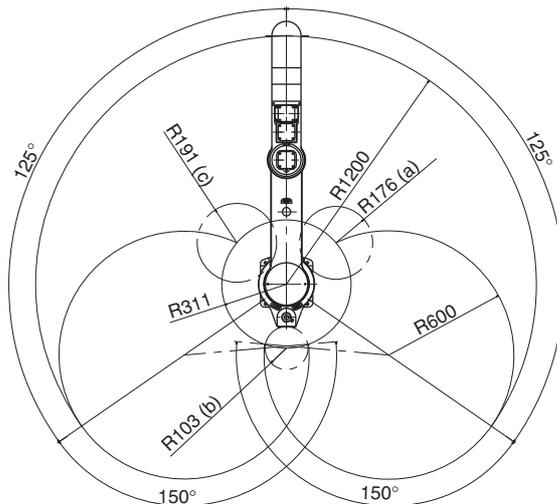
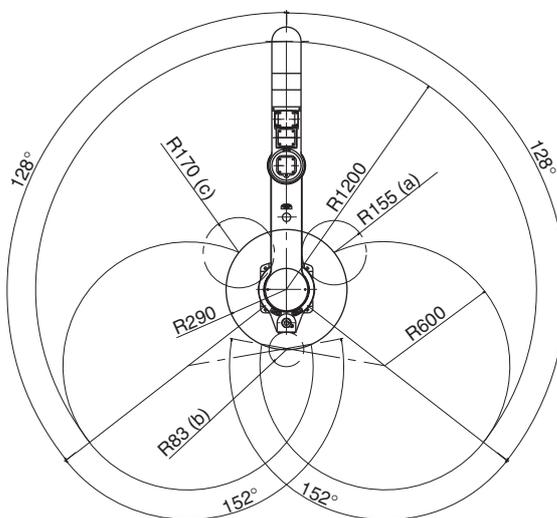


Fig. 7-13 YK1200X

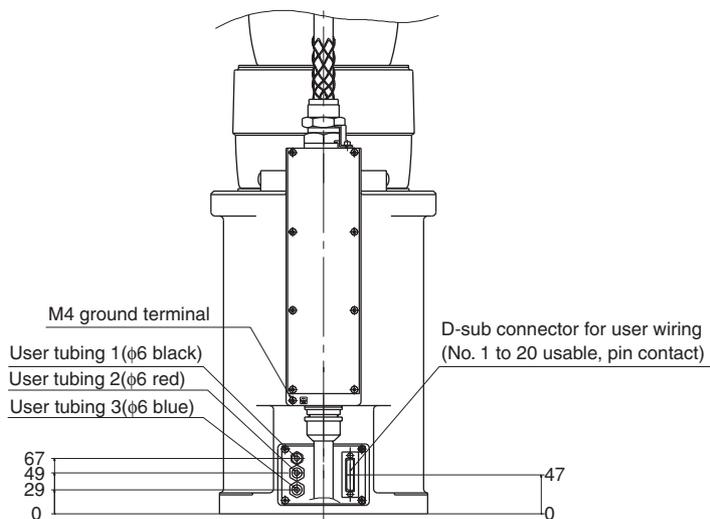
Interference position  
 (a) Base flange  
 (b) Base rear side  
 (c) Base



Working envelope



X and Y-axis mechanical stopper positions (maximum working envelope)



