RHD-0016E

BASE ROBOT
USER'S GUIDE

PF1000

Hirata
The Global Production Engineering Company

Warranty

All of Hirata's products which is passed our formal inspection test shall be guaranteed against faults due to the negligence of Hirata for either earlier period of one year or four thousand hours of operation from the day of shipment from Hirata Factory.

This warranty shall be applicable to the parts replacement and/or labor for repair in our factory and transportation cost shall not be applied.

We will charge the repair of faults caused by the following reasons:

* Wrong usage which are prohibited in the instruction manual.
* After the expiration of guarantee period.
* Earthquake, fire, riot, violence, war and other force majeure.
* Modification, repair or adjustment is performed by unauthorized person.

Contact your sales agent for individual warranty coverage.

PF1000
USER'S GUIDE (RHD-0016E)

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Hirata Corporation

Tokyo Head Quarters
3-9-20 Togoshi, Shinagawa, Tokyo 142-0041 JAPAN
Phone (03) 3786-1226
Facsimile (03) 3786-1264

Core Product Center
111 Hitotsugi, Ueki, Kamoto, Kumamoto, 861-0198 JAPAN
Phone (096) 272-3953
Facsimile (096) 272-0017

PREFACE

Safety

Hirata robot systems include computer controlled mechanism that are capable of moving at the high speed and entering considerable force. Like all robot systems and industrial equipment, they must be treated with respect by system user.

(1) Please read and understand instruction manual such as an operation manual, a robot hardware manual and an instruction manual attached to the products. These manual should be read by all personnel who maintain Hirata robot systems.

(2) Safeguards should be an integral part of robot work-cell design, installation, operator training, and operating procedure. Hirata robot systems have various communication features to aid you in constructing system safeguards. These includes remote emergency stop circuitry, and digital input and output lines.

(3) Hirata Corporation recommends the use of status lamp or any device to express the robot and operation status.

(4) Daily and periodical maintenance is highly recommended to ensure the robot performance and life time.

(5) Hirata Corporation requests to system integrator to provide necessary training and instruction to an operator.

(6) The teaching pendant equips dead-man switch. It is prohibited to disable the feature by banding.

(7) Pay particular attention and clearly notify before operation when the other operator is in the working envelope.

(8) When you operate a robot inside the safety barrier, the robot should be equipped with Hold-to-Run and enable devices (the operation speed should be 250 mm/sec or lower).

Robot Modification

Often, Hirata robots must be modified to successfully integrated them into a workcell. Unfortunately, many seemingly simple modifications can either cause a robot failure, or reduce the robot's performance, reliability or lifetime.

Acceptable Modifications

In general, the following robot modifications will not cause any problems but may affect robot performance.

(1) Attaching tooling utility boxes, solenoid packs, vacuum pumps, screwdrivers, cameras, lighting etc., to inner link or outer link. For Hirata robot, any loads attached to moving robot parts must be considered as robot payload.

(2) Attaching hoses, pneumatic lines, or cables to the robot. These should be designed so they do not restrict joint motion or cause robot motion errors.

(3) Modifying robot access covers, as long as adequate protection is provided after the modification.

Unacceptable Modification

If not done properly, the modification listed below will damage the robot, reduce system reliability, or shorten the life of the robot. For this reason, these modifications will void the warranty of any components that Hirata determines were damaged due to the modification. Please contact Hirata before attempting any of the following modifications to determine if the change can be made without causing problems.

(1) Modifying any robot harness

(2) Modifying any drive system components.

(3) Modifying, including drilling and cutting, any robot casting.

(4) Modifying any robot electrical component or PC assembly.

Notes, Cautions, and Warnings

There are three levels of special notations are used in this manual.

Notation	Description
 WARNING	If the actions indicated in a WARNING are not complied with, injury, death or major equipment damage could result.
 CAUTION	If the action specified in the CAUTION is not complied with, damage to your equipment could result.
 NOTE	A NOTE provides supplementary information, emphasizes a point or procedure, or gives a tip for easier operation.

CHAPTER 1 General

This manual describes about PF1000 series robot.

As shown in the later chapter which describes the robot specifications of this series, there are six types with different combinations.

The Hirata PF1000 series features:

- Max. speed : 2,000 mm / sec.
- Max. payload : 10 kgf
- Repeatability : ±0.01 mm

CHAPTER 2 General Specification

Robot specification is described below.

Table 2.1 Specification

Item	Description
Model series	PF1000 series
Application	Assembly Pick and place
Category	Record play back robot
Structural form	Cartesian coordinate robot
Degree of freedom	4 axes, 8 axes
Weight	Refer to the specification in CHAPTER 3.
Color	Standard (Charcoal gray) paintable part only
Applicable controller	HNC-96B
User utility	Pneumatic hose (φ6 × 2pcs) Cable (0.2 mm^2× 15pcs.)
Accessories	I/O connector× 2pcs.
Option	W-axis high inertia type X-axis Sensor (Overrun) Y-axis Sensor (Overrun)

CHAPTER 3 Specification and Dimensions

3.1 Product Number Definition

CRW 2 - U 15 15 - 1350 - 400 - 200 - S -□
① ② ③ ④ ⑤ ⑥ ⑦ ⑧ ⑨ ⑩

No.	Description	No.	Description
①	combination CRW	⑥	X-axis stroke 650mm 1100mm 1350mm
②	Head None: 1 head 2: 2 heads	⑦	Y-axis stroke 400mm
③	Speed U: 2000mm/sec	⑧	Z-axis stroke 200mm
④	X-axis frame size 15: 155mm width	⑨	Support Axis None: without Support Axis S: with Support Axis
⑤	Y axis frame size 15: 155mm width	-	-

(Option)

