YAMAHA
YAMAHA MOTOR CO., LTD.

YAMAHA SINGLE-AXIS ROBOT FLIP-X series

FLIP-XC

User's Manual

ENGLISH E

E27-Ver. 2.00

Before using the single-axis robot FLIP-X series (Be sure to read the following notes.)

Thanks for your purchasing YAMAHA single-axis robot FLIP-X series.
Before using this robot, read the following notes and set the origin position.

The "X" series single-axis and XY robots use absolute position detectors that do not require return-to-origin after turning on the controller power. However, when the controller power is turned on in the following cases, return-to-origin must be performed just the very first time.

(1) When robot cable was first connected after delivery from YAMAHA.
(2) When robot cable was disconnected from the controller and then reconnected.
(3) When no absolute battery is connected.
(4) When a motor or cable was replaced.

At this point, any of the following errors is issued immediately after controller power is turned on, but **this is not a malfunction.** The controller will operate normally by restarting.

When using ERCD, ERCX, SRCX, DRCX, TRCX or SR1 controllers:

15 : FEEDBACK ERROR 2
23 : ABS.BAT.L-VOLTAGE
24 : ABS.DATA.ERROR

... etc.

When using RCX142 or RCX222 controllers:

17.81 : ABS.battery wire breakage
17.92 : Resolver disconnected during power off
17.93 : Position backup counter overflow
17.94 : ABS.battery low voltage

... etc.

Setting the origin position

[1]When using a linear movement robot

Applicable robots:
All "X" series single-axis robots except single-axis rotary movement robots (see [2])
Linear movement axes (X, Y, Z axes) of "X" series Cartesian robots

The above robots use the stroke end origin detection method. The motor side stroke end is set as the origin at the factory prior to shipping
Set the origin position while referring to the following section in the robot controller user's manual.

When using ERCD controller:

See "8.1 Performing return-to-origin" in Chapter 8 of the "HPB Operation Guide" section.

When using ERCX, SRCX, DRCX or TRCX controllers:

See “9-1-1 Return-to-origin by the search method” in Chapter 9.

When using SR1 controller:

See “9.1.1 Return-to-origin by the search method” in Chapter 9 of the "HPB Operation Guide" section.

When using RCX142 or RCX222 controllers:

See “11.8 Absolute reset” in Chapter 4.

CAUTION

Avoid changing the origin position to the non-motor side. Changing the origin position to the non-motor side may cause a positional shift or robot breakdowns, and is also dangerous in some cases. If the origin position must be changed, please consult our sales office or dealer.

[2]When using a rotary movement robot

Applicable robots:

R5/R10/R20 (“X” series single-axis robots)

RF (R axis of “X” series Cartesian robots SXYx/MXYx)

RL/RH (R axis of “X” series Cartesian robots HXYx)

RM/RS (R axis of “X” series Cartesian robots ZRM/ZRS)

On the above robots, the customer should set the origin at the desired position. Move the robot to the desired position and set it as the origin while referring to the following section in the robot controller use's manual.

When using ERCX, SRCX, DRCX or TRCX controllers:

See “9-1-2 Return-to-origin by the mark method” in Chapter 9.

When using SR1 controller:

See “9.1.2 Return-to-origin by the mark method” in Chapter 9 of the "HPB Operation Guide" section.

When using RCX142 or RCX222 controllers:

See “11.8 Absolute reset” in Chapter 4.

After setting the origin position, affix the stickers (triangular stickers supplied with the robot) to both the tool side and workpiece side so that they can be used as the alignment marks. Use these marks as the reference position the next time the origin must be set.

Introduction

The YAMAHA FLIP-X series is a family of single-axis industrial robots that use the absolute positioning method as a standard feature to improve ease of use, resistance to environmental conditions and maintenance work. A wide varaiety of product lineup allows you to select the desired robot model that best matches your application.
This manual describes the safety measures, handling, adjustment and maintenance of FLIP-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.

About this manual

- This 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.
- Specifications of robot models other than standard models may be omitted in this manual if they are common to those of standard models. In this case, refer to the specifications of standard models.
- For details on specific operation and programming of the robot, refer to the separate "YAMAHA Robot Controller User's Manual".
- To operate or adjust the robot safely and correctly, refer to the user's manual by any of the following methods and comply with the instructions.
  1. Refer to the printed version of the manual (available for an additional fee).
  2. View the contents of the CD-ROM version of this manual on your computer screen.
  3. Refer to a printout of the necessary pages from the CD-ROM version of this manual.

The contents of this manual are subject to change without prior notice.
While every effort has been made to ensure the contents of this manual are correct, please contact us if you find any part of this manual to be unclear, confusing or inaccurate.

MEMO

General Contents

Chapter 8 Appendix

MEMO

Chapter 1 Using the Robot Safely

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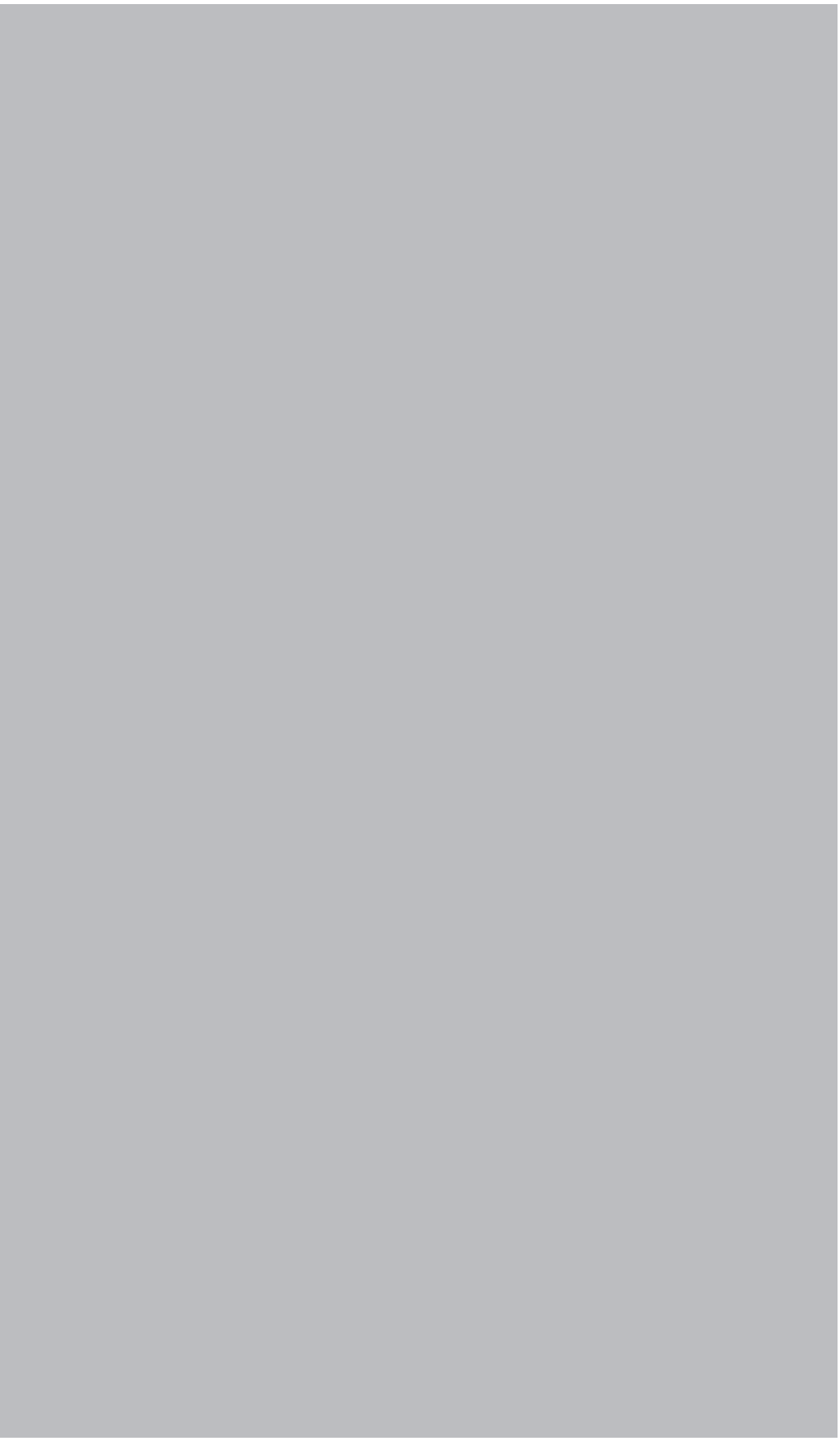


1-1 Safety information

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 symbols and signal words used in this manual are classified as explained below. Make sure that you fully understand the meaning of each symbol and comply with the instructions.

DANGER

FAILURE TO FOLLOW DANGER INSTRUCTIONS WILL RESULT IN SEVERE INJURY OR DEATH TO THE ROBOT OPERATOR, BYSTANDERS OR PERSONS INSPECTING OR REPAIRING THE ROBOT.

WARNING

FAILURE TO FOLLOW WARNING INSTRUCTIONS COULD RESULT IN SEVERE INJURY OR DEATH TO THE ROBOT OPERATOR, BYSTANDERS OR PERSONS INSPECTING OR REPAIRING THE ROBOT.

CAUTION

Failure to follow CAUTION instructions may result in injury to the robot operator, bystanders or persons 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.

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 affixed to the robot are written in English. If the robot operator or service personnel do not understand English, do not permit that person to handle the robot.

1-2 Essential precautions

Particularly important cautions for handling or operating the robot are described below. In addition, precautions during installation, operation, inspection and maintenance are also 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.

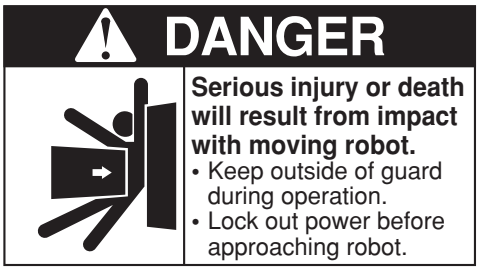
- Install a safeguard (safety enclosure) to keep any person from entering within the movement range of the robot and suffering injury due to being struck by moving parts.
- Install a safety interlock that triggers emergency stop when the door or panel is opened.
- Install a safety enclosure so that no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

DANGER

SERIOUS INJURY OR DEATH WILL RESULT FROM IMPACT WITH MOVING ROBOT.

- **KEEP OUTSIDE OF GUARD DURING OPERATION.**
- **LOCK OUT POWER BEFORE APPROACHING ROBOT.**

Warning label 1



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

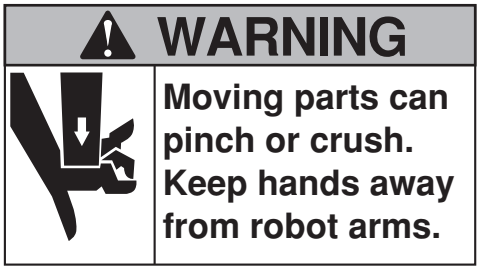
Warning label 2 is affixed to the robot.

Use caution to prevent hands or fingers from being pinched or crushed by the moving parts when carrying the robot or during teaching.

WARNING

MOVING PARTS CAN PINCH OR CRUSH HANDS.
KEEP HANDS AWAY FROM ROBOT ARMS.

Warning label 2



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

- Be sure to read the warning labels and this manual carefully and make sure you thoroughly understand their contents before attempting installation and operation of the robot.
- Before starting robot operation, be sure to reread the procedures and cautions relating to your work 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.
- The warning labels 3 are supplied with the robot and should be affixed to the robot or conspicuous spots near the robot.

WARNING

IMPROPER INSTALLATION OR OPERATION CAN RESULT IN SERIOUS INJURY OR DEATH. READ THE USER'S MANUAL AND ALL WARNING LABELS BEFORE INSTALLATION OR OPERATION.

Warning label 3

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

WARNING

IF WARNING LABELS ARE REMOVED OR DIFFICULT TO SEE, THEN ESSENTIAL PRECAUTIONS MIGHT NOT BE TAKEN, RESULTING IN ACCIDENTS.

- **DO NOT REMOVE, ALTER OR STAIN THE WARNING LABELS ON THE ROBOT.**
- **DO NOT ALLOW THE WARNING LABELS TO BE HIDDEN BY DEVICES INSTALLED ONTO THE ROBOT BY THE USER.**
- **PROVIDE PROPER LIGHTING SO THAT THE SYMBOLS AND INSTRUCTIONS ON THE WARNING LABELS CAN BE CLEARLY SEEN EVEN FROM OUTSIDE THE SAFETY ENCLOSURE.**

(5) 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 MIGHT OTHERWISE RESULT.

(6) 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. MALFUNCTIONS MIGHT OTHERWISE OCCUR.

(7) Use caution when releasing the brake of a vertical use robot.

WARNING

THE VERTICAL AXIS WILL SLIDE DOWN WHEN THE BRAKE IS RELEASED, CAUSING A HAZARDOUS SITUATION.

- PRESS THE EMERGENCY STOP BUTTON AND PROP UP THE VERTICAL AXIS WITH A SUPPORT STAND BEFORE RELEASING THE BRAKE.
- BE CAREFUL NOT TO LET YOUR BODY GET CAUGHT BETWEEN THE VERTICAL AXIS AND INSTALLATION BASE WHEN RELEASING THE BRAKE TO PERFORM DIRECT TEACH.

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

WARNING

- END EFFECTORS MUST BE DESIGNED AND MANUFACTURED SO THAT THEY CREATE NO HAZARDS (FOR EXAMPLE, A WORKPIECE THAT COMES LOOSE) 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.

(9) Use caution when removing the motor. (Vertical use robots)

WARNING

THE VERTICAL AXIS WILL SLIDE DOWN WHEN THE MOTOR IS RELEASED, CAUSING A HAZARDOUS SITUATION.

- TURN OFF THE ROBOT CONTROLLER AND PROP UP THE VERTICAL AXIS WITH A SUPPORT STAND BEFORE REMOVING THE MOTOR.
- BE CAREFUL NOT TO LET YOUR BODY GET CAUGHT BETWEEN THE VERTICAL AXIS PARTS AND INSTALLATION BASE.

(10) Be careful not to touch the motor or speed reduction gear casing when hot.

WARNING

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

(11) Consult us for corrective action when the robot is damaged or malfunctions occur.

WARNING

IF ANY PART OF THE ROBOT IS DAMAGED OR ANY MALFUNCTION OCCURS, CONTINUING THE OPERATION MAY BE VERY DANGEROUS. PLEASE CONSULT YOUR YAMAHA SALES OFFICE OR 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

(12) Protective bonding

WARNING

BE SURE TO GROUND THE ROBOT AND CONTROLLER TO PREVENT ELECTRICAL SHOCK.

(13) 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 these are not correct, drive unit service life may end prematurely, and damage to robot parts or residual vibration during positioning may result.

(14) Take the following safety precautions 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.**
- **REFER TO THE "YAMAHA ROBOT CONTROLLER USER'S MANUAL" FOR PRECAUTIONS ON HANDLING THE CONTROLLER.**

(15) Use caution not to touch the controller rear panel 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) Do not use the robot for tasks requiring motor thrust.

CAUTION

Avoid using the belt-driven type robots for tasks which utilize motor thrust (pressfitting, burr removal, etc.). These tasks may cause malfunctions in the robot.

(17) 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.

(18) 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.

1-3 Special training for industrial robot operation

Companies or factories using industrial robots must make sure that every person, who handles the robot such as for teaching, programming, movement check, inspection, adjustment and repair, has received appropriate training and also has the skills needed to perform the job correctly and safely. Since the YAMAHA robots fall under the industrial robot category, the user must observe local regulations and safety standards for industrial robots, and provide special training for every person involved in robot-related tasks (teaching, programming, movement check, inspection, adjustment, repair, etc.).

1-4 Robot safety functions

(1) Overload detection

This function detects an overload applied to the motor and shuts off the servo power.

(2) Overheat detection

This detects an abnormal temperature rise in the controller driver and shuts off the servo power.

If an overload or 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.

No mechanical stopper is provided on the rotating axis.

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

(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.

No mechanical stopper is provided on the rotating 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) Vertical axis brake

An electromagnetic brake is installed on the vertical use robot to prevent the vertical axis from sliding down when servo power is turned off. This brake is working when the controller is off or the vertical axis servo power is off even when the controller is on. The vertical 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 VERTICAL AXIS WILL SLIDE DOWN WHEN THE BRAKE IS RELEASED, CAUSING A HAZARDOUS SITUATION.

- **PRESS THE EMERGENCY STOP BUTTON AND PROP UP THE VERTICAL AXIS WITH A SUPPORT STAND BEFORE RELEASING THE BRAKE.**
- **BE CAREFUL NOT TO LET YOUR BODY GET CAUGHT BETWEEN THE VERTICAL AXIS AND INSTALLATION BASE WHEN RELEASING THE BRAKE TO PERFORM DIRECT TEACH.**

1-5 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.

1-6 Trial operation

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

(1) If a safety 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 safety 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 (safety 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 safety 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 safety enclosure and interlock working as intended?
8. Does the robot move correctly during automatic operation?

1-7 Work within the safety enclosure

(1) Work within the safety enclosure

When work is required inside the safety 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) Soft limit settings

2) Teaching

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

(2) Teaching

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

1) Check or perform the following points from outside the safety enclosure.

1. Make sure that no hazards are present within the safety enclosure by a visual check.
2. Check that the programming box MPB, RPB or HPB 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 safety enclosure.

1-8 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 safety 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 safety 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 signal light to ensure that the robot is in automatic operation.

2) Never enter the safety enclosure during automatic operation.

3) If an error occurs in the robot or peripheral equipment, observe the following procedure before entering the safety 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.

1-9 Warranty

The YAMAHA robot and/or related product you have purchased are warranted against the defects or malfunctions as described below.

Warranty description : If a failure or breakdown occurs due to defects in materials or workmanship in the genuine parts constituting this YAMAHA robot and/or related product within the warranty period, then YAMAHA will repair or replace those parts free of charge (hereafter called "warranty repair").