### 1-3 Robot inner wiring diagram

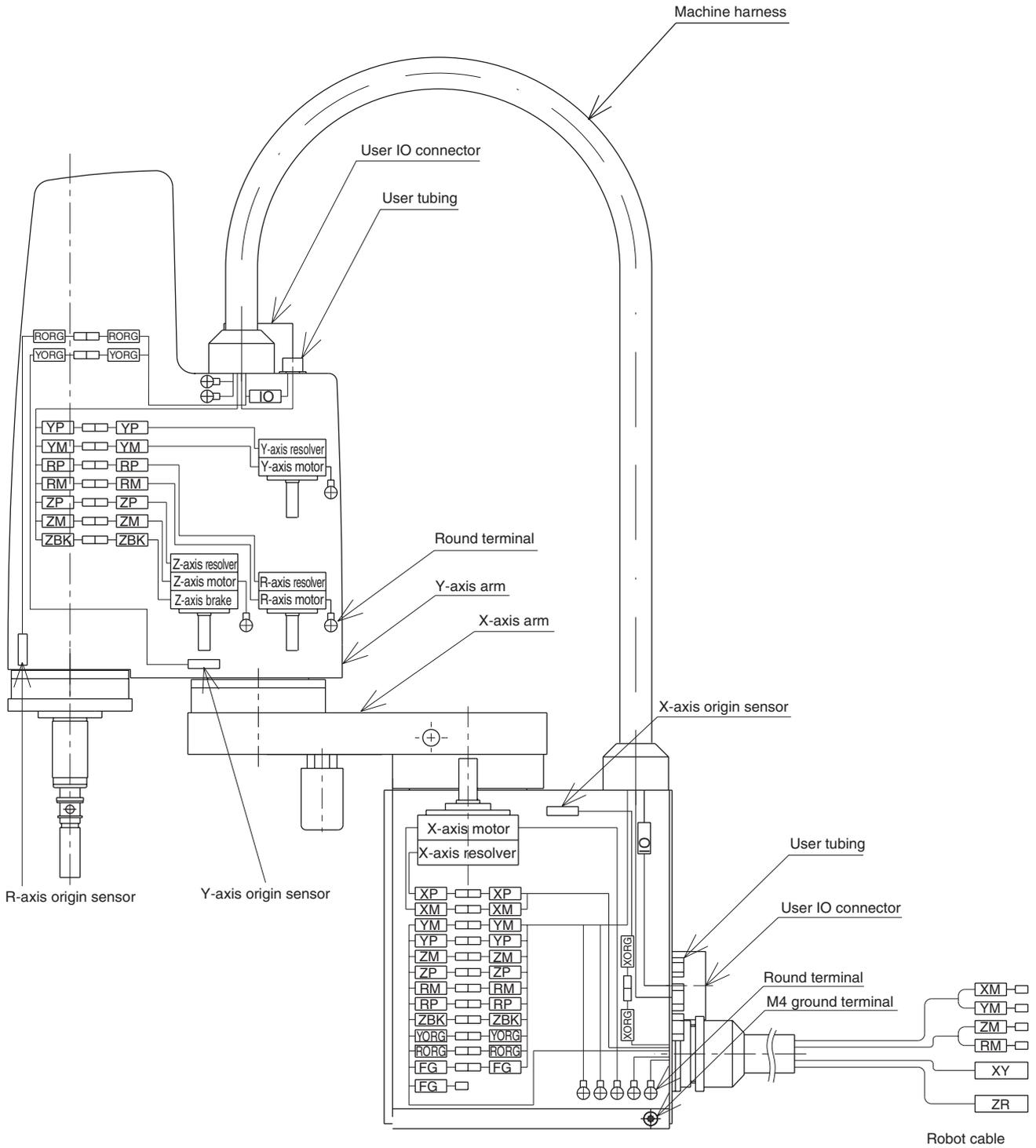


Fig. 7-14 YK250X, YK350X, YK400X

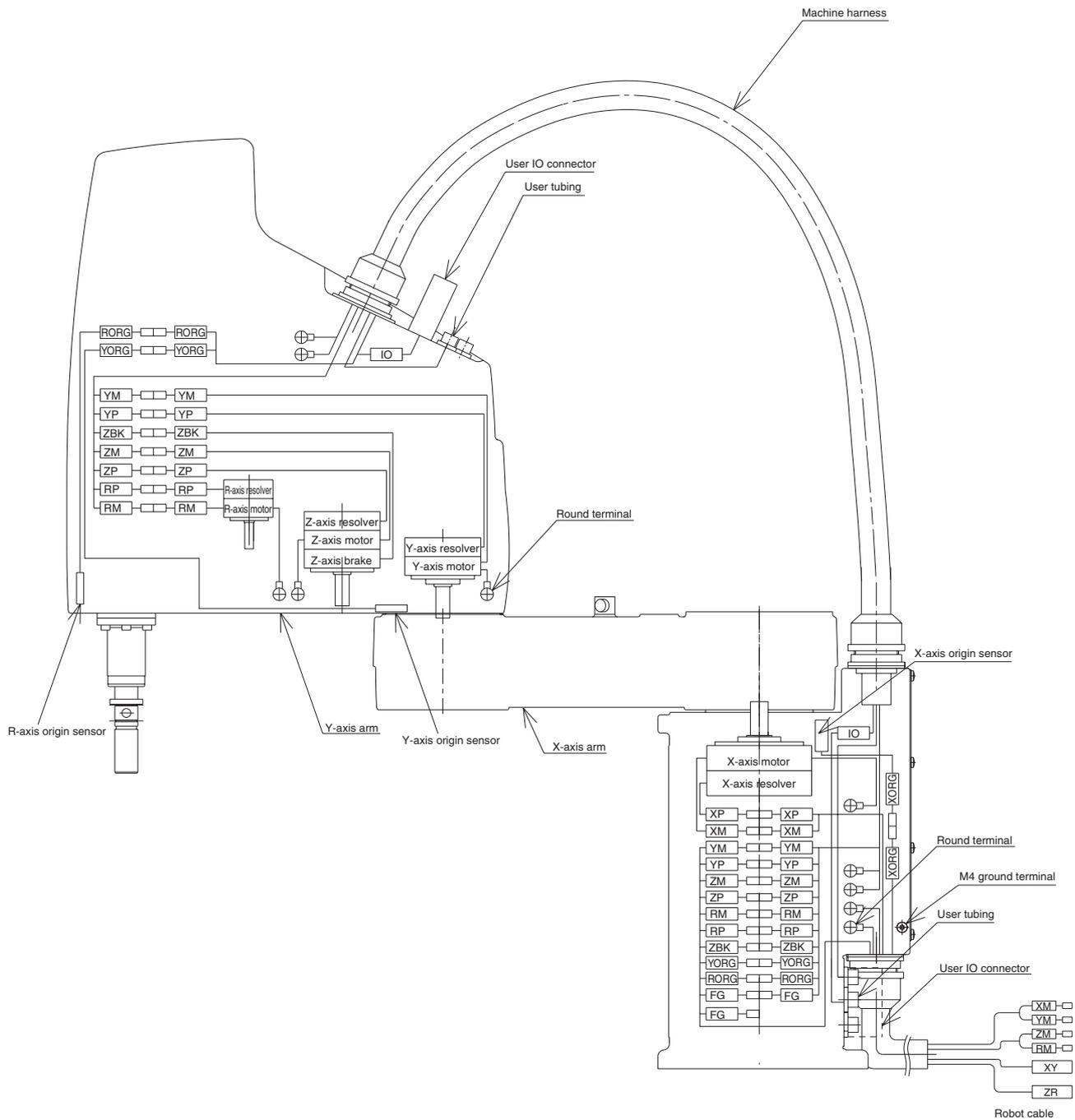


Fig. 7-15 YK500X, YK600X, YK700X, YK800X, YK1000X, YK1200X

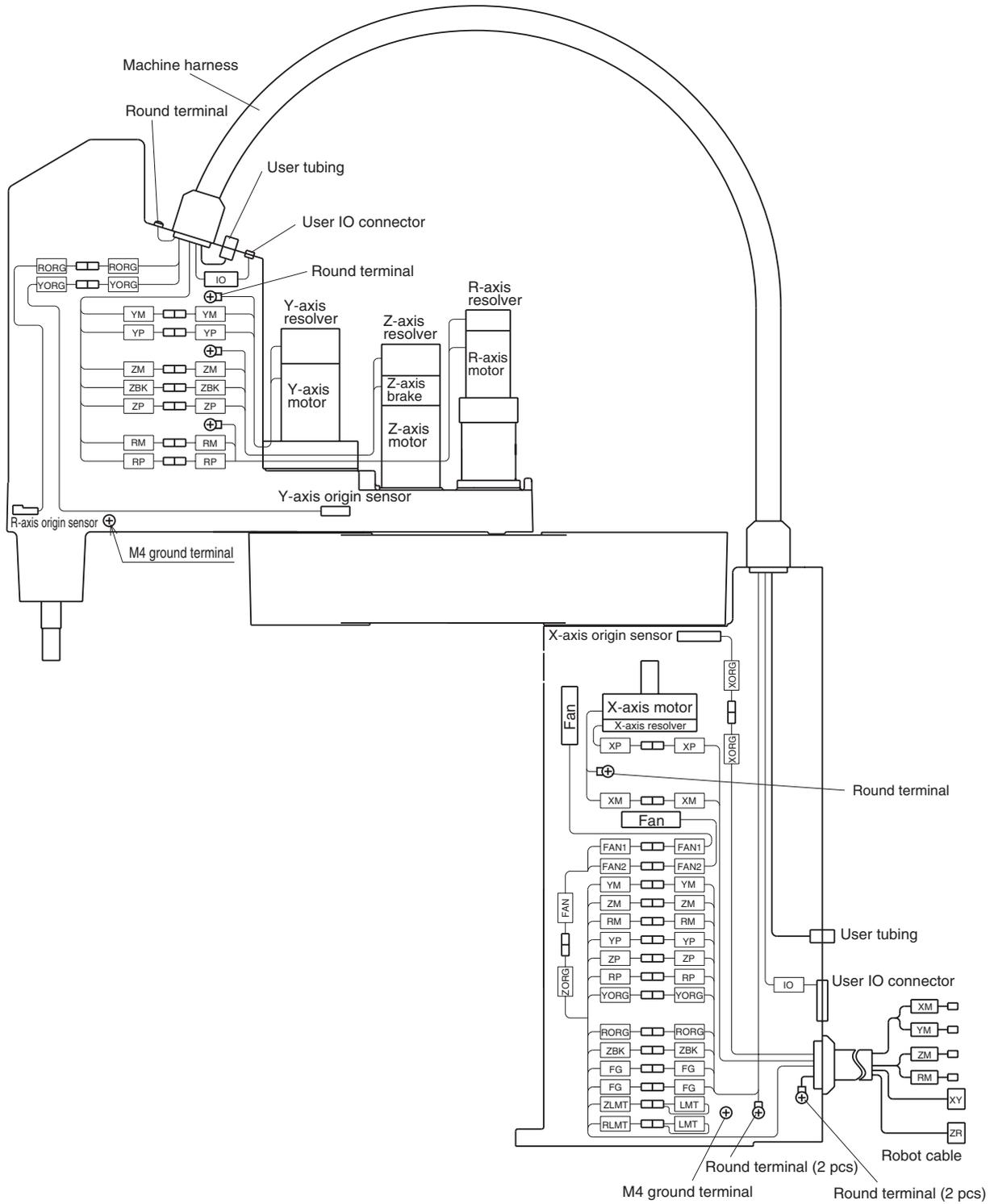


Fig. 7-16 YK550X

1-4 Wiring table

Robot cable wiring table

Signal	Connector	No	Connection	No	Connector	Color	Wire	
Resolver	S2	XP	1		1	XY	Blue	0.15sq
			2		2		Orange	Twisted pair
			3		3		Green	0.15sq
			4		4		Brown	Twisted pair
			5		5		Gray	0.15sq
			6		6		Red	Twisted pair
			7		7		Gray	0.3sq
Resolver	S2	YP	1		19	XY	Black	0.15sq
			2		20		Yellow	Twisted pair
			3		21		Pink	0.15sq
			4		22		Purple	Twisted pair
			5		23		White	0.15sq
			6		24		Blue/Red	Twisted pair
			7		25		Gray	0.3sq
FG	FG	1		18	XY	Orange/White	0.15sq	
				36		Green/White	0.15sq	
HLIM						10	Gray	0.3sq
GND24						11		
HLIM						28	Gray	0.3sq
GND24						29		
Origin Sensor	GND	XORG		3			13	XY
ORG	2		12	Pink/Black	Twisted pair			
24V	1		9	Purple/White	0.15sq			