No.	Description	No.	Description
⑩	W-axis high inertia type None: Standard H: High inertia	-	-

3.2 Robot Specification

3.2.1 CRW2-U1515-1100-400-200-S Specification

Table 3.1 CRW2-U1515-1100-400-200-S Specification

Type			**Unit**	2 heads Long with Support Axis
Axis combination				8 axes
Product Number	**Robot**			CRW2-U1515-1100-400-200-S
	controller			HNC-96B
	T-PEN(Option)			H-3332-4m/H-3332-8m/H-3332-15m (selectable)
Max. Payload			**kg**	10
Weight			**kg**	163
Stroke		**X-axis**	**mm**	1100
		Y-axis		400
		Z-axis		200
		W-axis	**deg**	540
Motor Power		**X-axis**	**W**	750
		Y-axis		400
		Z-axis		200
		W-axis		100
Speed		**X-axis**	**mm/sec**	2000
		Y-axis		2000
		Z-axis		1125
		W-axis	**deg/sec**	1200
X,Y Compounded Speed			**mm/sec**	2828
Repeatability		**X-axis**	**mm**	±0.01
		Y-axis		±0.01
		Z-axis		±0.01
		W-axis	**deg**	±0.03

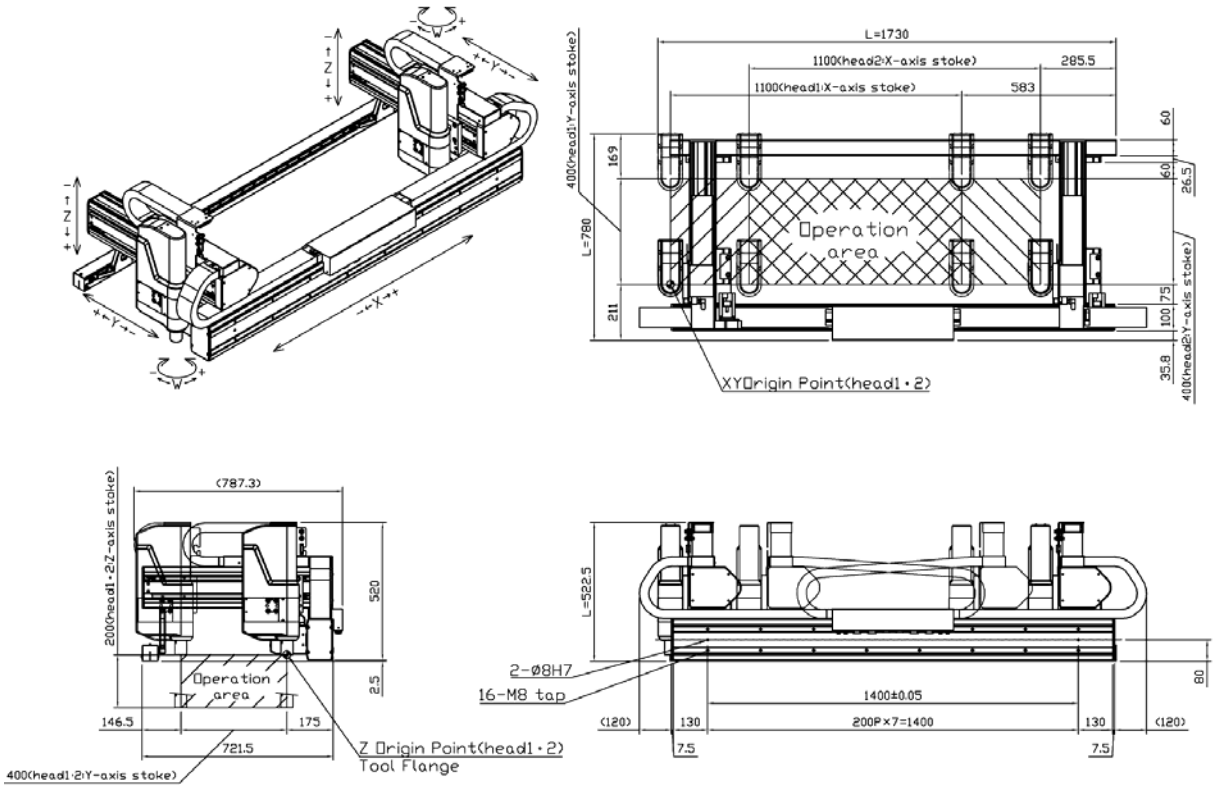


Figure 3.1 CRW2-U1515-1100-400-200-S Dimensions

3.2.2 CRW-U1515-1350-400-200-S Specification

Table 3.2 CRW-U1515-1350-400-200-S Specification

Type			**Unit**	1 head Long with Support Axis
Axis combination				4 axes
Product Number	**Robot**			CRW-U1515-1350-400-200-S
	controller			HNC-96B
	T-PEN(Option)			H-3332-4m/H-3332-8m/H-3332-15m (selectable)
Max. Payload			**kg**	10
Weight			**kg**	103
Stroke		**X-axis**	**mm**	1350
		Y-axis		400
		Z-axis		200
		W-axis	**deg**	540
Motor Power		**X-axis**	**W**	750
		Y-axis		400
		Z-axis		200
		W-axis		100
Speed		**X-axis**	**mm/sec**	2000
		Y-axis		2000
		Z-axis		1125
		W-axis	**deg/sec**	1200
X,Y Compounded Speed			**mm/sec**	2828
Repeatability		**X-axis**	**mm**	±0.01
		Y-axis		±0.01
		Z-axis		±0.01
		W-axis	**deg**	±0.03