Warranty Period : The warranty period ends when any of the following applies:
(1) After 18 months (one and a half year) have elapsed from the date of shipment
(2) After one year has elapsed from the date of installation
(3) After 2,400 hours of operation

Exceptions to the Warranty : This warranty will not apply in the following cases:
(1) Fatigue arising due to the passage of time, natural wear and tear occurring during operation (natural fading of painted or plated surfaces, deterioration of parts subject to wear, etc.)
(2) Minor natural phenomena that do not affect the capabilities of the robot and/or related product (noise from computers, motors, etc.).
(3) Programs, point data and other internal data that were changed or created by the user.

Failures resulting from the following causes are not covered by warranty repair.

1) Damage due to earthquakes, storms, floods, thunderbolt, fire or any other natural or man-made disasters.
2) Troubles caused by procedures prohibited in this manual.
3) Modifications to the robot and/or related product not approved by YAMAHA or YAMAHA sales representatives.
4) Use of any other than genuine parts and specified grease and lubricants.
5) Incorrect or inadequate maintenance and inspection.
6) Repairs by other than authorized dealers.

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1-10 CE marking

When the YAMAHA robots are exported to or used in EU (European Union) countries, refer to the separate "YAMAHA Robot Controller User's Manual" or "CE marking Supplement Manual" for related information about CE marking.

Chapter 2 Functions

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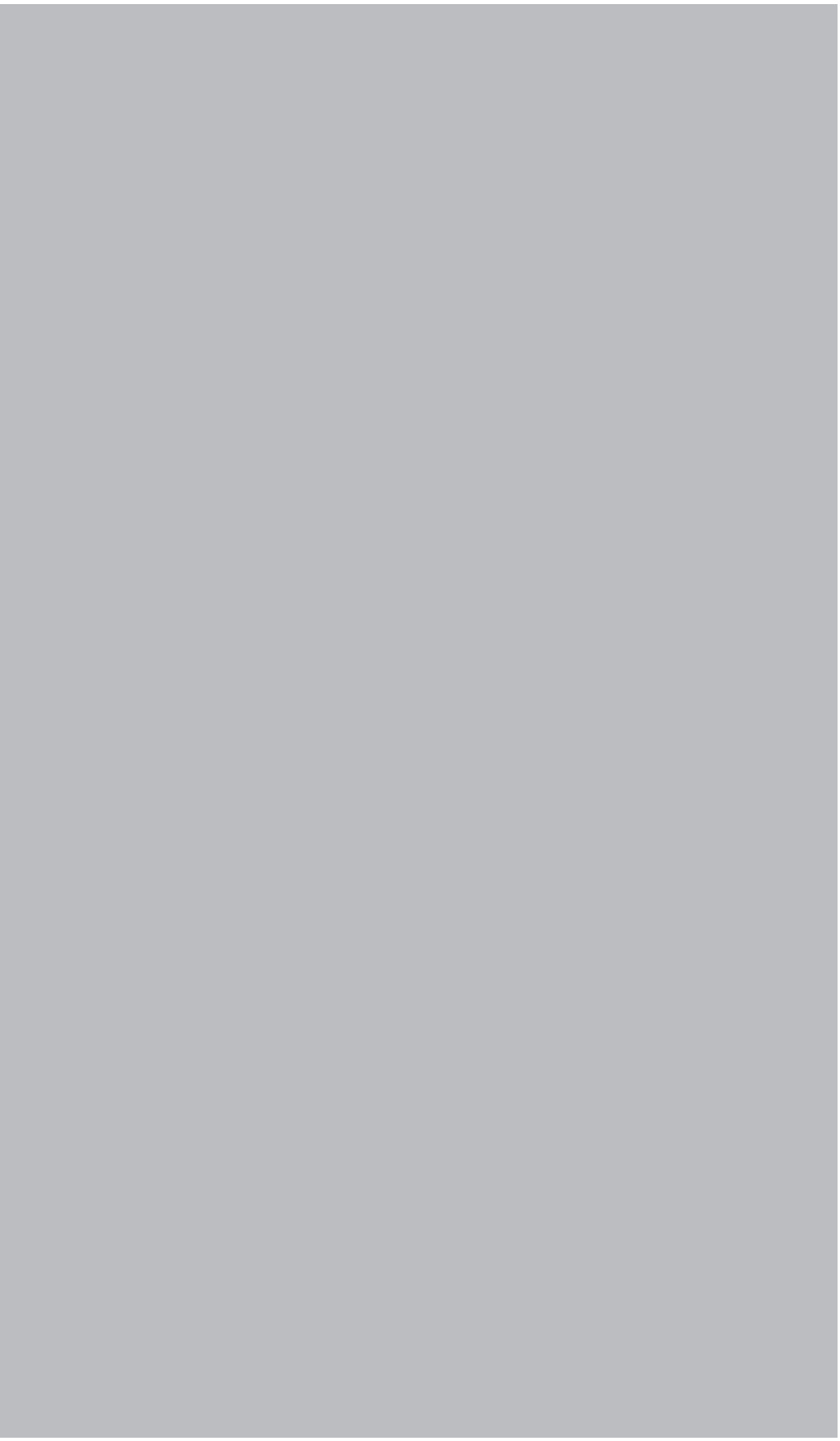
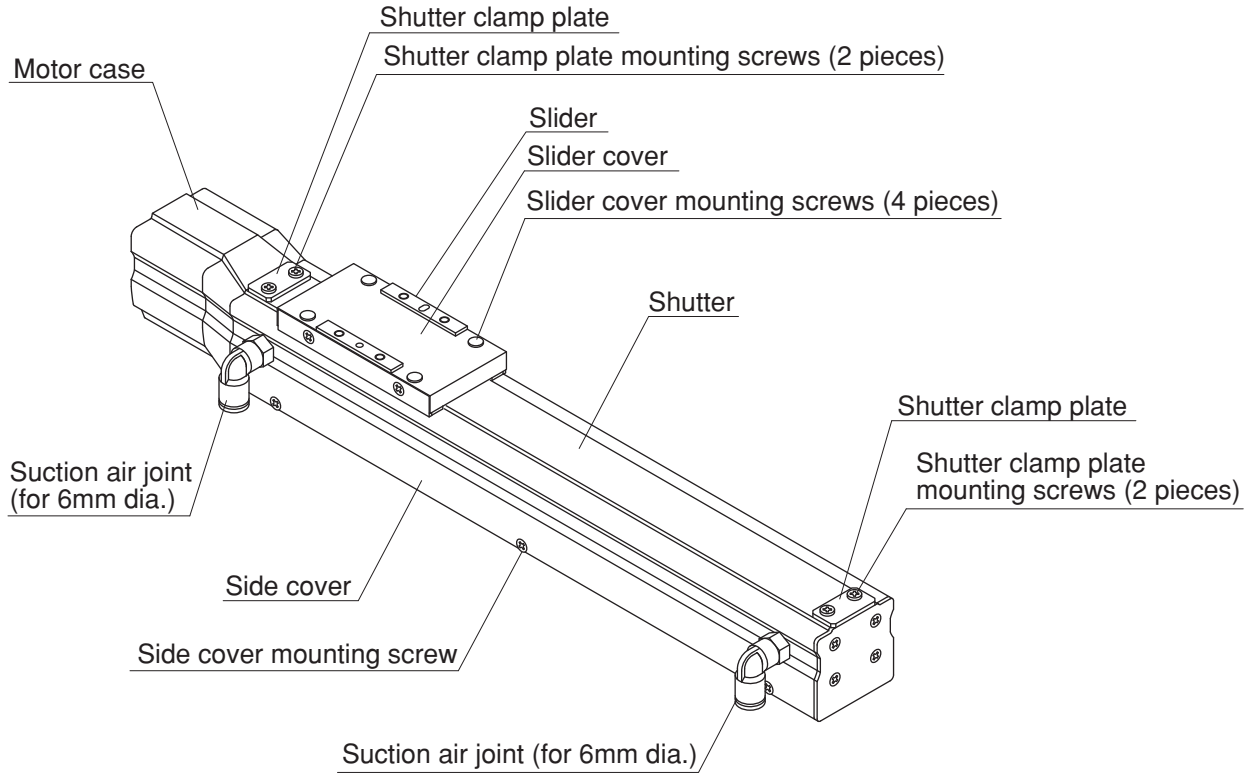
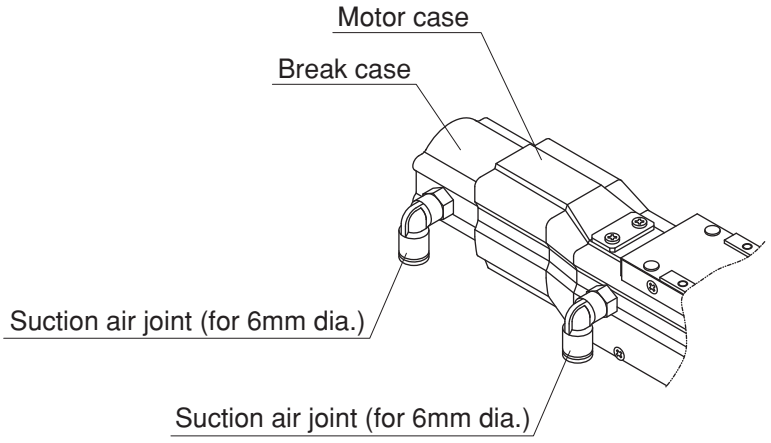


2-1 Robot manipulator (part names)

C4/C4H, C5/C5H, C6

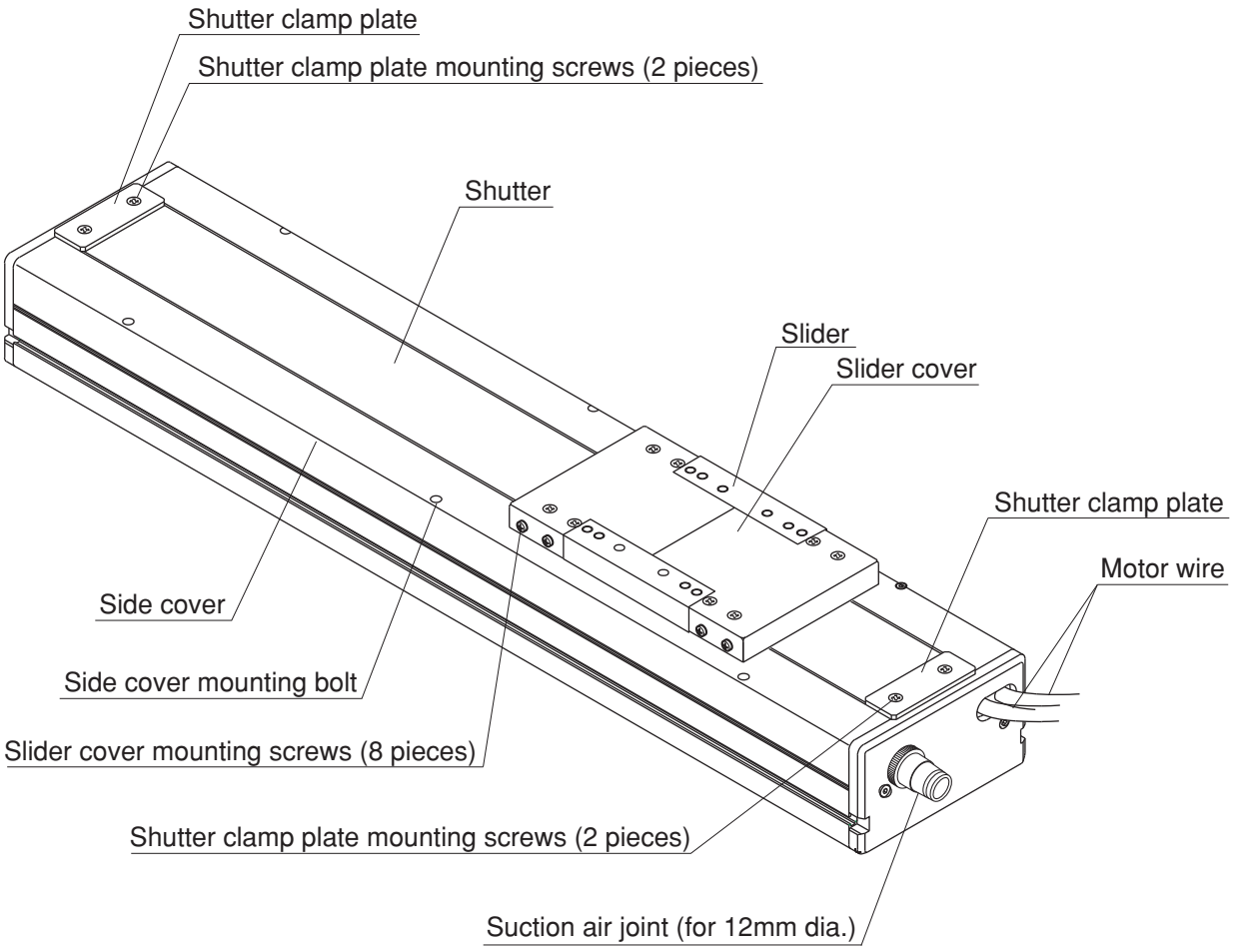


Standard model



Vertical installation model (with brake)

C10, C14/C14H, C17/C17L, C20



Chapter 3 Installation

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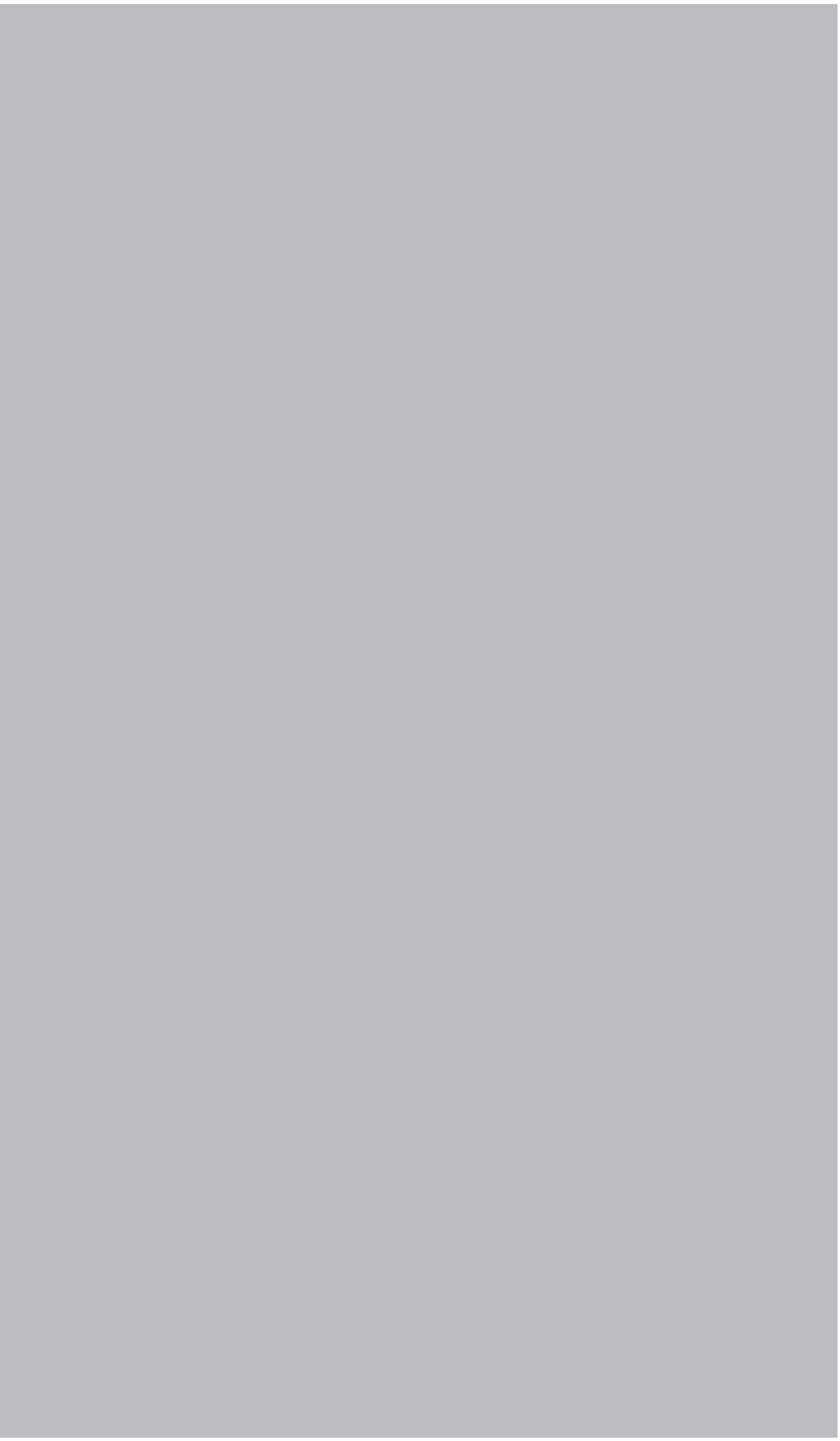


3-1 Robot installation conditions

3-1-1 Installation environments

Be sure to install the robot in the following environments.

Items	Specifications
Allowable ambient temperature	0 to 45°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.
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 EXCESSIVE MOISTURE, CORROSIVE GASES, METALLIC POWDER OR DUST ARE GENERATED. MALFUNCTIONS, FAILURES 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. MALFUNCTIONS 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.

3-1-2 Installation base

To mount the robot, use an installation base that satisfies the following conditions.

1) The installation base is subjected to a great deal of stress while the robot is in operation.
   Prepare a sufficiently rigid and stable installation base, taking into account the robot weight including the end effector (gripper) and workpiece.

CAUTION

If the installation base is not sufficiently rigid and stable, vibration (resonance) may occur during operation, causing adverse effects on the robot work.