Origin Sensor	24V	YORG	1		27	XY	White/Blue	Twisted pair
ORG	2		30		Blue/Red2		0.15sq	
GND	3		31		Orange/White2		Twisted pair	
U	XM	XM	1		2	XM	Black	0.75sq
V			2		3		Red	0.75sq
W			3		4		White	0.75sq
FG	Round terminal				1		Gray	0.75sq
U	YM	YM	1		2	YM	Yellow	0.75sq
V			2		3		Brown	0.75sq
W			3		4		Blue	0.75sq

**CHAPTER 7 Specifications**

Signal	Connector	No	Connection	No	Connector	Color	Wire
Resolver	S2	ZP		1	ZR	Blue	0.15sq
				2		Orange	Twisted pair
				3		Green	0.15sq
				4		Brown	Twisted pair
				5		Gray	0.15sq
				6		Red	Twisted pair
				7		Gray	0.3sq
Brake	MB+	ZBK		14	Black	0.15sq	
				16	Yellow	Twisted pair	
				15	Pink	0.15sq	
				17	Purple	Twisted pair	
Resolver	S2	RP		19	White	0.15sq	
				20	Blue/Red	Twisted pair	
				21	Orange/White	0.15sq	
				22	Green/White	Twisted pair	
				23	Brown/White	0.15sq	
				24	Gray/White	Twisted pair	
				25	Gray	0.3sq	
	FG	FG		18	Red/White	0.15sq	
				36	Black/White	0.15sq	
HLIM				10	Gray	0.3sq	
GND24				11			