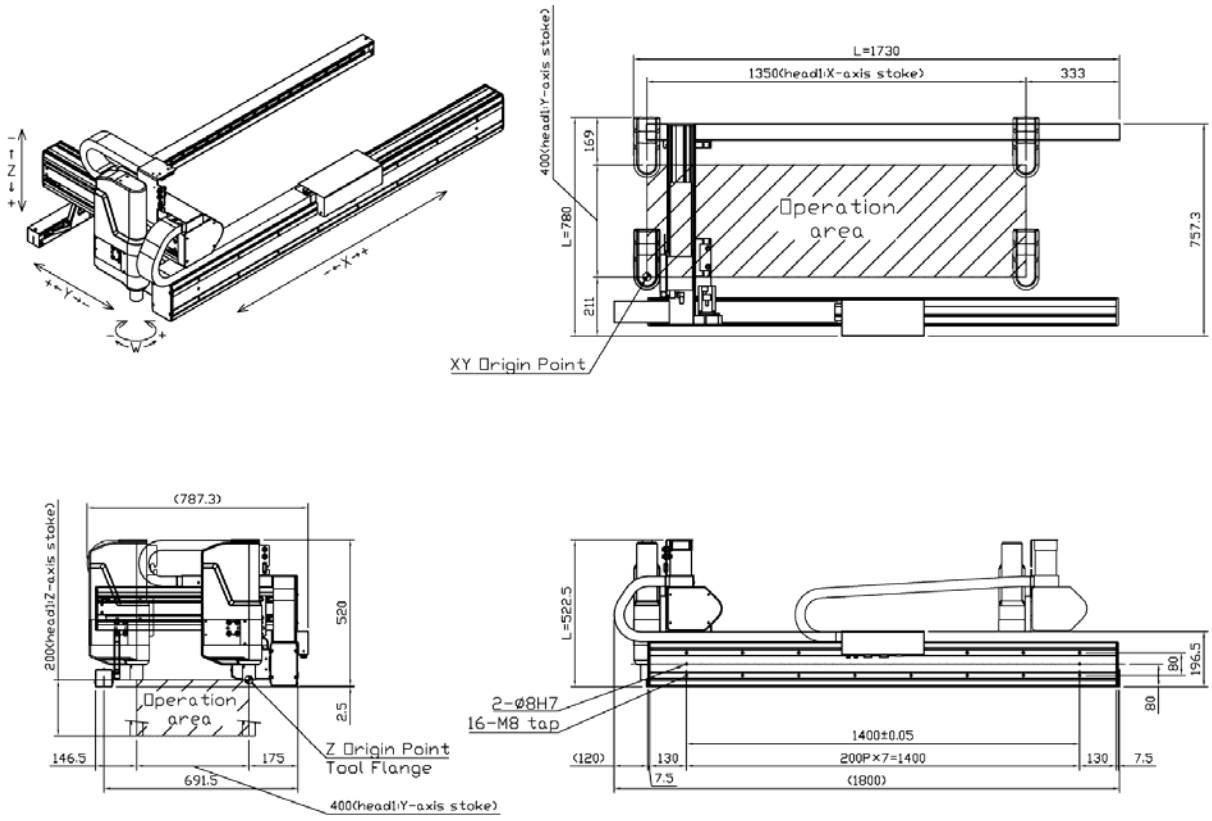


Figure 3.2 CRW-U1515-1350-400-200-S Dimensions

3.2.3 CRW-U1515-650-400-200-S Specification

Table 3.3 CRW-U1515-650-400-200-S Specification

Type			**Unit**	1 head Short with Support Axis
Axis combination				4 axes
Product Number	**Robot**			CRW-U1515-650-400-200-S
	controller			HNC-96B
	T-PEN(Option)			H-3332-4m/H-3332-8m/H-3332-15m (selectable)
Max. Payload			**kg**	10
Weight			**kg**	86
Stroke		**X-axis**	**mm**	650
		Y-axis		400
		Z-axis		200
		W-axis	**deg**	540
Motor Power		**X-axis**	**W**	750
		Y-axis		400
		Z-axis		200
		W-axis		100
Speed		**X-axis**	**mm/sec**	2000
		Y-axis		2000
		Z-axis		1125
		W-axis	**deg/sec**	1200
X,Y Compounded Speed			**mm/sec**	2828
Repeatability		**X-axis**	**mm**	±0.01
		Y-axis		±0.01
		Z-axis		±0.01
		W-axis	**deg**	±0.03