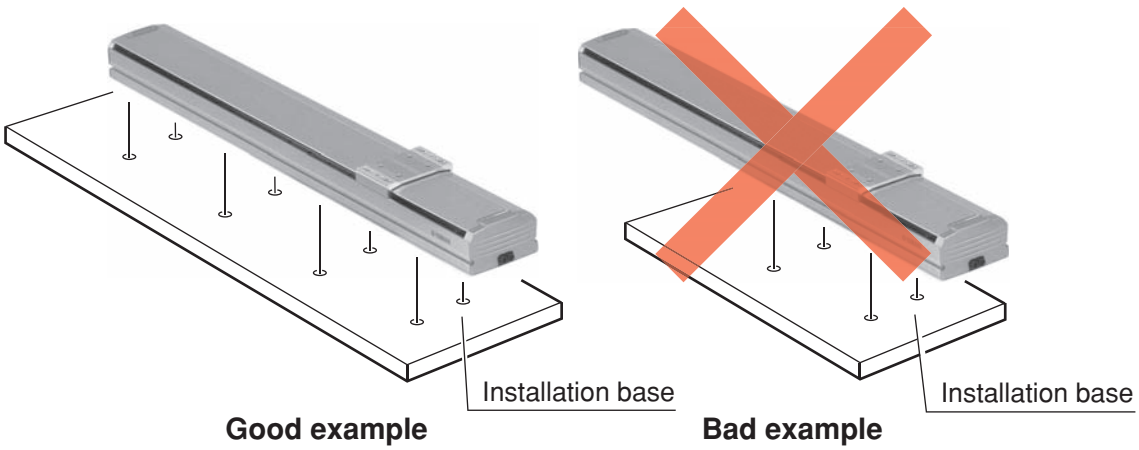
2) The installation base surface must be machined **within a flatness of ±0.05mm/500mm.**

CAUTION

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

3) Use an installation base of sufficient size to match the robot body so that the robot can be installed with the specified number of bolts. Avoid installing the robot with less than the specified number of bolts or installing the robot closer to one end as shown at the lower right.

Robot installation example



Good example **Bad example**

CAUTION

Using less than the specified number of bolts to install the robot may cause vibration and poor positioning accuracy.

NOTE

For the dimensions and positions of holes and threading in the robot installation base. refer to the outline dimension drawings shown in our robot catalog or our website (www.yamaha-motor.co.jp/global/industrial/robot/index.html).

3-2 Installation

3-2-1 Checking the product

After unpacking, make sure that all components and accessories are included (as specified in your order). Also check the product for any damage on the exterior which might have occurred during transportation.
If there are any missing parts or damage due to transportation, please notify your YAMAHA sales office or dealer immediately.

Example

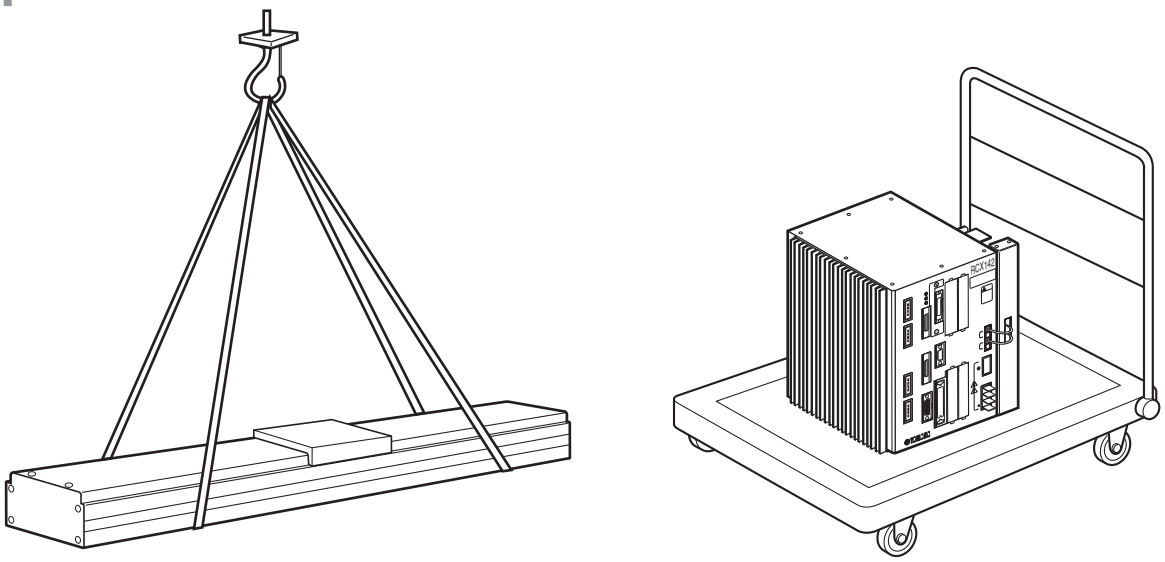
Controller: SR1
Robot : C14

Product name	Qty	
Single-axis robot	1	
SR1	1	
Robot cable	1	
I/O connector	1	
Battery	1	
Battery attachment	1set	
Warning label 1 (Danger label)	1	Affix to a conspicuous spot in the system.
Warning label 3 (Warning label)	1	Affix to a conspicuous spot in the system.
HPB	1	Option
POPCOM	1	Option
SD memory card	1	Option

3-2-2 Moving the robot

Using a hoist, carrying cart (dolly) or forklift is recommended for moving a single-axis robot or controller. Use sufficient caution when moving robot models with a long stroke or designed for large payload, since they are heavy.

Moving the robot



WARNING

SERIOUS INJURY MAY OCCUR IF THE ROBOT FALLS AND PINS SOMEONE UNDER IT.

- **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 BALANCE MIGHT SHIFT WHILE BEING CARRIED, AND THE ROBOT TOPPLE OVER CAUSING ACCIDENTS.**
- **ALWAYS WEAR A SAFETY HELMET, SHOES AND GLOVES DURING WORK.**
- **WHEN MOVING THE ROBOT BY EQUIPMENT SUCH AS A FORKLIFT THAT REQUIRES A LICENSE, ONLY PROPERLY QUALIFIED PERSONNEL MAY OPERATE SUCH EQUIPMENT. THE EQUIPMENT AND TOOLS USED FOR MOVING THE ROBOT SHOULD BE SERVICED DAILY.**

CAUTION

When moving or carrying the robot by hand, avoid placing the hand and fingers on the shutter of the robot. Pressing down on the shutter, even by a little force, may cause the shutter to warp or deform, resulting in a premature life end of the related parts.

3-2-3 Installing the robot

Securely fix the robot with hex socket head bolts.

WARNING

BE SURE TO INSTALL THE ROBOT WITH THE SPECIFIED NUMBER OF BOLTS AND TIGHTENING TORQUE. IF NOT, THE ROBOT MAY FALL OVER DURING OPERATION RESULTING IN SERIOUS ACCIDENTS.

3-2-3-1 Installing the C4/C4H, C5/C5H and C6

C4/C4H : Drill holes through the installation base, and secure the robot to the base with M4 bolts from the bottom.

C5/C5H, C6 : Drill holes through the installation base, and secure the robot to he base with M5 bolts from the bottom.

WARNING

ALWAYS TURN OFF THE POWER TO THE CONTROLLER BEFORE INSTALLING THE ROBOT. SERIOUS ACCIDENTS MIGHT OCCUR IF THE ROBOT STARTS TO OPERATE DURING INSTALLATION.

● **Installation method**

Drill holes through the installation base where the robot is to be secured. Then secure the robot with the specified bolts from the underside of the installation base. The bolt and tightening torque are shown below.

C4/C4H

Bolt	Hex socket-head M4 bolt, strength: 8.8T, length: installation base thickness + 5mm (maximum) is recommended
Tightening torque	30kgf•cm to 45kgf•cm

C5/C5H, C6

Bolt	Hex socket-head M5 bolt, strength: 8.8T, length: installation base thickness + 5mm (maximum) is recommended
Tightening torque	60kgf•cm to 90kgf•cm

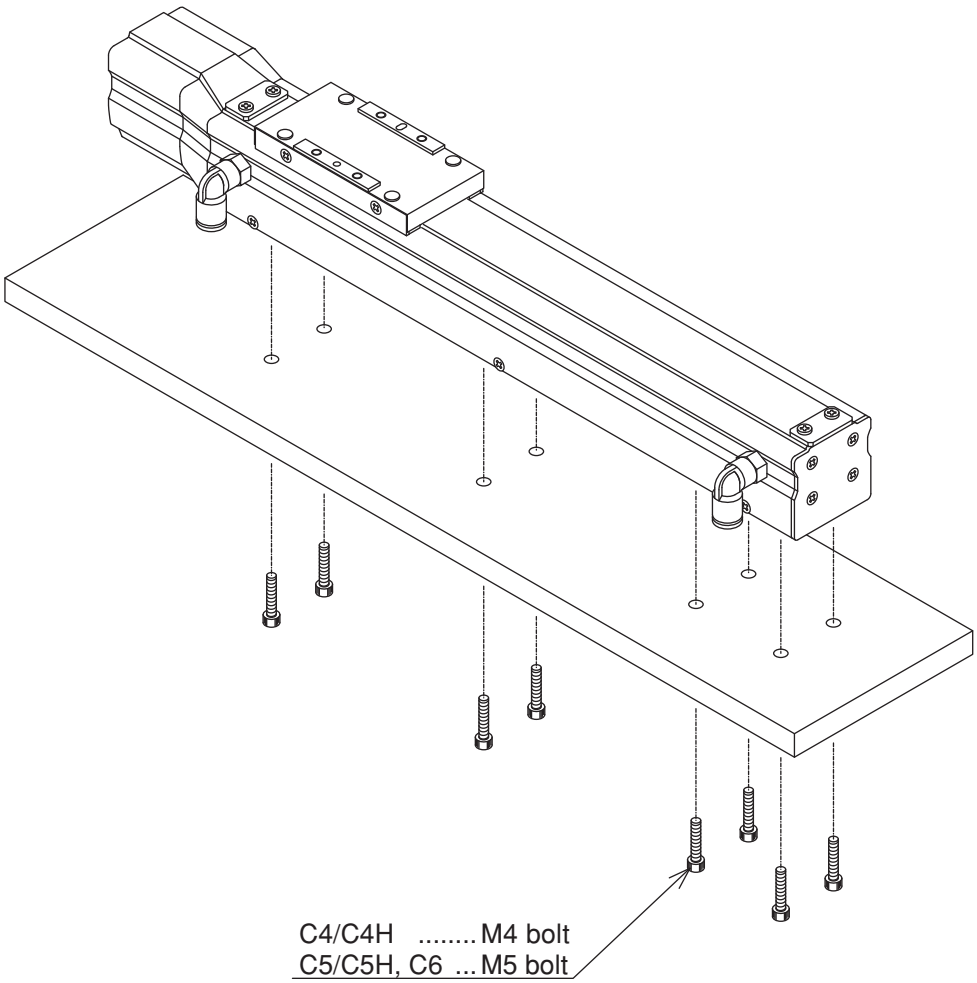
WARNING

- **BE SURE TO TIGHTEN THE BOLT TO THE CORRECT TORQUE. THE WRONG TORQUE MAY NOT ONLY CAUSE ROBOT POSITION ERRORS BUT ALSO LEAD TO SERIOUS ACCIDENTS.**
- **DO NOT USE A BOLT LONGER THAN THE SPECIFIED LENGTH. A BOLT THAT IS TOO LONG WILL PENETRATE INSIDE THE ROBOT FRAME AND CAUSE OPERATING DEFECTS OR MALFUNCTION.**

NOTE

For the dimensions and positions of holes and threading in the robot installation base. refer to the outline dimension drawings shown in our robot catalog or our website (www.yamaha-motor.co.jp/global/industrial/robot/index.html).

Installing the C4/C4H, C5/C5H and C6



CAUTION

The robot frame is made of aluminum so be careful not to damage the screw threads when tightening the bolt.

3-2-3-2 Installing the C10, C14/C14H, C17/C17L and C20

C10 : Drill holes through the installation base, and secure the robot to the base with M5 bolts from the bottom.

C14/C14H : Drill holes through the installation base, and secure the robot to the base with M6 bolts from the bottom.

C17/C17L, C20 : Drill holes through the installation base, and secure the robot to he base with M8 bolts from the bottom.

WARNING

ALWAYS TURN OFF THE POWER TO THE CONTROLLER BEFORE INSTALLING THE ROBOT. SERIOUS ACCIDENTS MIGHT OCCUR IF THE ROBOT STARTS TO OPERATE DURING INSTALLATION.

● **Installation method**

Drill holes through the installation base where the robot is to be secured. Then secure the robot with the specified bolts from the underside of the installation base. The bolt and tightening torque are shown below.

C10

Bolt	Hex socket-head M5 bolt, strength: 8.8T, length: installation base thickness + 10mm (maximum) is recommended *1
Tightening torque	60kgf•cm to 90kgf•cm

C14/C14H

Bolt	Hex socket-head M6 bolt, strength: 8.8T, length: installation base thickness + 10mm (maximum) is recommended *1
Tightening torque	100kgf•cm to 130kgf•cm

*1: Because the robot frame has a cavity inside the tapped holes, it is possible to use bolts whose length is up to the installation base thickness + 20mm. Even in this case, the length of the bolt thread engagement is 10mm.

C17/C17L, C20

Bolt	Hex socket-head M8 bolt, strength: 8.8T, length: installation base thickness + 15mm (maximum) is recommended
Tightening torque	230kgf•cm to 370kgf•cm

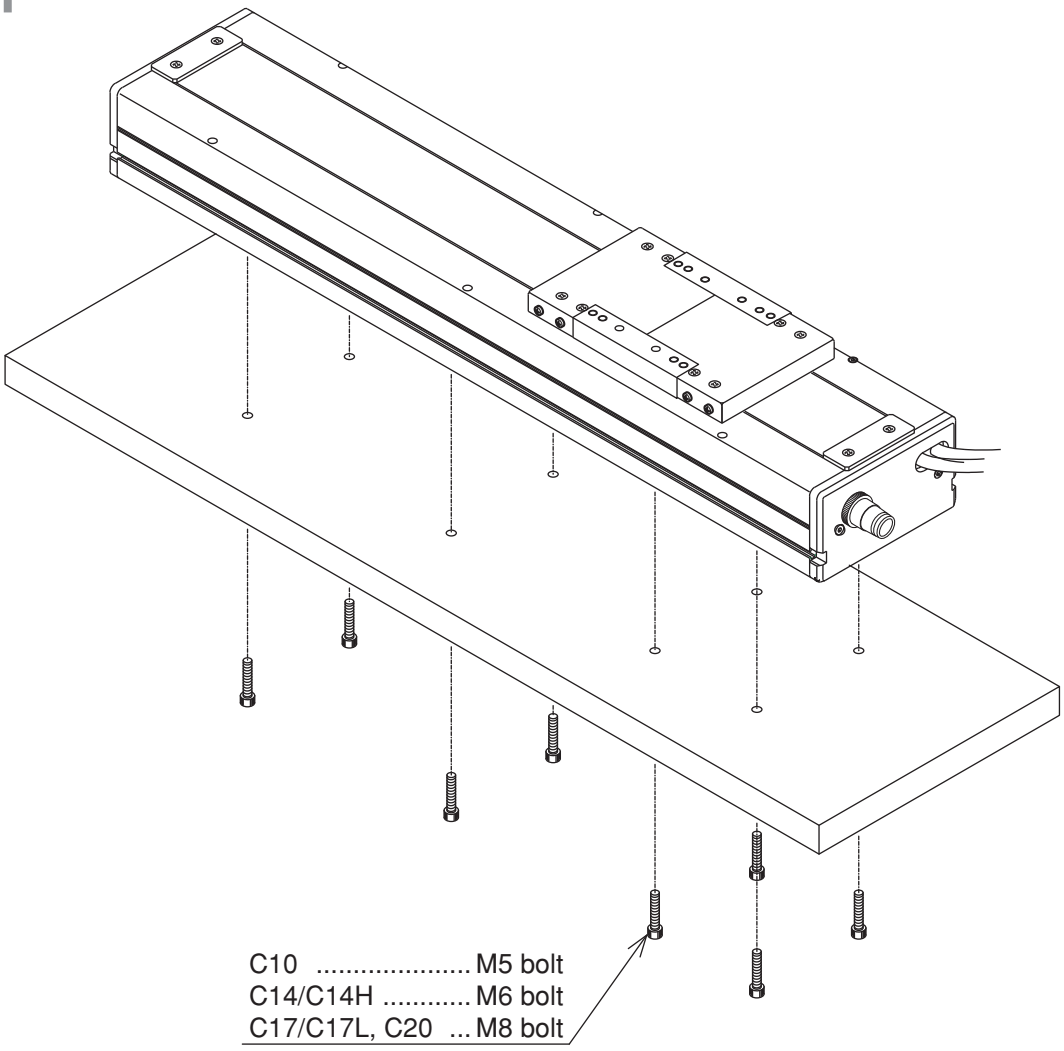
WARNING

- **BE SURE TO TIGHTEN THE BOLT TO THE CORRECT TORQUE. THE WRONG TORQUE MAY NOT ONLY CAUSE ROBOT POSITION ERRORS BUT ALSO LEAD TO SERIOUS ACCIDENTS.**
- **DO NOT USE A BOLT LONGER THAN THE SPECIFIED LENGTH. A BOLT THAT IS TOO LONG WILL PENETRATE INSIDE THE ROBOT FRAME AND CAUSE OPERATING DEFECTS OR MALFUNCTION.**

NOTE

For the dimensions and positions of holes and threading in the robot installation base. refer to the outline dimension drawings shown in our robot catalog or our website (www.yamaha-motor.co.jp/global/industrial/robot/index.html).

Installing the C10, C14/C14H, C17/C17L and C20



CAUTION

The robot frame is made of aluminum so be careful not to damage the screw threads when tightening the bolt.

3-3 Protective bonding

WARNING

ALWAYS GROUND THE ROBOT AND CONTROLLER UNIT TO PREVENT ELECTRICAL SHOCK.

Always use the ground terminal (M4 screw) on the side of the robot unit to make ground connection.

CAUTION

- **A secure ground connection (less than 100Ω resistance to ground) is recommended.**
- **Use electrical wire thicker than AWG14 (2mm^2) as the ground wire.**

WARNING

ALWAYS TURN OFF THE POWER TO THE CONTROLLER BEFORE MAKING THE GROUND CONNECTION.

Provide a terminal with the PE marking as the protective conductor for the entire system, and connect it to an external protective conductor. Also securely connect the ground terminal on the robot frame to the protective conductor.

(Symbol 417-IEC5019)

3-4 Robot cable connection

Connect the robot cables to the mating connectors on the controller as shown. Refer to the SR1 robot controller user's manual for the controller connectors.