HLIM				28	Gray	0.3sq	
GND24				29			
Origin Sensor 24V	RORG			27	White/Blue	0.15sq	
				30	Blue/Red2	0.15sq	
				31	Orange/White2	Twisted pair	
U	ZM			ZM	Black	0.75sq	
V					Red	0.75sq	
W					White	0.75sq	
FG	Round terminal				Gray	0.75sq	
U	RM			RM	Yellow	0.75sq	
V					Brown	0.75sq	
W					Blue	0.75sq	

Machine harness wiring table  
(YK250X, YK350X, YK400X)

Y-axis arm side				Base side			
Signal	Connector	No	Connection	No	Connector	Color	Wire
Y-axis Resolver	S2	1		1	YP	Brown	0.2mm <sup>2</sup>
		2		2		White	Twisted pair
		3		3		Red	0.2mm <sup>2</sup>
		4		4		White	Twisted pair
		5		5		Orange	0.2mm <sup>2</sup>
		6		6		White	Twisted pair
		7		7		Green	Shield
Z-axis Resolver	S2	1		1	ZP	Brown	0.2mm <sup>2</sup>
		2		2		Black	Twisted pair
		3		3		Red	0.2mm <sup>2</sup>
		4		4		Black	Twisted pair
		5		5		Orange	0.2mm <sup>2</sup>
		6		6		Black	Twisted pair
		7		7		Green	Shield
R-axis Resolver	S2	1		1	RP	Brown	0.2mm <sup>2</sup>
		2		2		Gray	Twisted pair
		3		3		Red	0.2mm <sup>2</sup>