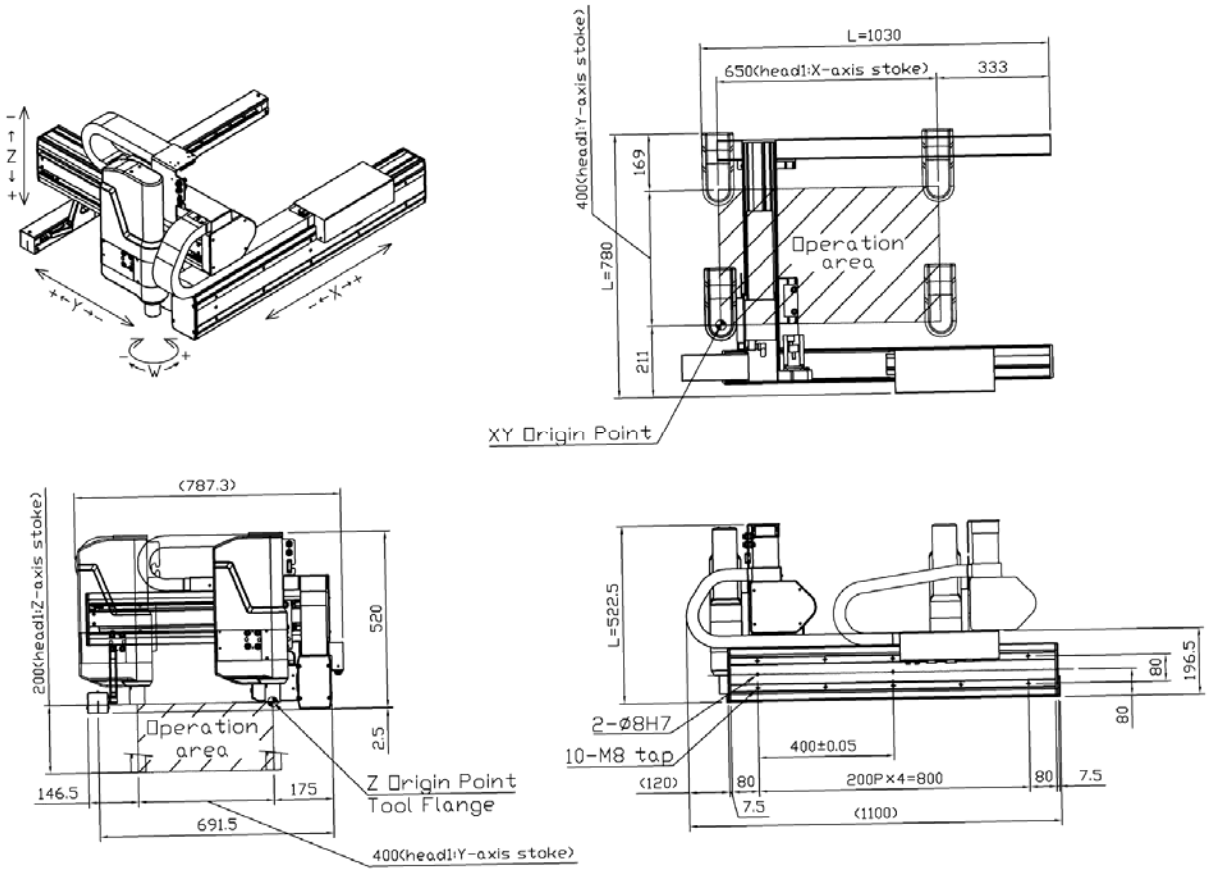


Figure 3.3 CRW-U1515-650-400-200-S Dimensions

3.2.4 CRW2-U1515-1100-400-200 Specification

Table 3.4 CRW2-U1515-1100-400-200 Specification

Type			**Unit**	2head long, cantilevered
Axis combination				8 axes
Product Number	**Robot**			CRW2-U1515-1100-400-200
	controller			HNC-96B
	T-PEN(Option)			H-3332-4m/H-3332-8m/H-3332-15m (selectable)
Max. Payload			**kg**	5
Weight			**kg**	150
Stroke		**X-axis**	**mm**	1100
		Y-axis		400
		Z-axis		200
		W-axis	**deg**	540
Motor Power		**X-axis**	**W**	750
		Y-axis		400
		Z-axis		200
		W-axis		100
Speed		**X-axis**	**mm/sec**	2000
		Y-axis		2000
		Z-axis		1125
		W-axis	**deg/sec**	1200
X,Y Compounded Speed			**mm/sec**	2828
Repeatability		**X-axis**	**mm**	±0.01
		Y-axis		±0.01
		Z-axis		±0.01
		W-axis	**deg**	±0.03