WARNING

- **BEFORE CONNECTING THE CABLES, CHECK THAT THERE ARE NO BENDS OR BREAKS IN THE ROBOT CABLE CONNECTOR PINS AND THAT THE CABLES ARE NOT DAMAGED. BENT OR BROKEN PINS OR CABLE DAMAGE MAY CAUSE ROBOT MALFUNCTIONS.**
- **ENSURE THAT THE CONTROLLER IS OFF BEFORE CONNECTING THE ROBOT CABLE TO THE CONTROLLER.**

CAUTION

After connecting the relay connectors on the robot cables, fit the connector hoods together securely.

WARNING

- **IF THE CONNECTOR INSTALLATION IS INADEQUATE OR IF THERE ARE CONTACT FAILURES IN THE PINS, THE ROBOT MAY MALFUNCTION CAUSING A HAZARDOUS SITUATION. RECHECK THAT EACH CONNECTOR IS SECURELY INSTALLED BEFORE TURNING ON THE CONTROLLER.**
- **TAKE CAUTION NOT TO APPLY AN EXCESSIVE LOAD TO THE CONNECTORS DUE TO STRESS OR TENSION ON THE CABLES.**

WARNNIG

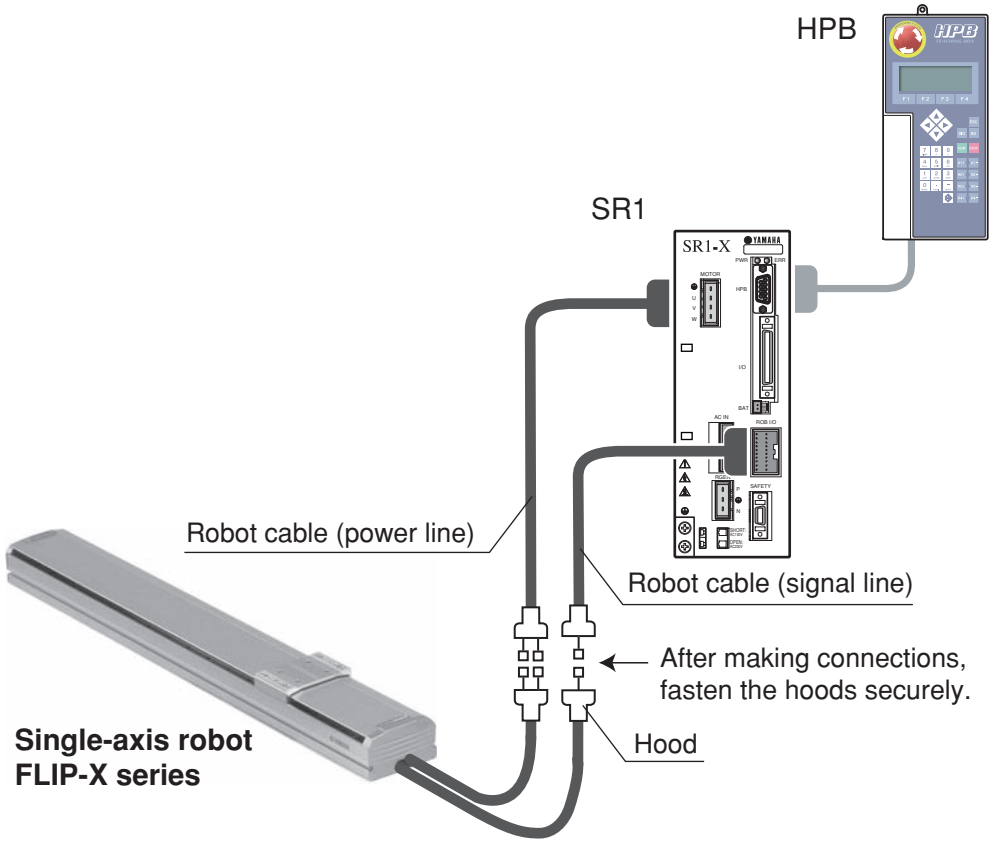
LAY OUT THE ROBOT CABLES SO THAT THEY DO NOT OBSTRUCT THE ROBOT MOVEMENT. DETERMINE THE ROBOT WORK AREA IN WHICH THE ROBOT CABLES WILL NOT INTERFERE WITH THE LOAD OR WORKPIECE PICKED UP BY THE ROBOT MANIPULATOR TIP. IF THE ROBOT CABLES INTERFERE WITH THE MOVABLE PARTS OF THE ROBOT, THE CABLES MAY BE DAMAGED CAUSING MALFUNCTION AND HAZARDOUS SITUATIONS.

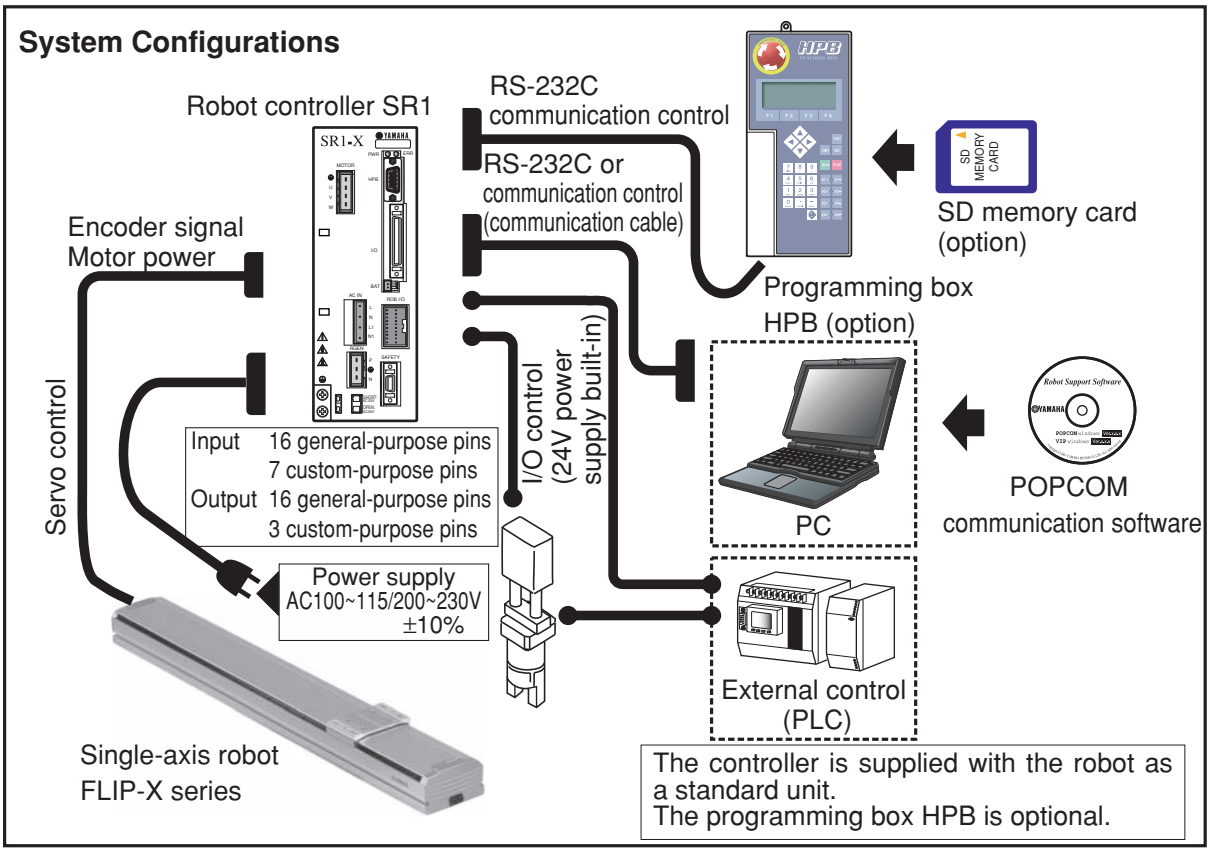
WARNING

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.

● Robot cable connections

For wiring of each cable, refer to "6-1 AC servo motor specifications" and "6-2 Robot cable" in Chapter 6.





3-5 Suction hoses connection

The FLIP-X Type C series robots are designed to connect to an air unit that suctions air inside the robot to maintain cleanliness. When using the robot in a clean room, adjust the suction air to the specified flow rate. (For the suction hose attachment position on each robot, refer to "2-1 Robot manipulator (part names)" in Chapter 2, "Functions".)

Suction hose

Model No.	Hose diameter	Number of hoses	Suction rate (Nℓ/min.)
C4	ϕ6	2	20 to 30
C4 (with brake)	ϕ6	3	20 to 30
C4H	ϕ6	2	20 to 30
C4H (with brake)	ϕ6	3	20 to 30
C5	ϕ6	2	20 to 30
C5 (with brake)	ϕ6	3	20 to 30
C5H	ϕ6	2	20 to 30
C5H (with brake)	ϕ6	3	20 to 30
C6	ϕ6	2	20 to 30
C6 (with brake)	ϕ6	3	20 to 30
C10	ϕ12	1	30 to 90
C10 (with brake)	ϕ12	1	30 to 90
C14	ϕ12	1	30 to 90
C14 (with brake)	ϕ12	1	30 to 90
C14H	ϕ12	1	30 to 90
C14H (with brake)	ϕ12	1	30 to 90
C17	ϕ12	1	30 to 90
C17 (with brake)	ϕ12	1	30 to 90
C17L	ϕ12	1	30 to 90
C17L (with brake)	ϕ12	1	30 to 90
C20	ϕ12	1	30 to 90
C20 (with brake)	ϕ12	1	30 to 90

NOTE: On the C4/C4H, C5/C5H and C6, arrange the air hoses so that the total suction rate will be 20 to 30 [Nℓ/min.] or more.

CAUTON

Avoid excessive bends in the air hoses. Lay out the air hoses to keep the hose length to the air unit as short as possible. Too long of a hose may prevent obtaining the specified suction flow rate.

3-6 Setting the operating conditions

3-6-1 Payload

Optimal acceleration for the YAMAHA FLIP-X Type C series robots is automatically determined by setting the controller payload parameters. Set the total weight of the workpiece and the end effectors such as grippers attached to the robot slider in the payload parameter as shown below.

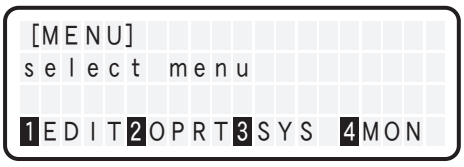
CAUTION

Be sure to enter an accurate value when making this setting, since a mistake will cause troubles such as vibration or a shorter machine service life span.

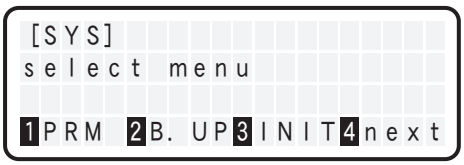
● **To set the payload parameter**

Use the following method when setting the payload parameter on a single-axis robot controller (SR1). When setting this parameter on other controllers (RCX142, RCX222) refer to their controller user's manuals.

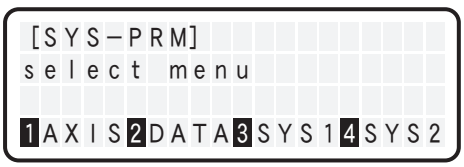
1) Press F3 (SYS) on the initial menu screen.
The SYS (system) mode screen appears.

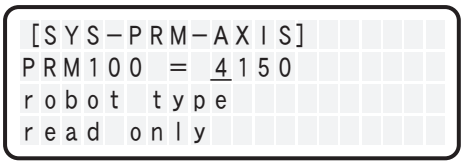


2) Press F1 (PRM) to enter the parameter setting mode.
The SYS-PRM mode screen appears.



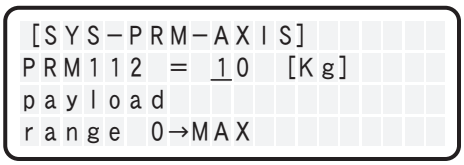
3) Select the parameter group.
Press F1 (AXIS) to select the axis parameter.
The current setting for PRM100 (Robot type) appears on the screen.





4) Display PRM112 (payload).
Press the ◈▲ ◈▼ keys to scroll up or down the parameter list and select the parameter you want to set.

5) Set the parameter.
Enter the parameter value with the number keys and press ◈→.
The parameter setting range is shown on the bottom line of the screen.
When setting is complete, the cursor moves back to the beginning of the parameter data.



3-6-2 Maximum speed setting

In operation of a single-axis robot with a long stroke ball screw, resonance of the ball screw may occur. In this case, the maximum speed must be reduced to an appropriate level. The maximum speed can be reduced by lowering the SPEED setting in automatic operation or by programming. Use the desired method that matches your application. If the maximum speed does not reach a hazardous level, reducing the speed is unnecessary even when a robot has a long stroke axis.

CAUTION

Do not operate the robot if the ball screw is vibrating. The ball screw may otherwise wear out prematurely.

NOTE

For the maximum speed setting for stroke length, refer to the specifications and outline dimension drawings shown in our robot catalog or our website (www.yamaha-motor.co.jp/global/industrial/robot/index.html).

3-6-3 Duty

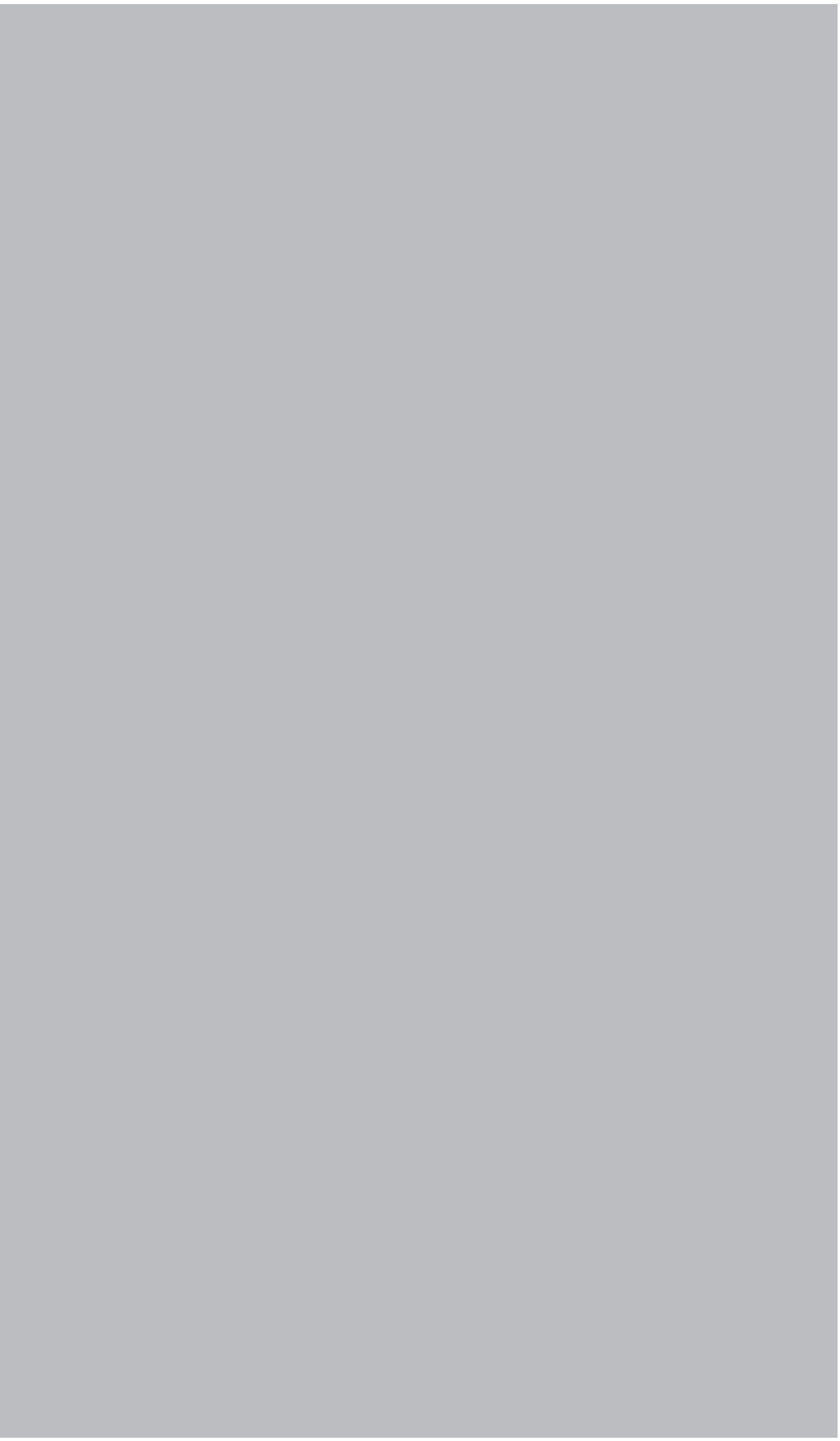
To achieve maximum service life for the YAMAHA single-axis robots, the robot must be operated within the allowable duty (50%). The duty is calculated as follows:

$$\text{Duty (\%)} = \frac{\text{Operation time}}{\text{Operation time + Non-operation time}} \times 100$$

If the robot duty is too high, an error such as “overload” or “overheat” occurs. In this case, increase the stop time to reduce the duty.

Chapter 4 Adjusting the Robot

Contents



4-1 Overview

YAMAHA robots have been completely adjusted at the factory or sales representative before shipment. However, when the operating conditions are changed and adjustment of the robot becomes necessary, follow the procedure described in this chapter.

4-2 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 safety 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 safety 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 other personnel from entering the movement area of the manipulator.

(4) To check operation after adjustment, refer to “1-6 Trial operation” in Chapter 1.

4-3 Adjusting shutter looseness

The shutter may elongate or develop a slight stretch after long-term use. Continuous operation with a stretched shutter may cause a “slack” (or a gap between the shutter and the cover of the robot) and degrade the degree of cleanliness. In such cases, adjust looseness in the shutter as explained below.