		4		4		Gray	Twisted pair
		5		5		Orange	0.2mm <sup>2</sup>
		6		6		Gray	Twisted pair
		7		7		Green	Shield
Y-axis motor	U	1		1	YM	Brown	0.75mm <sup>2</sup>
		2		2		Red	
		3		3		Orange	
Z-axis motor	U	1		1	ZM	Blue	0.75mm <sup>2</sup>
		2		2		Purple	
		3		3		Gray	
R-axis motor	U	1		1	RM	Black	0.75mm <sup>2</sup>
		2		2		White	
		3		3		Red	
Z-axis brake	1	1		1	ZBK	Purple	0.3mm <sup>2</sup>
Z-axis brake	2	2		2		Gray	
User signal line	IO	1		1	IO	Brown	0.2mm <sup>2</sup>
		2		2		Red	
		3		3		Orange	
		4		4		Blue	
		5		5		Purple	
		6		6		Gray	
		7		7		White	
		8		8		Brown	0.2mm <sup>2</sup>
		9		9		Red	
		10		10		Orange	
		11		11			
		12		12			
		13		13			
		14		14			
		15		15			
Frame ground				1	FG	Green	Shield
Origin Sensor 24V	YORG	1		1	YORG	White	0.2mm <sup>2</sup>
		2		2		Purple	
		3		3		Gray	
Origin Sensor 24V	RORG	1		1	RORG	White	0.2mm <sup>2</sup>
		2		2		Blue	
		3		3		Gray	
	Round terminal				Round terminal	Yellow/Green	0.75sq
	Round terminal				Round terminal	Blue	0.75sq