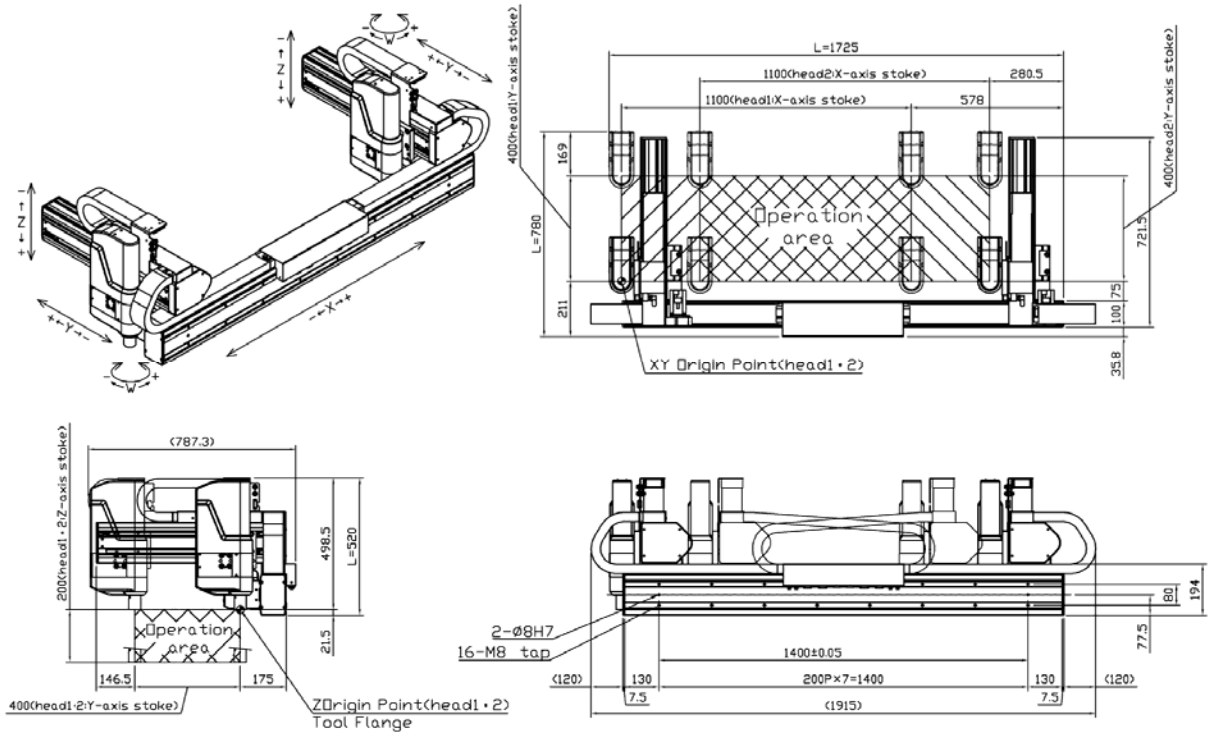


Figure 3.4 CRW2-U1515-1100-400-200 Dimensions

3.2.5 CRW-U1515-1350-400-200 Specification

Table 3.5 CRW-U1515-1350-400-200 Specification

Type			**Unit**	1head long, cantilevered
Axis combination				4 axes
Product Number	**Robot**			CRW-U1515-1350-400-200
	controller			HNC-96B
	T-PEN(Option)			H-3332-4m/H-3332-8m/H-3332-15m (selectable)
Max. Payload			**kg**	5
Weight			**kg**	90
Stroke		**X-axis**	**mm**	1350
		Y-axis		400
		Z-axis		200
		W-axis	**deg**	540
Motor Power		**X-axis**	**W**	750
		Y-axis		400
		Z-axis		200
		W-axis		100
Speed		**X-axis**	**mm/sec**	2000
		Y-axis		2000
		Z-axis		1125
		W-axis	**deg/sec**	1200
X,Y Compounded Speed			**mm/sec**	2828
Repeatability		**X-axis**	**mm**	±0.01
		Y-axis		±0.01
		Z-axis		±0.01
		W-axis	**deg**	±0.03

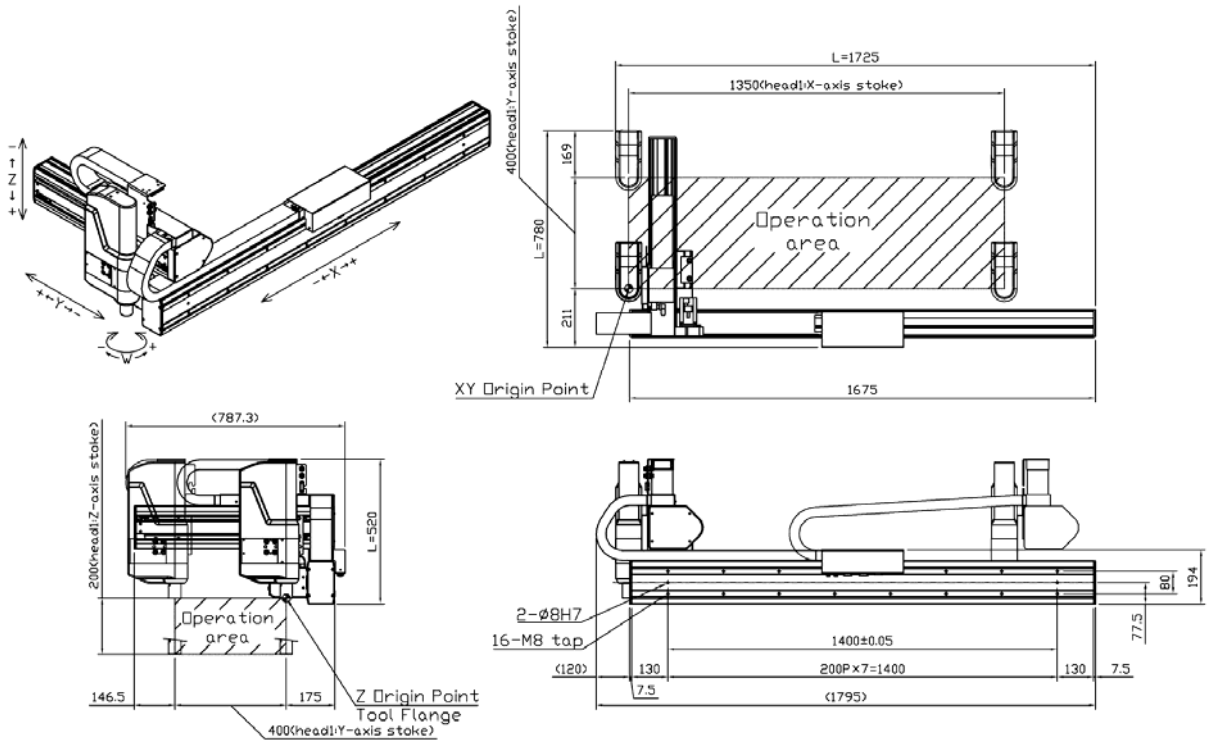


Figure 3.5 CRW-U1515-1350-400-200 Dimensions

3.2.6 CRW-U1515-650-400-200 Specification

Table 3.6 CRW-U1515-650-400-200 Specification

Type			**Unit**	1head short, cantilevered
Axis combination				4 axes
Product Number	**Robot**			CRW-U1515-650-400-200
	controller			HNC-96B
	T-PEN(Option)			H-3332-4m/H-3332-8m/H-3332-15m (selectable)
Max. Payload			**kg**	5
Weight			**kg**	79
Stroke		**X-axis**	**mm**	650
		Y-axis		400
		Z-axis		200
		W-axis	**deg**	540
Motor Power		**X-axis**	**W**	750
		Y-axis		400
		Z-axis		200
		W-axis		100
Speed		**X-axis**	**mm/sec**	2000
		Y-axis		2000
		Z-axis		1125
		W-axis	**deg/sec**	1200
X,Y Compounded Speed			**mm/sec**	2828
Repeatability		**X-axis**	**mm**	±0.01
		Y-axis		±0.01
		Z-axis		±0.01
		W-axis	**deg**	±0.03