4-3-1 Adjusting the shutter looseness (C4/C4H, C5/C5H, C6)

1) Prepare the tools required for adjustment.
   - Phillips-head screwdriver

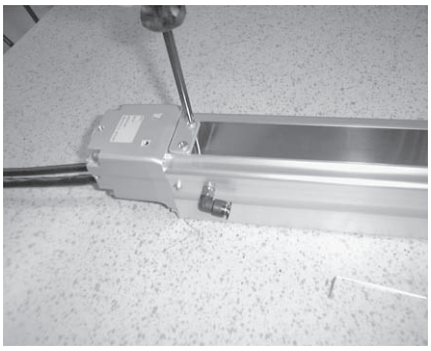
2) Turn off the controller.

3) Place a sign indicating the robot is being adjusted, to keep others from operating the controller switch.

4) Enter the safety enclosure.

5) While moving the slider back and forth by hand, find the position where the shutter is loosest.
   When a vertical installation model is used, slowly move the robot in jog before entering the safety enclosure and find the position of maximum shutter looseness.

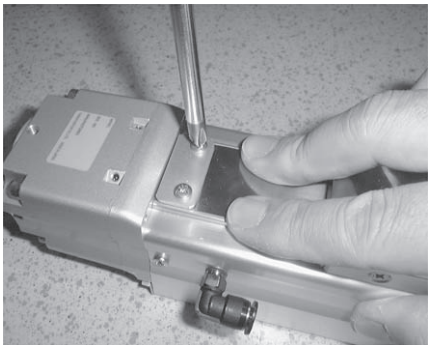
6) Loosen the screws securing the shutter clamp plate on the side where the shutter is loose.



Motor side

Stroke end side

7) While pulling (pressing down) on both ends of the shutter with your fingers, tighten the two screws to secure the shutter clamp plate.
At this point, alternately tighten the two screws a little at a time.



Motor side

Stroke end side

8) While moving the slider back and forth by hand a few times, check that no looseness or slack occurs in the shutter and also that the shutter does not jerk to the right or left. If any abnormalities are found, repeat the adjustment in steps 6) and 7).

9) Go outside the safety enclosure.

10) Check that no one is inside the safety enclosure, and then turn on the controller.

NOTE

When securing the shutter clamp plate, tighten equally on left and right a little at a time. Avoid excessive tightening as this may cause the shutter to slacken or warp.

4-3-2 Adjusting the shutter looseness (C10, C14/C14H, C17/C17L, C20)

1) Prepare the tools required for adjustment.
   - Phillips-head screwdriver

2) Turn off the controller.

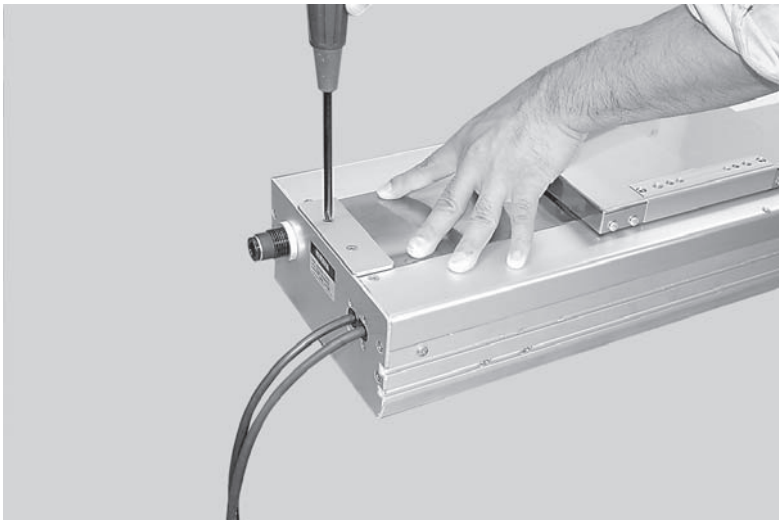
3) Place a sign indicating the robot is being adjusted, to keep others from operating the controller switch.

4) Enter the safety enclosure.

5) While moving the slider back and forth by hand, find the position where the shutter looseness is maximum.
When a vertical installation model is used, slowly move the robot in jog before entering the safety enclosure and find the position of maximum shutter looseness.

6) Loosen the screws securing the shutter clamp plate on the side where the shutter looseness occurs.

7) While pulling (pressing down) on both ends of the shutter with your fingers, tighten the two screws to secure the shutter clamp plate.
At this point, tighten the two screws alternately a little at a time.



8) While moving the slider back and forth by hand a few times, check that no looseness or slack occurs in the shutter and also that the shutter does not sway right and left. If any abnormality is found, repeat the adjustment in steps 6) and 7).

9) Go outside the safety enclosure.

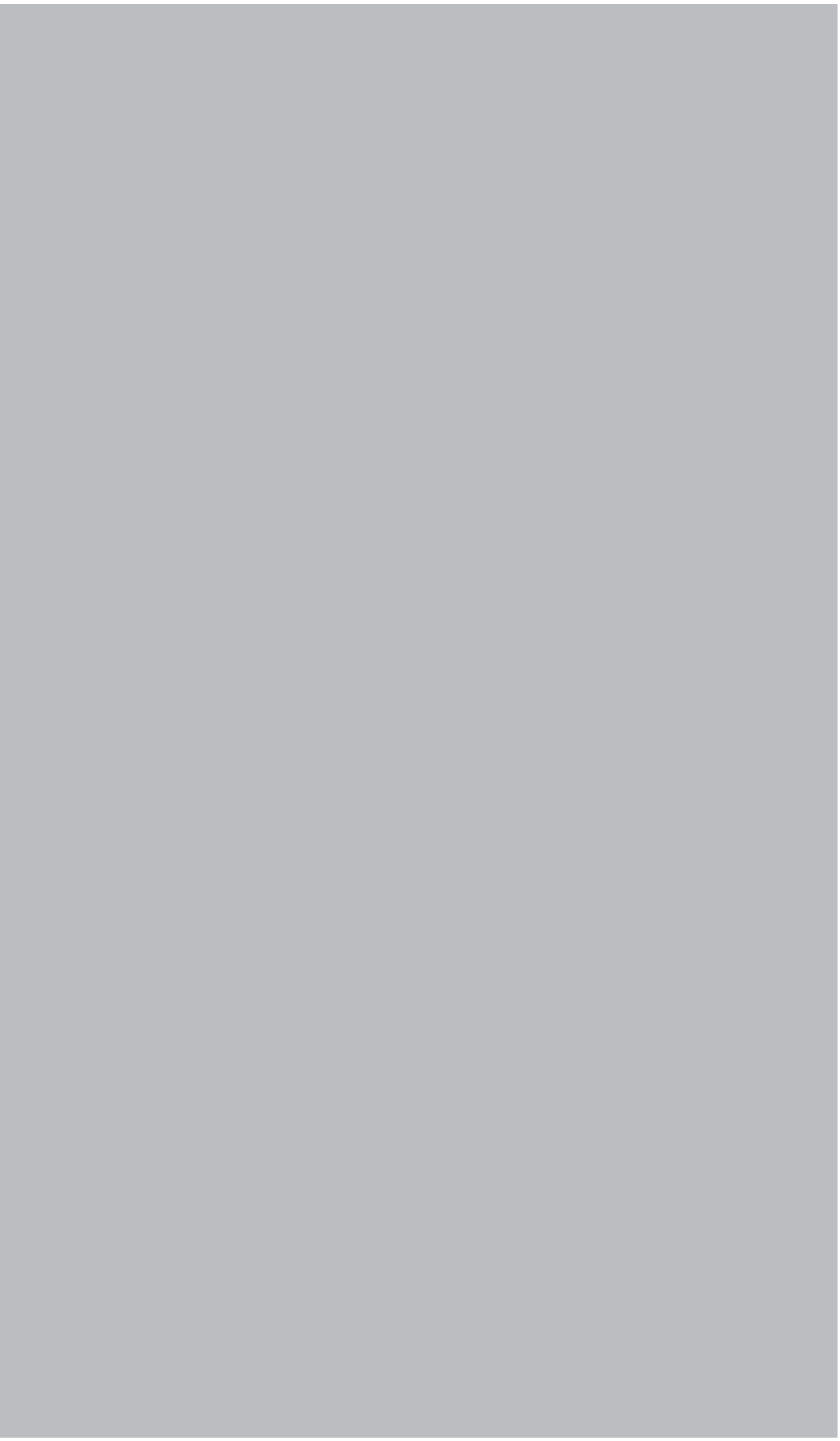
10) Check that no one is inside the safety enclosure, and then turn on the controller.

NOTE

When securing the shutter clamp plate, tighten equally on left and right a little at a time. Avoid excessive tightening as this may cause the shutter to slacken or warp.

Chapter 5 Periodic Inspection and Maintenance

Contents



5-1 Before beginning work

Periodic inspection and maintenance are essential to ensure safe and efficient operation of YAMAHA robots. This chapter describes periodic inspection items and procedures for the FLIP-XC robot. Before beginning work, carefully read the next section "5-2 Precautions" and also Chapter 1 "Using the Robot Safely", and follow the instructions.

5-2 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 sales 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 safety 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 safety 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 sales dealers.

(7) To check the operation after inspection, refer to “1-6 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”.

5-3 Periodic inspection

5-3-1 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 safety enclosure and check the following points.

Checkpoints	Check items	Notes
Cables and shutter	Check for scratches, dents, and excessively tight bends. Stain or grime on the shutter surface *1	Replace if necessary.
Ball screws and bearings	Check for unusual vibration and noise.	
Motor	Check for unusual vibration and noise, and for abnormal temperature rise.	

*1: Depending on robot operating conditions, stain or grime may appear in a stripe pattern near the slider stop point on the shutter surface. If this is found, use cloth moistened with alcohol or detergent to wipe away the stain or grime. If this occurs frequently, please consult your YAMAHA sales dealer.

(2) Inspection to be performed with the controller turned on

1) Check that no one is inside the safety 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 safety enclosure.

Checkpoint	Procedure
Safety enclosure	Check if the safety 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.)
Vertical use robot brake operation *1	Check if the brake works to stop vertical use robot from dropping more than 3mm from the stationary point. (If any abnormal operation is found, contact YAMAHA dealer.)

*1: Visually check the movement when you press the emergency stop button from outside the safety 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 safety enclosure to perform the necessary work. After adjustment or replacement is finished, again review the checkpoints explained in (1) and (2) above.

2) If repair or parts replacement is required for the robot or controller, please contact your YAMAHA sales dealer. This work requires specialized technical knowledge and skill, so do not attempt it by yourself.

5-3-2 Three-Month inspection

Take the following precautions when performing 3-month inspection.

WARNING

THE SLIDER OF VERTICAL USE ROBOT WILL SLIDE DOWN WHEN THE BRAKE IS RELEASED, CAUSING A HAZARDOUS SITUATION. DO NOT RELEASE THE BRAKE WHEN LUBRICATING VERTICAL USE ROBOT PARTS.

When applying grease to the ball screws and linear guide, take the following precautions.

WARNNIG

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 GREASE GETS IN THE EYES, WASH LIBERALLY WITH PURE WATER FOR ABOUT 15 MINUTES AND CONSULT A PHYSICIAN FOR TREATMENT.**
- **IF 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 PROPER 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 IN YOUR COUNTRY.**
- **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

Using a grease other than recommended by YAMAHA may shorten the service life of the ball screw, linear guide and linear bushing shaft.

(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 safety enclosure and check the following points.

Checkpoint	Procedure
Robot manipulator bolts and screws (only main externally exposed bolts and screws)	Check for looseness and tighten securely if necessary. *1
Controller	Check for loose terminals and connectors on the controller panel.
Grease lubrication of ball screw, linear guide and ball bushing	• Clean if dust deposits and debris are found. Apply grease after cleaning. • Apply grease if the checked parts are dry or grease is insufficient. On clean room models, use LG-2 grease (NSK).
Shutter	Check for looseness or slack. Adjust if necessary. (See "4-3 Adjusting shutter looseness" in Chapter 4.)

*1: Bolt tightening torque

Bolt size	Tightening torque (kgf•cm)	Tightening torque (N•m)
M3 button head bolt	14	1.4
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

(2) Inspection to be performed with the controller turned on

WARNNIG

THE ROBOT CONTROLLER MUST BE INSTALLED OUTSIDE THE SAFETY ENCLOSURE, TO PREVENT A HAZARDOUS SITUATION IN WHICH YOU OR ANYONE ENTER THE SAFETY 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.**

After turning on the controller, check the following points.

Checkpoint	Procedure
Cooling fan at rear of controller	• Check if the fan rotates normally. • Check if objects blocking the fan are located and remove if any are found. • 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 your YAMAHA sales dealer. • Check for dust deposits on the fan cover. Remove and clean if necessary.

(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 safety enclosure to perform the necessary work. After adjustment or replacement is finished, again review the checkpoints explained in (1) and (2) above.

2) If repair or parts replacement is required for the robot or controller, please contact your YAMAHA sales dealer. This work requires specialized technical knowledge and skill, so do not attempt it by yourself.

5-3-3 Six-Month inspection

Take the following precautions when performing 6-month inspection.

WARNING

THE SLIDER OF VERTICAL USE ROBOT WILL SLIDE DOWN WHEN THE BRAKE IS RELEASED, CAUSING A HAZARDOUS SITUATION. DO NOT RELEASE THE BRAKE WHEN LUBRICATING THE VERTICAL USE ROBOT PARTS.

When applying grease to the ball screws and linear guide, take 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 GREASE GETS IN THE EYES, WASH LIBERALLY WITH PURE WATER FOR ABOUT 15 MINUTES AND CONSULT A PHYSICIAN FOR TREATMENT.**
- **IF 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 PROPER 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 IN YOUR COUNTRY.**
- **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

Using a grease other than recommended by YAMAHA may shorten the service life of the ball screw, linear guide and linear bushing shaft.

(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 safety enclosure and check the following points.

Checkpoint	Procedure	Notes
Robot manipulator bolts and screws (only main externally exposed bolts and screws	Check for looseness and tighten securely if necessary. *1	
Ball screw, linear guide	• Check for backlash in the ball screw and linear guide. Tighten securely if necessary. • Check for vibration during operation. Tighten the drive parts and axis installation bolts securely if necessary. • Check for wear and backlash.	If equipment problems cannot be resolved or wear and backlash are found, contact your YAMAHA sales dealer.
Controller	• Check for looseness at the terminals. • Check for looseness at the connectors.	
Grease lubrication of ball screw/nut and linear guide	Apply LG-2 grease to the ball screw nut section and linear guide every 6 months.	

*1: Bolt tightening torque

Bolt size	Tightening torque (kgf•cm)	Tightening torque (N•m)
M3 button head bolt	14	1.4
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

(2) Inspection to be performed with the controller turned on

WARNING

THE ROBOT CONTROLLER MUST BE INSTALLED OUTSIDE THE SAFETY ENCLOSURE, TO PREVENT A HAZARDOUS SITUATION IN WHICH YOU OR ANYONE ENTER THE SAFETY 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.**

After turning on the controller, check the following points.

Checkpoint	Procedure
Cooling fan at rear of controller	• Check if the fan rotates normally. • Check if objects blocking the fan are located and remove if any are found. • 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 your YAMAHA sales dealer. • Check for dust deposits on the fan cover. Remove and clean if necessary.

(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 safety enclosure to perform the necessary work. After adjustment or replacement is finished, again review the checkpoints explained in (1) and (2) above.

2) If repair or parts replacement is required for the robot or controller, please contact your YAMAHA sales dealer. This work requires specialized technical knowledge and skill, so do not attempt it by yourself.

5-4 Applying grease

When applying grease according to periodic inspection, follow the procedure described in this section. Before beginning work, carefully read the precautions below and also in Chapter 1 "Using the Robot Safely", and always follow the instructions.

DANGER

IF THE INSPECTION OR MAINTENANCE PROCEDURE CALLS FOR OPERATION OF THE ROBOT, STAY OUT OF THE WORKING AREA OF THE ROBOT DURING OPERATION. DO NOT TOUCH ANY PARTS INSIDE THE CONTROLLER.
KEEP WATCHING THE ROBOT MOVEMENT AND SURROUNDING AREA SO THAT THE OPERATOR CAN PRESS THE EMERGENCY STOP BUTTON IF ANY DANGER OCCURS.

WARNING

- **WHEN THE ROBOT DOES NOT NEED TO BE OPERATED DURING ADJUSTMENT OR MAINTENANCE, ALWAYS TURN OFF THE CONTROLLER AND THE EXTERNAL SWITCH BOARD.**
- **DO NOT TOUCH INTERNAL PARTS OF THE CONTROLLER FOR 5 SECONDS AFTER THE CONTROLLER HAS BEEN TURNED OFF.**
- **USE ONLY LUBRICANT AND GREASES SPECIFIED BY YAMAHA SALES OFFICE OR DEALER.**
- **USE ONLY PARTS SPECIFIED BY YAMAHA SALES OFFICE OR DEALER. TAKE SUFFICIENT CARE NOT TO ALLOW ANY FOREIGN MATTER TO CONTAMINATE THEM DURING ADJUSTMENT, PARTS REPLACEMENT OR REASSEMBLY.**
- **DO NOT MODIFY ANY PARTS ON THE ROBOT OR CONTROLLER. MODIFICATION MAY RESULT IN UNSATISFACTORY SPECIFICATIONS OR THREATEN OPERATOR SAFETY.**
- **WHEN ADJUSTMENT OR MAINTENANCE IS COMPLETE, RETIGHTEN THE BOLTS AND SCREWS SECURELY.**
- **DURING ROBOT ADJUSTMENT OR MAINTENANCE, PLACE A SIGN INDICATING THAT THE ROBOT IS BEING ADJUSTED OR SERVICED, TO PREVENT OTHERS FROM TOUCHING THE CONTROL KEYS OR SWITCHES. PROVIDE A LOCK ON THE SWITCH KEYS OR ASK SOMEONE TO KEEP WATCH AS NEEDED.**

When applying grease to the ball screws and linear guide, take 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 GREASE GETS IN THE EYES, WASH LIBERALLY WITH PURE WATER FOR ABOUT 15 MINUTES AND CONSULT A PHYSICIAN FOR TREATMENT.**
- **IF 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 PROPER TREATMENT.**

5-4-1 Replenishing grease (C4/C4H, C5/C5H, C6)

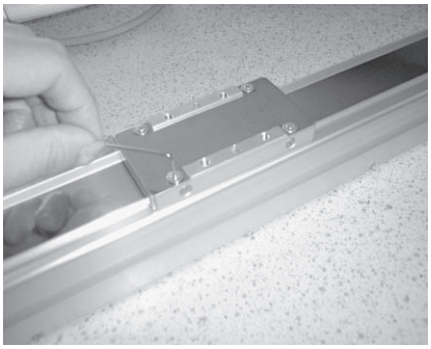
1) Prepare the required tools and grease.
   - Phillips-head screwdriver
   - Hex wrench set
   - Recommended grease: NSK LG-2

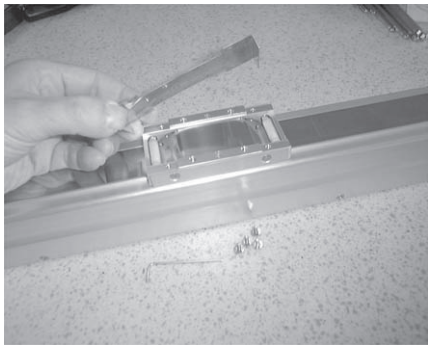
2) Turn off the controller.