Machine harness wiring table  
(YK500X, YK600X, YK700X, YK800X, YK1000X, YK1200X)

Y-axis arm side				Base side			
Signal	Connector	No	Connection	No	Connector	Color	Wire
Y-axis Resolver	S2	1		1	YP	Brown	0.2mm <sup>2</sup>
		2		2		White	Twisted pair
		3		3		Red	0.2mm <sup>2</sup>
		4		4		White	Twisted pair
		5		5		Orange	0.2mm <sup>2</sup>
		6		6		White	Twisted pair
		7		7		Green	Shield
Z-axis Resolver	S2	1		1	ZP	Brown	0.2mm <sup>2</sup>
		2		2		Black	Twisted pair
		3		3		Red	0.2mm <sup>2</sup>
		4		4		Black	Twisted pair
		5		5		Orange	0.2mm <sup>2</sup>
		6		6		Black	Twisted pair
		7		7		Green	Shield
R-axis Resolver	S2	1		1	RP	Brown	0.2mm <sup>2</sup>
		2		2		Gray	Twisted pair
		3		3		Red	0.2mm <sup>2</sup>
		4		4		Gray	Twisted pair
		5		5		Orange	0.2mm <sup>2</sup>
		6		6		Gray	Twisted pair
		7		7		Green	Shield
Y-axis motor	U	1		1	YM	Brown	0.75mm <sup>2</sup>
		2		2		Red	
		3		3		Orange	
Z-axis motor	U	1		1	ZM	Blue	0.75mm <sup>2</sup>
		2		2		Purple	
		3		3		Gray	
R-axis motor	U	1		1	RM	Black	0.75mm <sup>2</sup>
		2		2		White	
		3		3		Brown	
Z-axis brake	1	1		1	ZBK	White	0.3mm <sup>2</sup>
Z-axis brake	2	2		2		Black	
User signal line	IO	1		1	IO	Brown	0.2mm <sup>2</sup>
		2		2		Red	
		3		3		Orange	
		4		4		Blue	
		5		5		Purple	
		6		6		Gray	
		7		7		White	
		8		8		Black	
		9		9		Brown	0.2mm <sup>2</sup>
		10		10		Red	
		11		11		Orange	
		12		12		Blue	
		13		13		Brown	
		14		14		Red	
		15		15		Orange	
		16		16		Blue	
		17		17		Purple	
		18		18		Gray	
		19		19		White	
		20		20		Black	
		21		21		Brown	
		22		22		Red	
		23		23		Orange	
		24		24		Blue	
Frame ground		25		25	FG	Green	Shield
Frame ground							
Origin Sensor 24V	ORG	1		1	YORG	Brown	0.2mm <sup>2</sup>
		2		2		Red	
		3		3		Orange	
Origin Sensor 24V	ORG	1		1	RORG	Brown	0.2mm <sup>2</sup>
		2		2		Blue	
		3		3		Orange	
	Round terminal				Round terminal	Yellow/Green	0.75sq
	Round terminal				Round terminal	Black	0.75sq