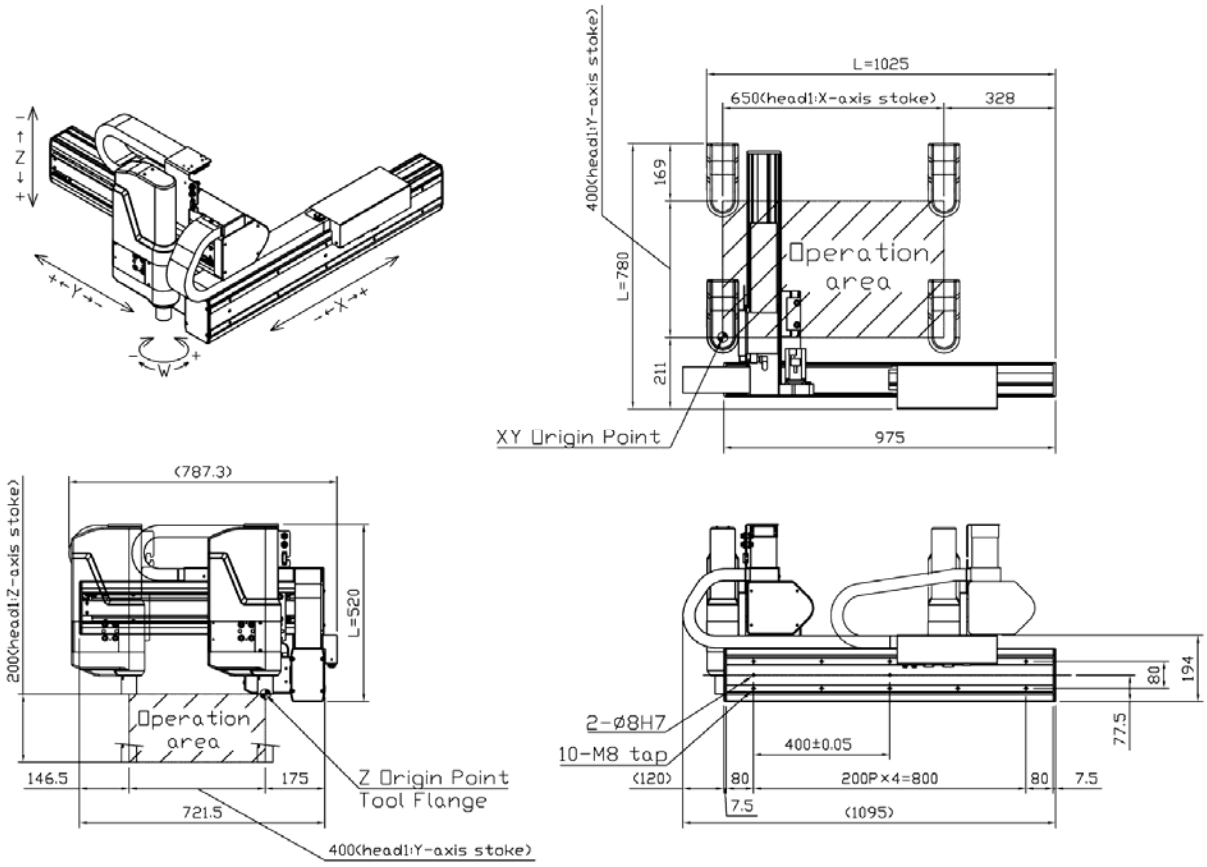


Figure 3.6 CRW-U1515-650-400-200 Dimensions

3.2.7 W-axis high inertia type (Option) Specification

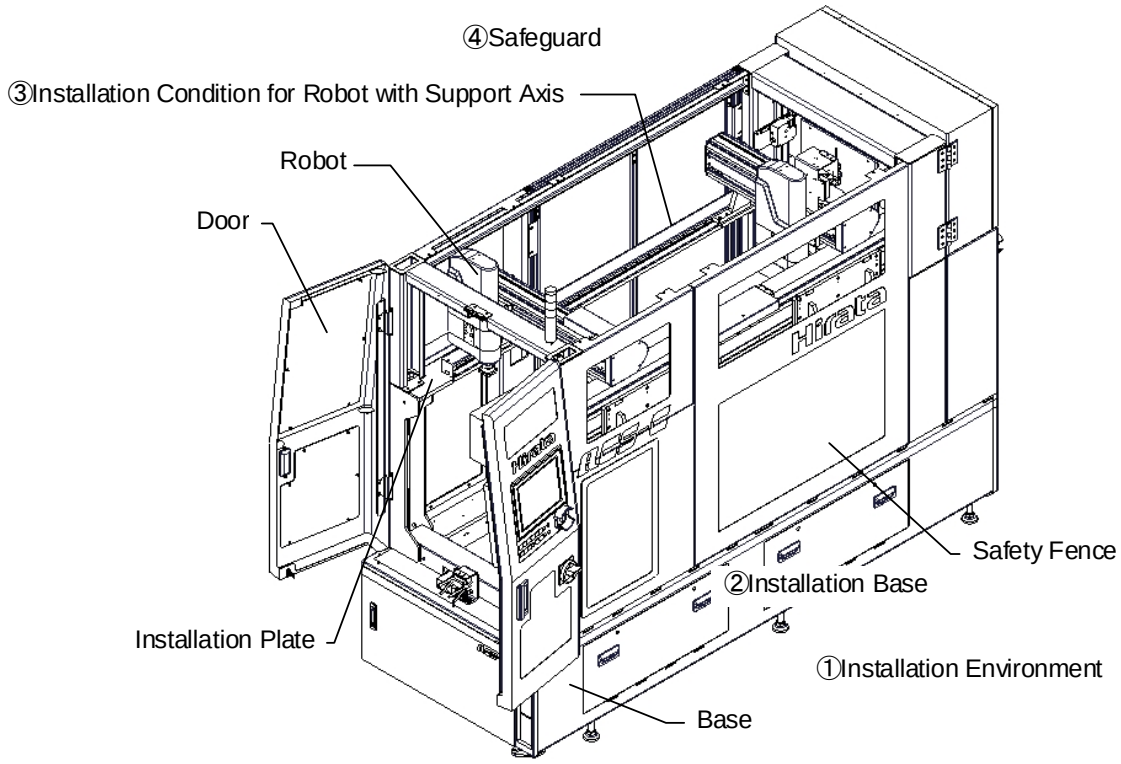
Table 3.7 W-axis high inertia type Specification

Type	Axis	Unit	high inertia
Stroke	W-axis	deg	540
Motor Power	W-axis	W	100
Speed	W-axis	deg/sec	540
Repeatability	W-axis	deg	±0.03

*It adjusts to all types.