3) Place a sign indicating that the robot is being inspected, to keep others from operating the controller switch.

4) Enter the safety enclosure.

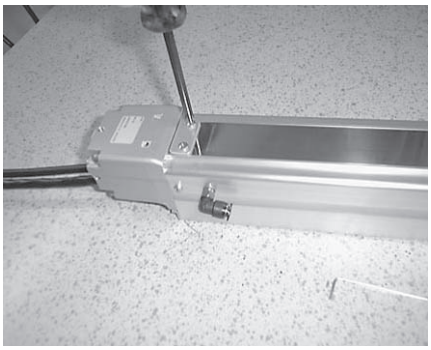
5) Detach the tool (gripper, etc.) on the slider, remove the screws securing the slider cover and take off the slider cover.





Removing the slider cover

6) Remove the screws securing the shutter clamp plates at both ends.



Motor side

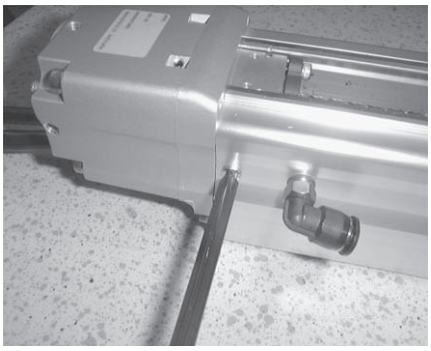
Stroke end side

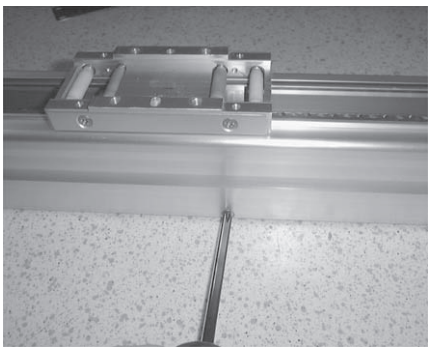
7) Press on the shutter with fingers to get some slack in the slider.
While gripping the slack part of the shutter, slowly pull the shutter out from the slider.

Pushing to get slack in the shutter

Pulling out the shutter

8) Remove the screws securing the right (or left) side cover.

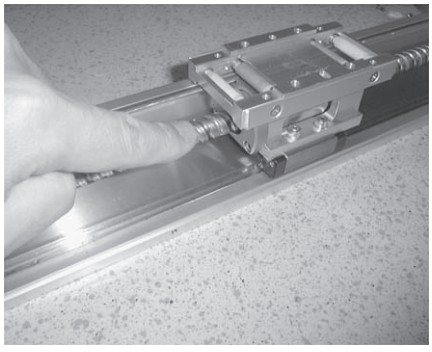


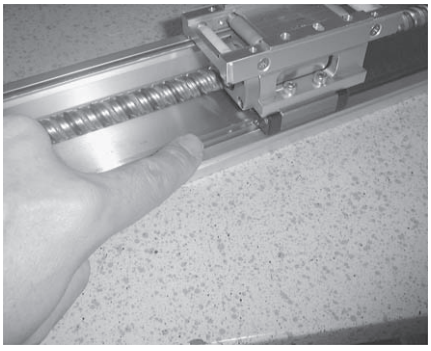


9) Move the slider to one end (motor side) and pull the side cover outwards. Then move the side cover towards the stroke end side to separate it from the slider.

Removing the side cover

10) Wipe away the old grease with a clean cloth. Next, apply grease by hand to the ball screw and linear guide. Then move the slider back and forth to spread the grease and remove excess grease with a clean cloth.



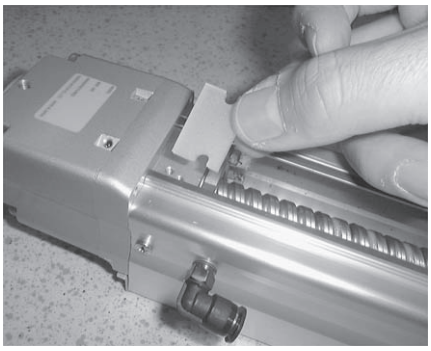


Applying grease to the ball screw **Applying grease to the linear guide**

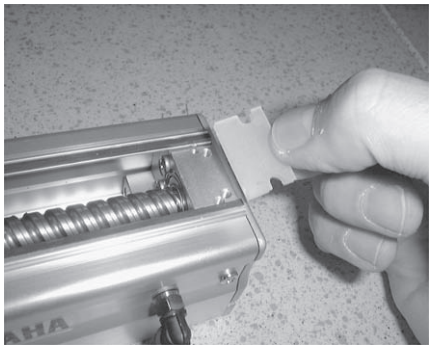
When a vertical installation model is used, go outside the safety enclosure once, check that no one is inside the safety enclosure, and turn on the controller. Then, slowly move the slider back and forth a few times in MANUAL mode to spread the grease. Next, turn off the controller again and re-enter the safety enclosure to continue the job.

11) Reinstall the side cover and perform the procedure of step 9) in reverse order, to tighten the screws securing the side cover.

12) Reinstall the parts (made of stainless steel) that came off when the side cover was removed.



Motor side

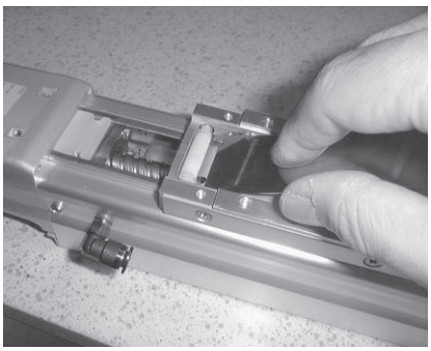


Stroke end side

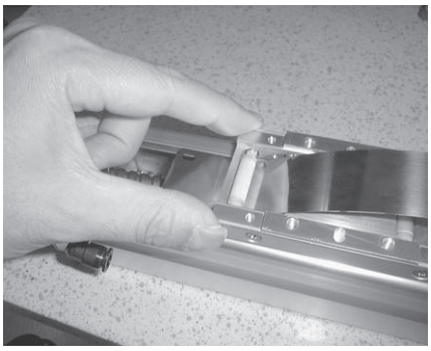
13) Move the slider to one end and lightly insert the shutter between the roller and the robot body. Then push gently on the slider to pass the shutter through it.

NOTE

Pass the shutter through the slider so it fits in the center of the robot body. Do not push on the shutter with excessive force as this may deform or damage the shutter.



Inserting the shutter

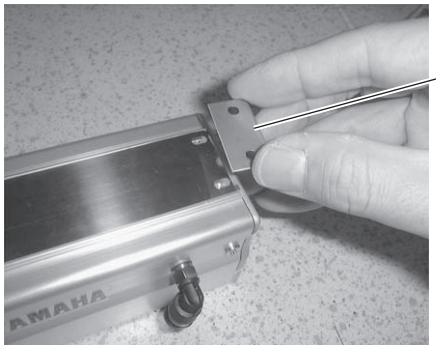


Pushing the slider to pass the shutter through it

When a vertical installation model is used, the slider won't move by hand, so rotate the roller with your fingers to pass the shutter through the slider.

14) Pass the shutter through the other end of the slider in the same way.

15) Reattach the shutter clamp plates removed in step 6) and finger-tighten the screws (do not tighten securely). On the stroke end side of the C5 and C6, place the spacer plate between the shutter and the shutter clamp plate.



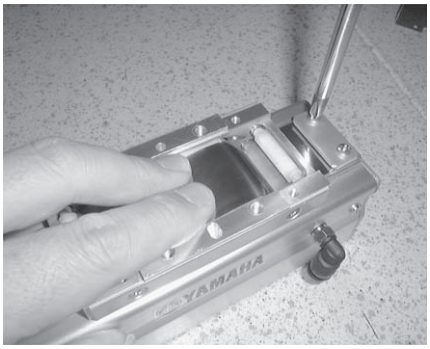
Spacer plate (C5, C6 only)

16) Move the slider back and forth by hand a few times so that the shutter fits in the center of the robot body.

17) Move the slider to one end, and while pressing down on the shutter in the center of the slider, tighten the shutter clamp plate screws alternately a little at a time.

NOTE

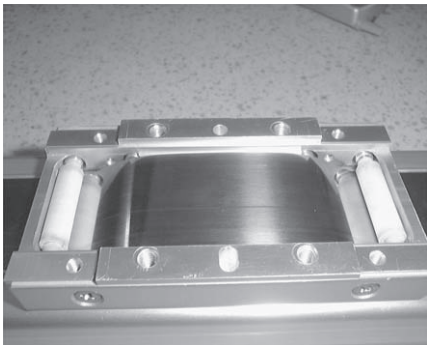
When securing the shutter clamp plate, tighten equally on left and right a little at a time. Avoid excessive tightening as this may cause the shutter to slacken or warp.



18) Use the same procedure to tighten the screws on the other shutter clamp plate, alternately a little at a time. After tightening, check that the shutter does not protrude (or bulge) above the slider, If the shutter is protruding, loosen the screws on the shutter clamp plates on both ends and repeat the adjustment in steps 16) and 17).

CAUTION

If the shutter protrudes (bulges) above the slider, the shutter surface might rub against the slider cover creating dust or grit. This will also shorten the shutter service life.



Correct shutter installation on the slider

19) While moving the slider back and forth by hand a few times, check that the shutter does not slacken or jerk to the right or left. If slack or sway occurs in the shutter, repeat the adjustment from step 16) to step 18).

When a vertical installation model is used, go outside the safety enclosure once, check that no one is inside the safety enclosure, and turn on the controller. Then slowly move the slider back and forth a few times in MANUAL mode to spread the grease. Then turn off the controller again and re-enter the safety enclosure to continue the job.

20) Reattach the slider cover.

21) Go outside the safety enclosure.

22) Check that no one is inside the safety enclosure and then turn on the controller.

5-4-2 Replenishing grease (C10, C14/C14H, C17/C17H, C20)

1) Prepare the required tools and grease.
   - Phillips-head screwdriver
   - Grease gun
   - Recommended grease: NSK LG-2

2) Turn off the controller.

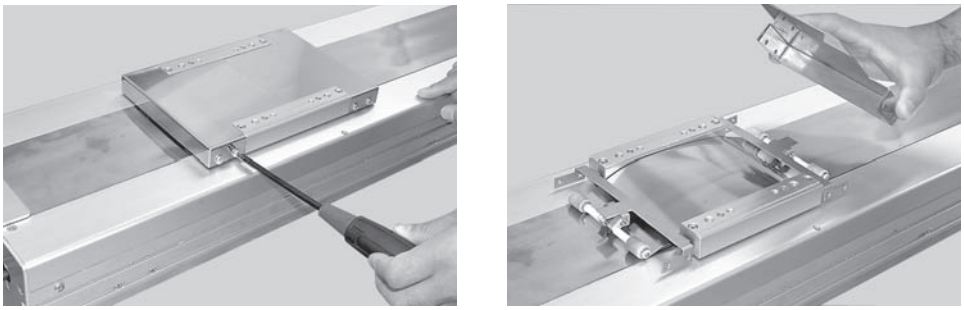
3) Place a sign indicating that the robot is being inspected, to keep others from operating the controller switch.

4) Enter the safety enclosure.

5) Detach the tool (gripper, etc.) on the slider, remove the screws securing the slider cover and take off the slider cover.

CAUTION

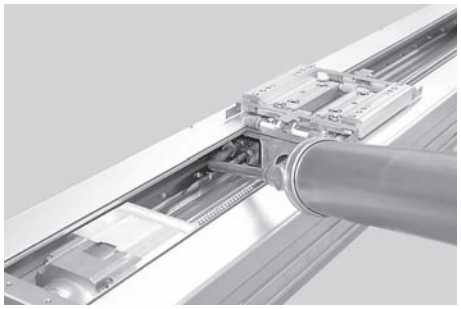
The slider cover is fastened to the slider, with the four screws at the inner positions on the slider. Do not loosen and remove the screws at the outer positions on the slider.



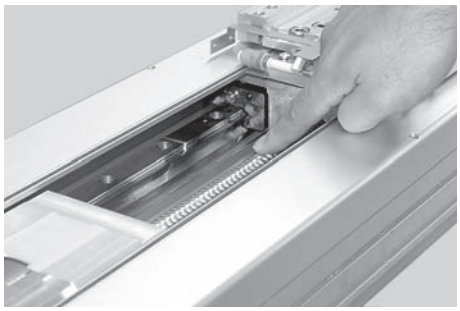
Removing the slider cover

6) Remove the screws securing the shutter clamp plates at both ends.

7) Wipe away the old grease with a clean cloth. Next, use a grease gun to supply grease into the grease nipple for the linear guide. Also apply grease by hand to the thread valley of the ball screw. Then move the slider back and forth to spread the grease. Finally, remove excess grease with a clean cloth.



Applying grease to the linear guide



Applying grease to the ball screw

When a vertical installation model is used, go outside the safety enclosure once, check that no one is inside the safety enclosure, and turn on the controller. Then, slowly move the slider back and forth a few times in MANUAL mode to spread the grease. Next, turn off the controller again and re-enter the safety enclosure to continue the job.

8) Place the shutter, rubber plates and shutter clamp plates in order on the robot body, and lightly tighten the screws (do not tighten securely).

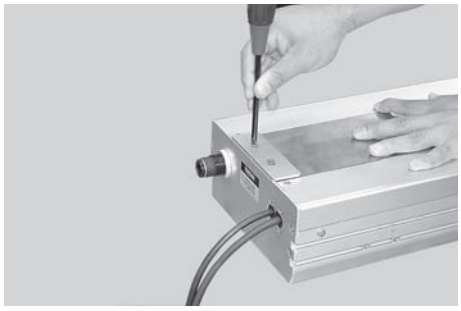
NOTE

Place the shutter on the robot body so that it is clamped in the center of long holes at both ends of the shutter.

Shutter clamp position

9) Reattach the slider cover and lightly fasten with the screws.

10) While moving the slider back and forth by hand a few times, check that the shutter does not slacken or jerk to the right or left. If slack or sway occurs in the shutter, loosen the screws securing the shutter clamp plate on the side where the shutter is loose. While pulling (pressing down) on both ends of the shutter with your fingers, tighten the two screws to secure the shutter clamp plate.



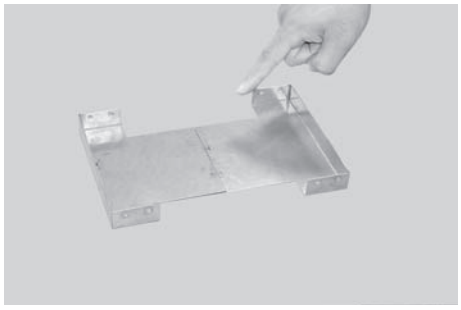
Instralling the shutter

NOTE

When securing the shutter clamp plate, tighten equally on left and right a little at a time. Avoid excessive tightening as this may cause the shutter to slacken or warp.

When a vertical installation model is used, go outside the safety enclosure once, check that no one is inside the safety enclosure, and turn on the controller. Then, slowly move the slider back and forth a few times in MANUAL mode to spread the grease. Next, turn off the controller again and re-enter the safety enclosure to continue the job.

11) Move the slider back and forth by hand and then remove the slider cover. Check the inner side of the slider cover for scratches caused by rubbing against the shutter. If scratches are found, reattach the slider cover and loosen the screws on either shutter clamp plate. Then repeat the adjustment in step 10).



Inner side of slider cover

12) Firmly tighten those screws on the shutter and cover which were lightly attached. At this point, gradually tighten the screws on the shutter. Finally, move the slider back and forth by hand and check that no looseness or slack occurs in the shutter and also that the shutter does not slacken or jerk to the right or left.

13) Go outside the safety enclosure.

14) Check that no one is inside the safety enclosure and then turn on the controller.

When a vertical installation model is used, slowly move the slider back and forth a few times in MANUAL mode to make the same check as explained in step 12).

5-5 Replacing the shutter

When replacing the shutter of the C4/C4H, C5/C5H or C6, refer to the procedure explained in "5-4-1 Replenishing grease (C4/C4H, C5/C5H, C6,)" in this chapter.

Likewise, refer to the procedure explained in "5-4-2 Replenishing grease (C10, C14/C14H, C17/C17L, C20)" in this chapter to replace the shutter of the C10, C14/C14H, C17/C17L or C20.