4-axis machine harness wiring table  
(YK550X)

Y-axis arm side			Base side			Y-axis arm side			Base side							
Signal	Connector	No	Connection	No	Connector	Color	Signal	Connector	No	Connection	No	Connector	Color			
Y-axis Resolver S2 S4 S1 S3 R1 R2 DG	YP	1		1	YP	Brown	+24V	YORG	1		1	YORG	Brown			
		2		2		White			2		Red					
		3		3		Red			3		Orange					
		4		4		White		4	RORG		White	1	1	White		
		5		5		Orange		2			2	RORG	Black			
		6		6		White		3			3	Brown				
		7		7		Green		7	ZBK		1	1	ZBK	Red		
Z-axis Resolver S2 S4 S1 S3 R1 R2 DG	ZP	1		1	ZP	Brown	Z-axis Brake 2	ZBK	2	2	Orange	FG	1	Green		
2		2		Black		1	1		Brown							
3		3		Red		2	2	Red								
4		4		Black		3	3	Orange								
5		5		Orange		4	4	Blue								
6		6		Black		5	5	Purple								
7		7		Green		6	6	Gray								
R-axis Resolver S2 S4 S1 S3 R1 R2 DG	RP	1		1	RP	Brown	User signal line	IO	7	7	White	IO	7	Black		
2		2		Gray		8			8	Black						
3		3		Red		9			9	Brown						
4		4		Gray		10			10	Red						
5		5		Orange		11			11	Orange						
6		6		Gray		12			12	Blue						
7		7		Green		13			13	Purple						
Y-axis motor U V W	YM	1		1	YM	Brown			14	14	Gray					
2		2		Red		15			15	White						
3		3		Orange		16			16	Black						
Z-axis motor U V W	ZM	1		1	ZM	Blue			17	17	Brown					
2		2		Purple		18			18	Red						
3		3		Gray		19			19	Orange						
R-axis motor U V W	RM	1		1	RM	White			20	20	Blue					
2		2		Black		25			25	Green						
3		3		Brown												
Frame ground	FG			1	Round terminal	Green			Shield							
									Frame ground					1	FG	Green
									Protective ground	Round terminal					Round terminal	Yellow/Green

Motor wiring table

Signal	Color	Connection	No.	Connector
Resolver	S2	Yellow	1	XP, YP, ZP, RP
	S4	Blue	2	
	S1	Red	3	
	S3	Black	4	
	R1	White	5	
	R2	Green	6	
	SHIELD	Black	7	
Motor	U	Red	1	XM, YM, ZM, RM
	V	White	2	
	W	Black	3	
	PE	Yellow/Green	1	Round terminal
Brake	BK	Yellow	1	ZBK (Z-axis motor only)
	BK	Yellow	2	

Origin sensor wiring table

Signal	Color	Connection	No.	Connector
+24V	Brown		1	XORG, YORG, RORG
ORG	Black		2	
0V	Blue		3	

Fan wiring table

Signal	Connection	No	Connector	Color
+24V		1	FAN	Red
FAN stop signal		2		Yellow
0V		3		Black

# MEMO

## Revision record

Manual version	Issue date	Description
Ver. 5.23	Aug. 2010	Clerical error corrections, etc.
Ver. 5.24	Jan. 2011	The description regarding "Warranty" was changed. Clerical error corrections.
Ver. 5.25	Jun. 2011	Clerical error corrections, etc.
Ver. 5.26	Aug. 2011	Descriptions such as the amount of harmonic grease and aging after harmonic drive replacement were added.
Ver. 5.27	Jul. 2012	The description regarding "Warranty" was changed.

## User's Manual

SCARA Robot

# YK-X/XH Series

Jul. 2012

Ver. 5.27

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**YAMAHA MOTOR CO., LTD. IM Operations**

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Please use the following for more detailed information.

<http://www.yamaha-motor.co.jp/global/industrial/robot/>