CHAPTER 4 Installation

WARNING | Installation must be done by trained person.



4.1 Environmental and Facility Requirement

Table 4.1 Facility Ambient Air Quality

Check Item	Required Range
Storage Temperature	-15℃ to 55℃
Operational Temperature	0℃ to 40℃
Storage Humidity	35% to 85% (non-condensing)
Operational Humidity	45% to 85%(non-condensing)
Vibration during operation	0.3G or less

Avoid install where:

(1) Water, shower dust, oil mist may reach to the robot and controller.

(2) Near a heating element exists.

(3) Ignitable and corrosive gas exist.

(4) Near a vibration source exists.

(5) Near an electrical noise exists.

(6) No enough clearance for service and maintenance.

4.2 Installation Base

(1) Installation base should be rigid enough. Secure the base tightly with an anchor bolt to withstand the maximum force from the robot.

(2) Use the iron material base plate for the installation base. It should have over 10mm thickness, less than 0.05mm/500mm flatness and 6.3S roughness . The installation plate should support the entire undersurface of the robot.

(3) To install the robot to the installation plate, surely secure the robot with M8 bolt from the outside of the frame or with M6 bolt from the inside of the frame to the installation bracket*1.
*Use a bolt with the strength class 12.9.

(4) It is recommended not to have any peripheral to interfere with the robot.

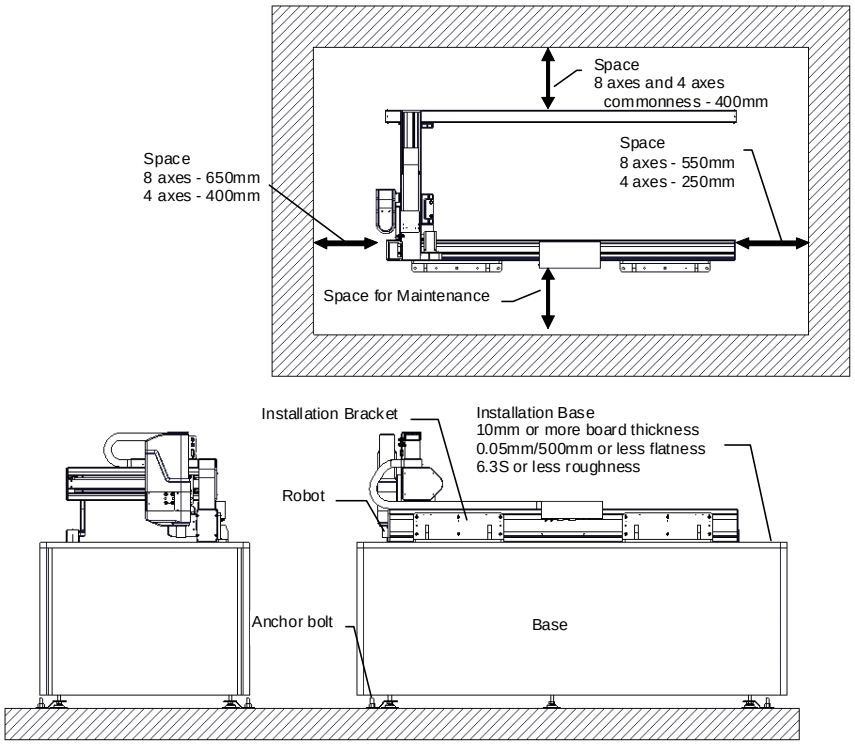


Figure 4.1 Installation Base

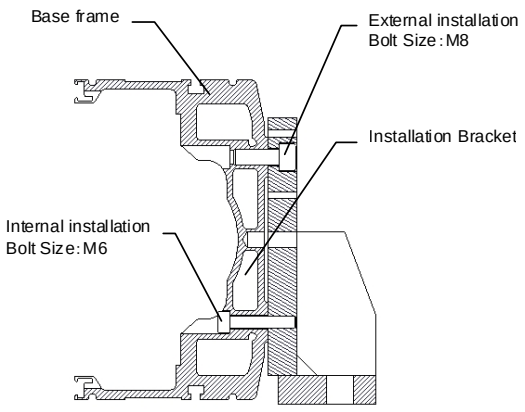


Figure 4.2 Robot fixation part*2

*1 The installation bracket should be provided by the user.
*2 Either installation method is possible, M8 bolt from the outside of the frame or M6 bolt from the inside of the frame.

Table 4.2 Recommended Tightening Torque (Base)

Item	Bolt Size	Tightening Torque
X-axis Internal tightening	M6	15.9N·m
X-axis External tightening	M8	38.6N·m

4.3 Installation Condition for the Robot with Support Axis

Install the robot as following figure if the robot has support axis. A bad parallelism makes motions heavy, resulting in an overload error, or contributes to the reduction of the lifetime of LM guide.