MEMO

Chapter 6 Specifications

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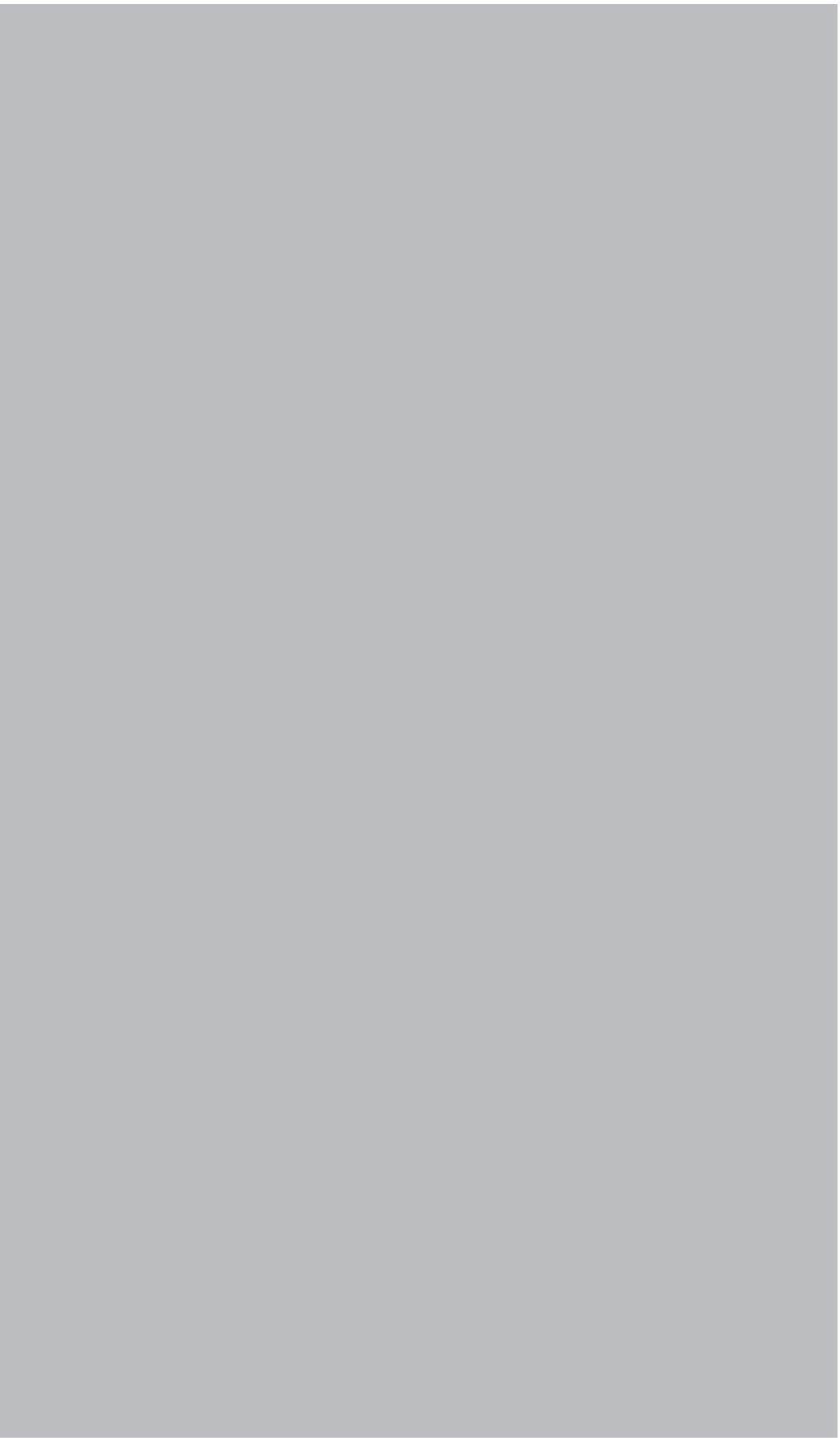


6-1 AC servo motor specifications

6-1-1 AC servo motor termination (C4/C4H, C5/C5H)

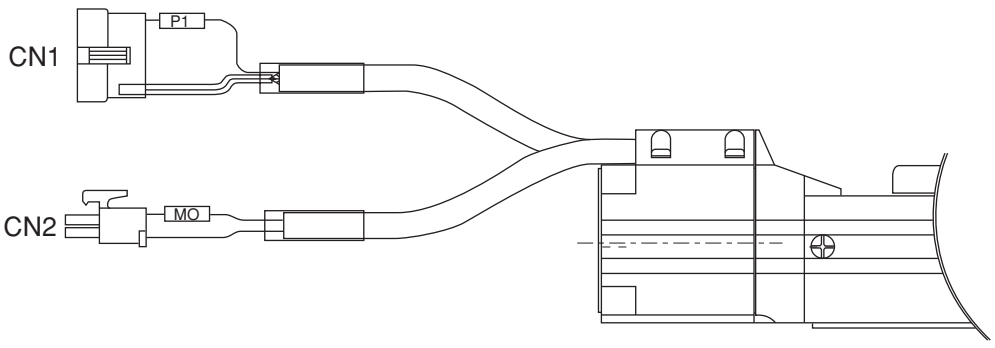
■ Connector specifications

No.	Parts	Type No.	Maker	Qty	Note
1	Servo motor			1	
2	Receptacle housing	SMR-09V-B	JST	1	CN1 (9 polarities)
3	Pin contact	BYM-001T-P0.6	JST	9	CN1
4	Receptacle housing	5557-04R	MOLEX	1	CN2 (4 polarities)
5	Receptacle	5556T	MOLEX	4	CN2

■ Connector wiring

Connector	Pin No.	Signal	Wire Color
CN1	1	S2	Yellow
	2	S4	Blue
	3	S1	Red
	4	S3	Black
	5	R1	White
	6	R2	Green
	7	JP1	Red
	8	JP2	Red
	9	Shield	Black *1
CN2	1	U	Red
	2	V	White
	3	W	Black
	4	PE	Green/Yellow

*1: Heat shrinkable tube



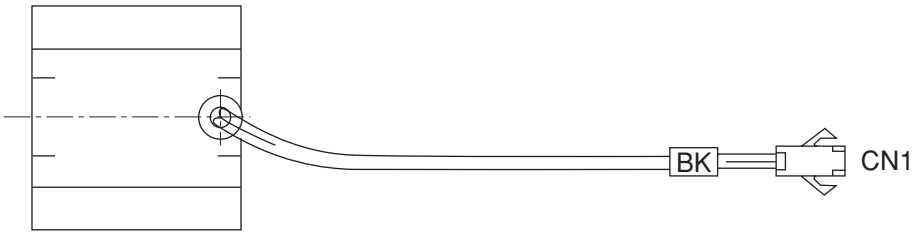
6-1-2 Brake cable specifications (C4/C4H, C5/C5H, C6)

■ **Connector specifications**

No.	Parts	Type No.	Maker	Qty	Note
1	Brake parts			1	
2	Receptacle housing	SMR-02V-B	JST	1	CN1
3	Pin contact	BYM-001T-P0.6	JST	9	CN1

■ **Connector wiring**

Connector	Pin No.	Signal	Wire Color
CN1	1	S1	Yellow (black)
	2	S2	Yellow (black)



6-1-3 AC servo motor termination (C6, C10, C14/C14H, C17/C17L, C20)

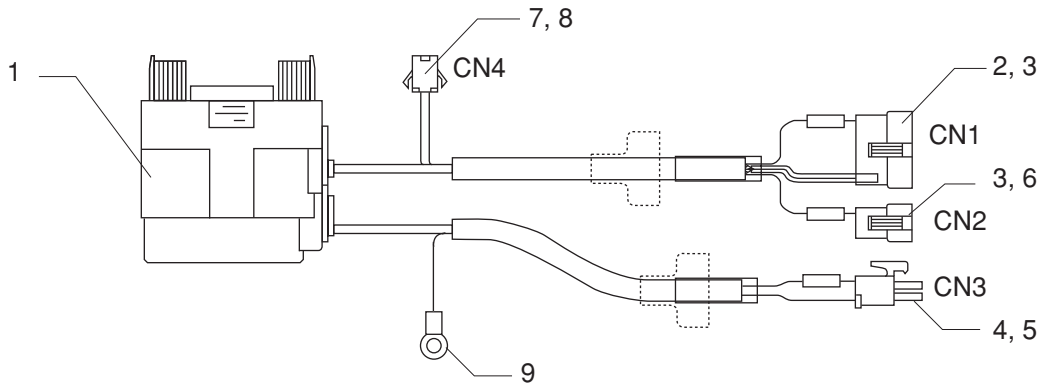
■ **Connector specifications**

No.	Parts	Type No.	Maker	Qty	Notes
1	Servo motor			1	
2	Receptacle housing	SMR-07V-B	JST	1	CN1 (7 polarities)
3	Pin contact	BYM-001T-P0.6	JST	9	CN1, CN2
4	Plug housing	176273-1	AMP	1	CN3 (4 polarities)
5	Receptacle	175156-2	AMP	4	CN3
6	Receptacle housing	SMR-02V-B	JST	1	CN2 (2 polarities)
7	Plug housing	SMR-02V-BC	JST	1	CN4 (2 polarities)
8	Socket contact	BHF-001T-0.8BS	JST	2	CN4
9	Round terminal	1.25-M4		1	

■ Connector wiring

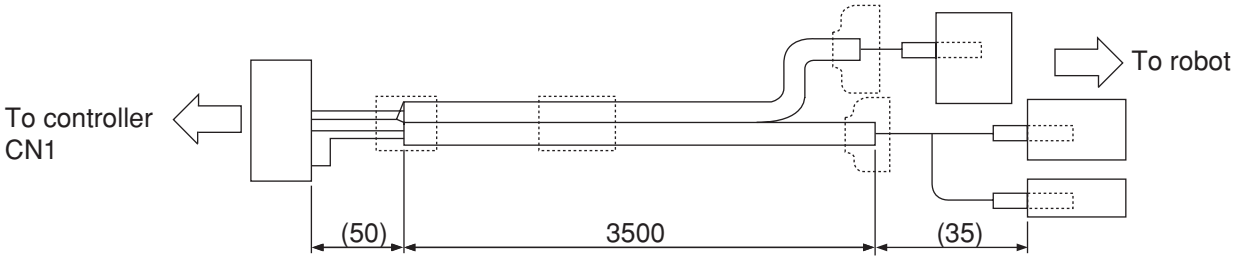
Connector	Pin No.	Signal	Wire Color	Connection	
CN1	1	S2	Yellow	P	Motor
	2	S4	Blue		
	3	S1	Red		
	4	S3	Black		
	5	R1	White		
	6	R2	Green		
	7	Shield	Black *1		
CN2	1	BK	Gray		1
	2	BK	Brown		2
CN3	1	U	Red	M	Motor
	2	V	White		
	3	W	Black		
	4	PE	Yellow/Green		Round terminal

*1: Heat shrinkable tube



6-2 Robot cable

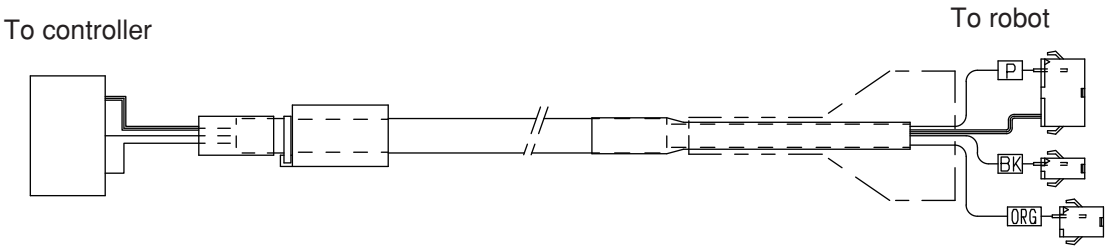
6-2-1 Robot cable (C4/C4H, C5/C5H)



Parts	Signal	PIN	Connection	PIN	Parts	Wire	
Controller CN1	D.G	9		9	Resolver	Drain wire	
	S2	1		1		0.3sq black	KVC-36SB
	S4	2		2		black/white	
	S1	3		3		Red	
	S3	4		4		Red/white	
	R1	5		5		Green	
	R2	6		6		Green/white	
	JP1	7		8		Yellow	
	JP2	8		7		Yellow/white	
	U	11		1	Motor	0.5sq Red	KVC-36
	V	14		2		white	
	W	13		3		black	
	FE	12		4		Green	
	BK+	15		1	Brake	Yellow	
	BK–	16		2		Brown	

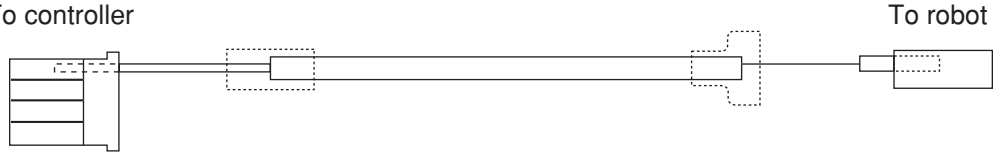
6-2-2 Robot cable (C6, C10, C14/C14H, C17/C17L, C20)

● Signal line



Parts	Signal	PIN	Connection	PIN	Parts	Wire	
Controller CN1	S2	1		1	Resolver	0.3sq Blue	SPMCU-14K
	S4	2		2		Orange	
	S1	3		3		Green	
	S3	4		4		Brown	
	R1	5		5		Grey	
	R2	6		6		Red	
	D.G	9		7		Clear	Shield
	BK+	17		1	Brake	Black	
	BK-	18		2		Yellow	
	ORG	12		2	ORG	Pink	
	24V	13		1		White	
	GND24	15		3		Blue Red	

● Power line



Parts	Signal	PIN	Connection	PIN	Parts	Wire
Motor wire	FG	1		4		0.75sq Yellow/ Green
	U	2		1		0.75sq Red
	V	4		2		0.75sq White
	W	3		3		0.75sq Black

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Chapter 7 Troubleshooting

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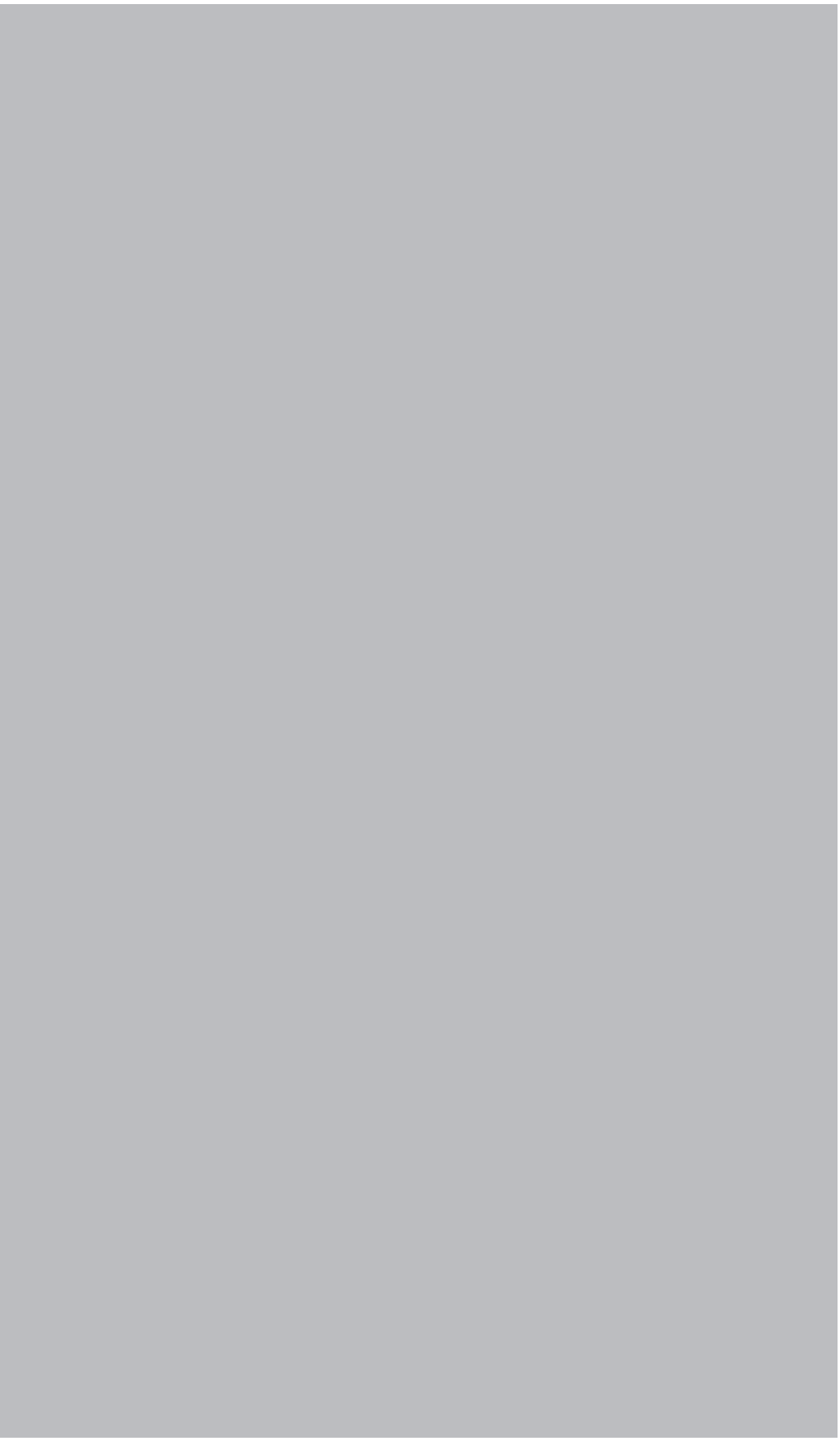
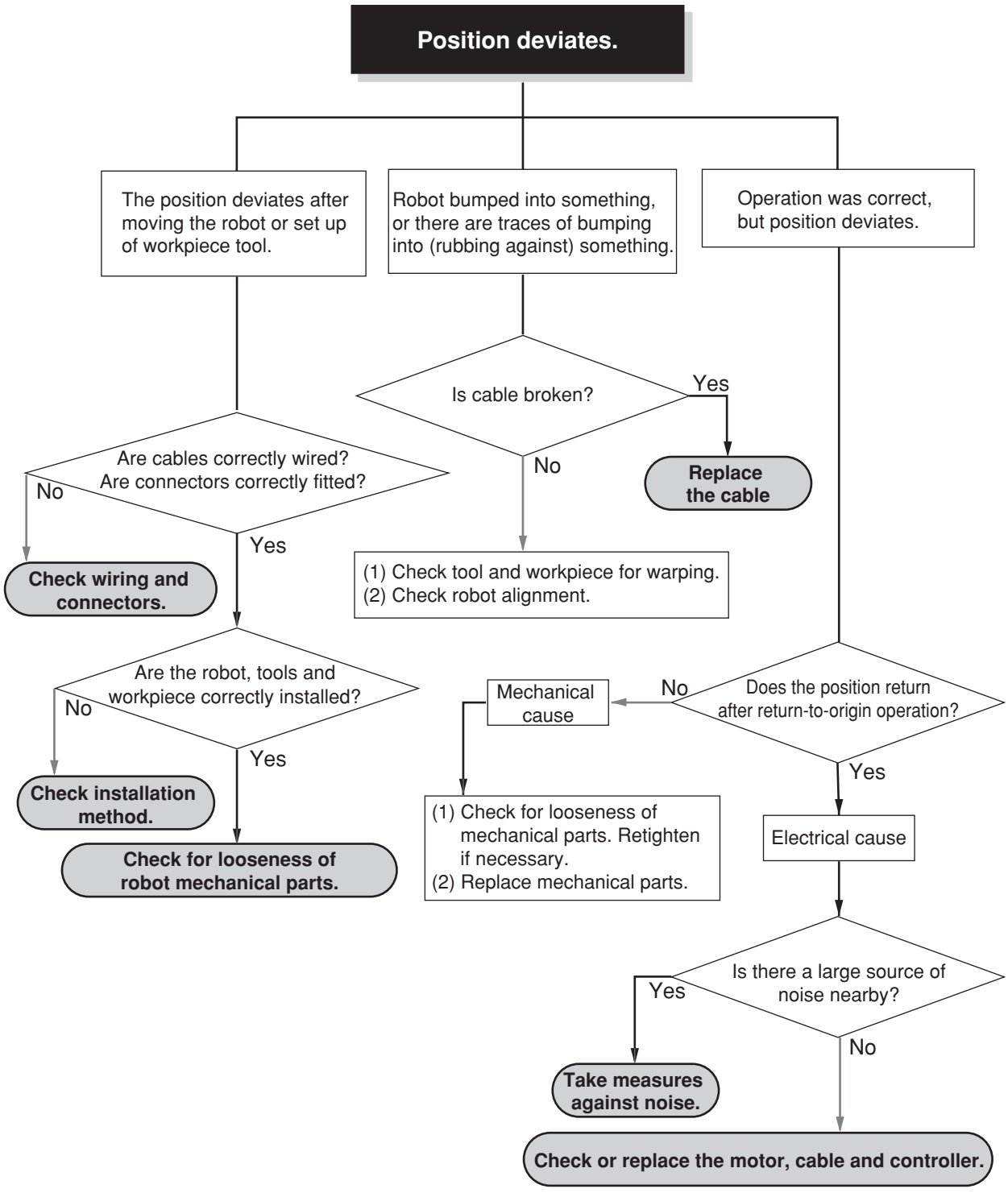
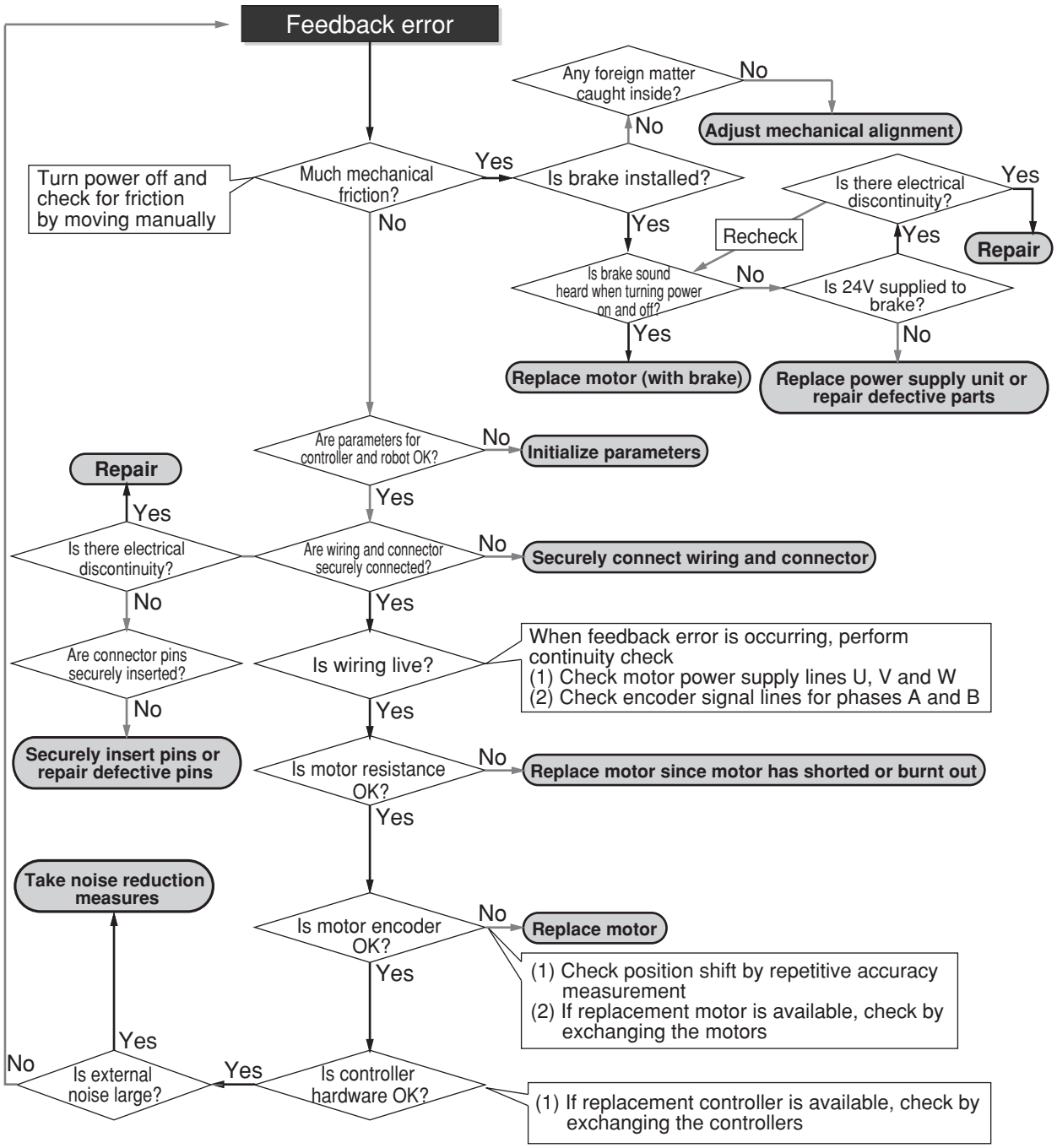


7-1 Positioning error

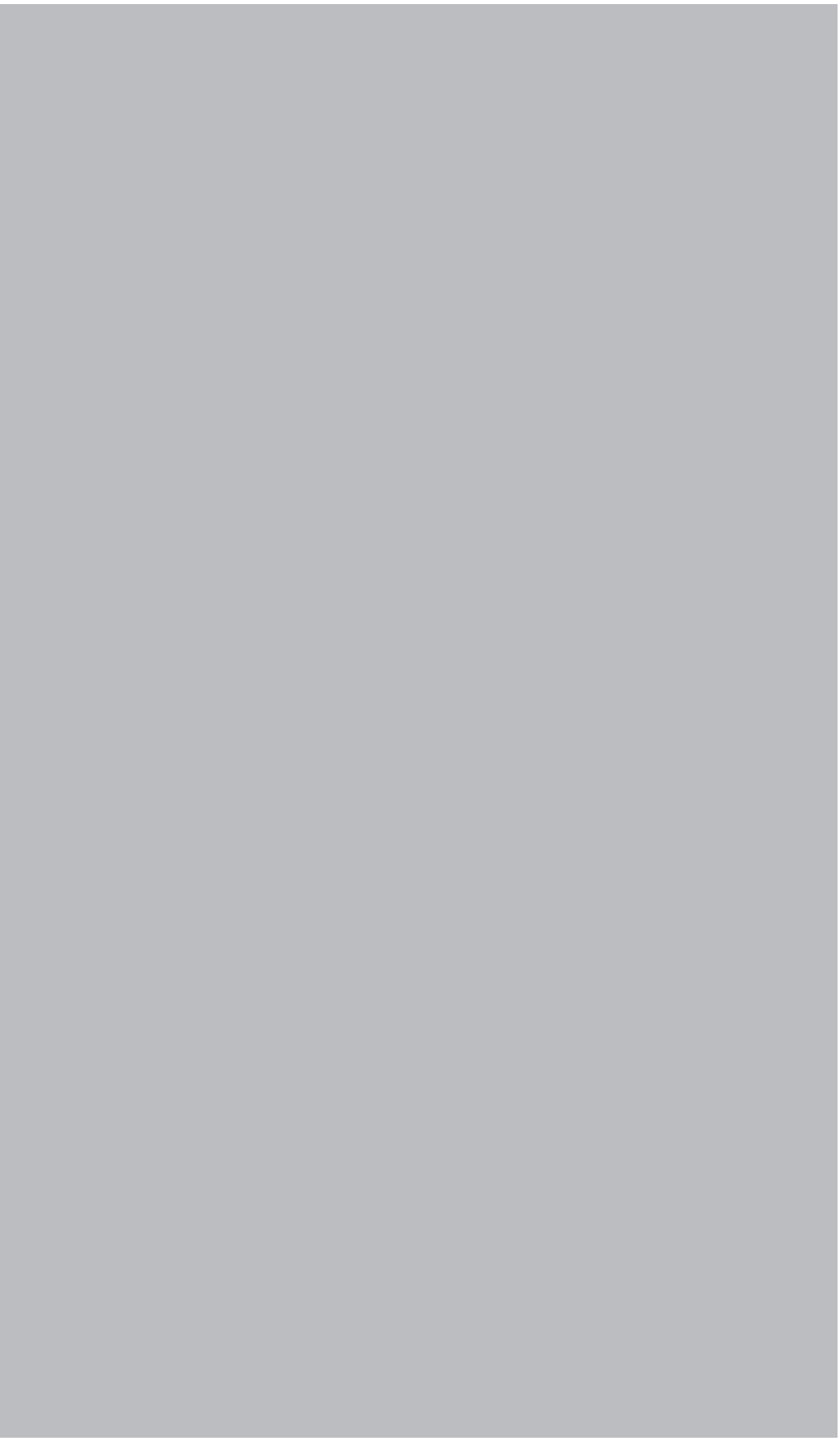


7-2 Feedback error



Chapter 8 Appendix

Contents



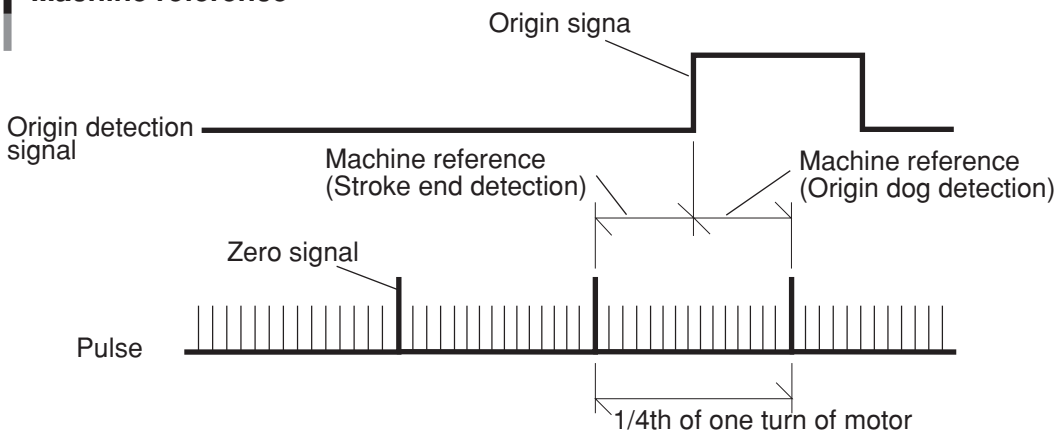
8-1 About machine reference

The position detector built into the motor issues a "0" pulse each time the motor rotates 1/4th of one turn. When return-to-origin is performed, a difference in distance occurs between the position where the origin signal is detected and the point at which the next "0" pulse is received. This is called the machine reference and is usually expressed as a percent, with 100% being equal to 1/4th of one turn of the motor. The machine reference value must be within the allowable range (25 to 75%) to maintain axis movement repeatability.
To check the machine reference value, an optional programming box (HPB, MPB or RPB) is needed. The machine reference value is displayed on the LCD screen of the programming box when return-to-origin is complete. (See the figure below.)

NOTE

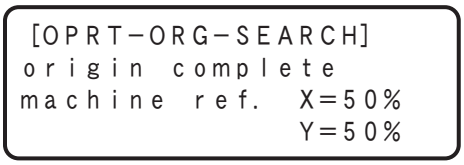
The FLIP-X series uses an absolute type position detector. You do not have to perform return-to-origin each time the robot controller is turned on and readjust the machine reference value. If for some reason the machine reference adjustment becomes necessary, please contact YAMAHA sales office or dealer.

Machine reference

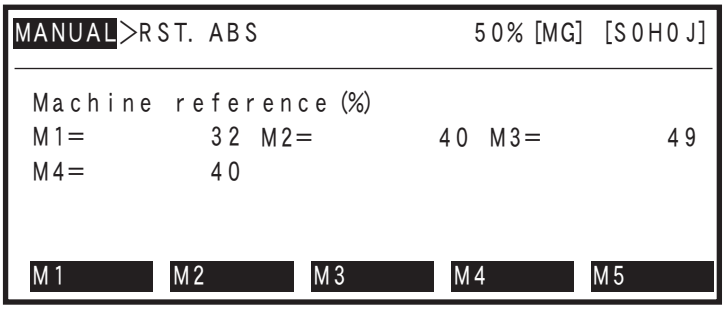


Machine reference value display examples

SR1



DRCX (Two FLIP-X control)



RCX142 (Multiple FLIP-X control)

8-2 Equation of moment of inertia calculation

CAUTION

he 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.

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.

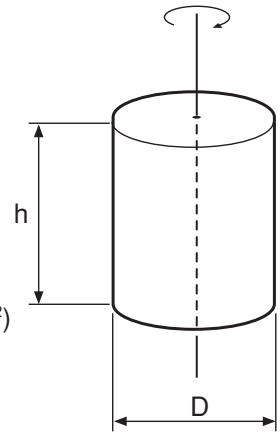
1. Moment of inertia for cylinder

The moment of inertia (J) for a cylinder having a rotation center such as shown below is given by

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

$$= \frac{mD^2}{8} \quad (kgm^2)$$

ρ : Density (kg/cm^3)
g : Gravitational acceleration (cm/sec^2)
W : Weight of cylinder (kgf)
m : Mass of cylinder (kg)



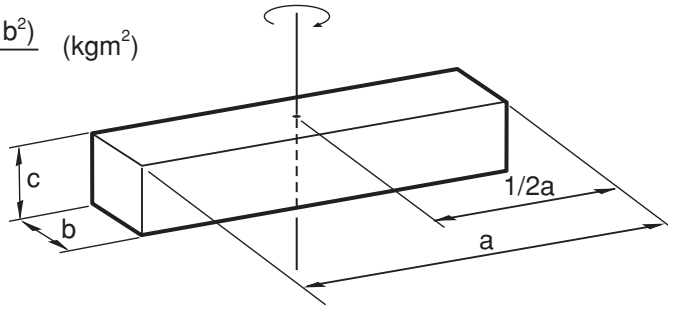
2. Moment of inertia for rectangular parallelepiped

The moment of inertia (J) for a rectangular parallelopiped having a rotation center as shown below is given by

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

$$= \frac{m\,(a^2 + b^2)}{12} \quad (kgm^2)$$

ρ : Density (kg/cm^3)
g : Gravitational acceleration (cm/sec^2)
W : Weight of prism (kgf)
m : Mass of prism (kg)



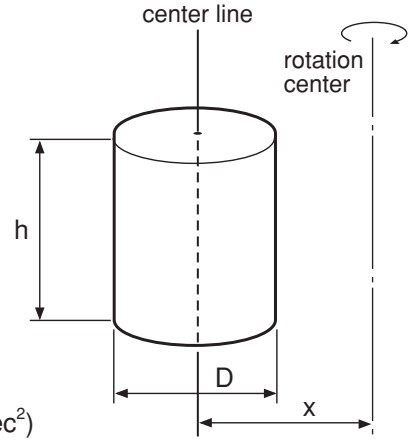
3. When the object's center line is offset from the rotation center.

The moment of inertia (J) when the center of the cylinder is offset by a distance "x" from the rotation center as shown below is given by

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

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

$$= \frac{mD^2}{8} + mx^2 \ (kgm^2)$$



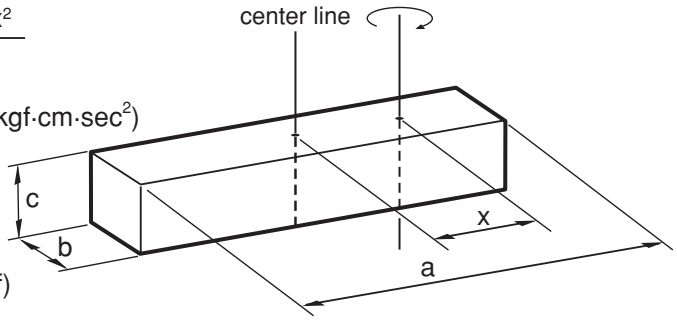
W : Weight of cylinder (kgf)
m : Mass of cylinder (kg)
e : Density (kg/cm^3)
g : Gravitational acceleration (cm/sec^2)

In the same manner, the moment of inertia (J) of a prism as shown below is given by

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

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

$$= \frac{m(a^2 + b^2)}{12} + mx^2 \ (kgm^2)$$



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

8-3 Duty

To achieve maximum service life for the YAMAHA single-axis robots, the robot must be operated within the allowable duty (50%). The duty is calculated as follows:
Operation time

$$\text{Duty (\%)} = \frac{\text{Operation time}}{\text{Operation time + Non-operation time}} \times 100$$

If the robot duty is high, an error such as "overload" or "overheat" occurs. In this case, increase the stop time to reduce the duty.

Revision record

Manual version	Issue date	Description
Ver. 1.03	Aug. 2006	English manual Ver. 1.03 is based on Japanese manual Ver. 1.03.
Ver. 2.00	Apr. 2008	English manual Ver. 2.00 is based on Japanese manual Ver. 2.00.

User's Manual

YAMAHA **FLIP-XC**

Single-axis Robot

Apr. 2008
Ver. 2.00
This manual is based on Ver. 2.00 of Japanese manual.