Table 4.3 Recommended Tightening Torque (Support Axis)

Item	Bolt Size	Tightening Torque
Support Axis	M5	9.37N·m

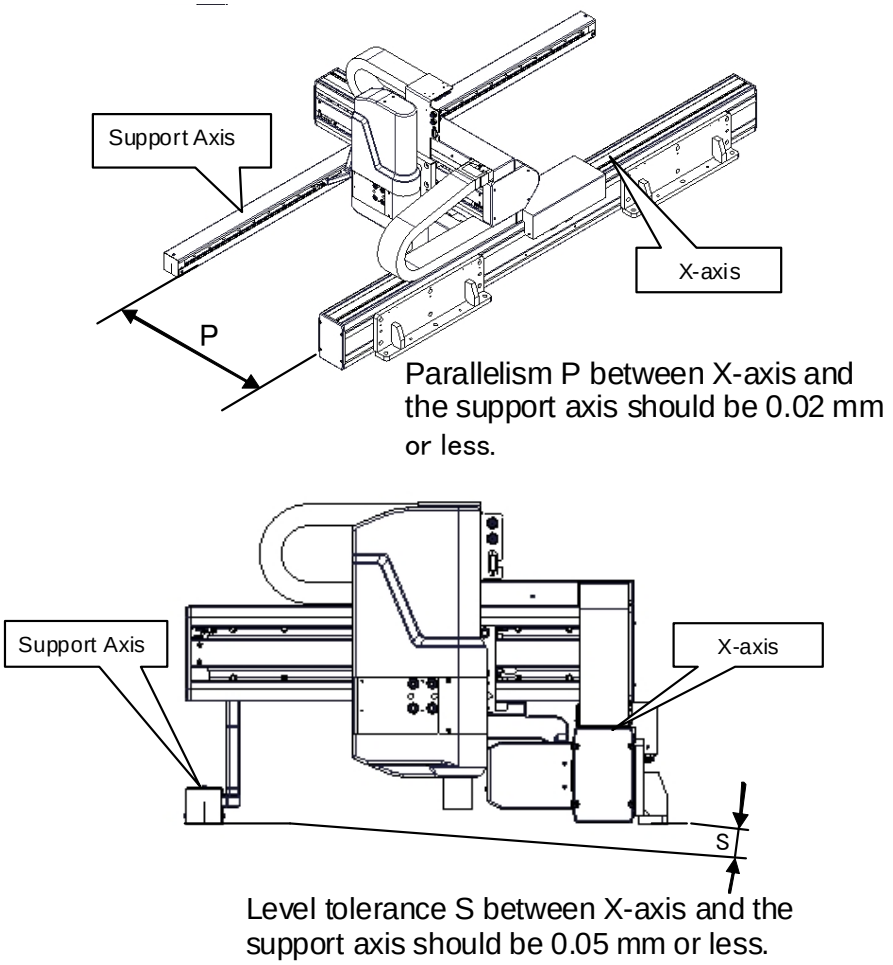


Figure 4.3 Installation Condition for the Robot with Support Axis

4.4 System Safeguard

WARNING

System safeguard should be prepared by system integrator. Unless having the device may result sever injury.

(1) System safeguard should be rigid enough to withstand the maximum force from the robot and to fit the environment. It should not be removed and got over easily.

(2) Safety fence should not have any sharp edges.

(3) Fixed type is recommended.

(4) Emergency Stop function should be incorporated in doors of a protective fence around the robot, stopping the robot when the doors are opened.

WARNING

System safeguard must have Emergency Stop function to stop the robot immediately in case of error.

(5) Emergency Stop(E.S) button should be located where operator can access easily and should be activated by minimum operation, such as pulling, pressing, touching and interrupting the light.

(6) E.S button also should be colored red to recognize easily. E.S function required that the robot should not be reset automatically other than the action to release the E.S status.

4.5 Other Important Notice

WARNING

- Do not modify the machine body and control unit arbitrarily.
- Excessive usage of robot ability cause a robot failure, or reduce the robot performance, reliability or lifetime.

CHAPTER 5 Maintenance

5.1 Precaution for Maintenance

(1) Turn OFF the power.

(2) Clearly identify that you are in working envelope when servicing.

(3) Avoid containment of any foreign object to robot mechanism when replacing the parts or reassembling.

(4) Unplug the power connector of the controller when servicing inside of controller.

(5) All parts should be met manufacture's specification. Especially, use same rating fuse. Using different rating fuse may damage the controller enclosure or cause of fire.

(6) Confirm no one is inside of the working envelope before operating the robot. Also, Initiate operation in slow speed, then back to normal speed after servicing.

5.2 Daily Maintenance

(1) Before stating robot operation

Check the following items

① Air pressure (if necessary)
② Air leakage (if necessary)
③ Visible damage on cables
④ Disconnection or looseness of the sensor connector

(2) During operation

① Any abnormal sound or vibration
② Connection for cable and piping.
③ Any position shift

(3) After operation

① Excessive motor heating
② Visible damage on cables and mechanism

5.3 Periodical Maintenance

To ensure full performance and longer lifetime, periodical maintenance is highly recommended. Check following items periodically.

Table 5.1 Check Items for Periodical Maintenance

Item	Check Point	Interval	Reference	Note
X-axis installation part Support Axis installation part	Tightening torque	6 months (1 week after the initial operation)	5.3.1	Tightening torque Support Axis - 8.0N･m Internal tightening - 6.8N･m External tightening– 16.5N･m
Base level	Flatness	6 months	5.3.2	Check with level gauge
LM guide	Seal	3 years	-	-
Ball screw	Grease lubrication	2 months	5.3.3	Suggested grease Multemp SRL3(KYODO YUSHI)
Z-axis ball spline	Grease lubrication	2 months	5.3.3	Injection amount=proper amount Suggested grease Multemp SRL3(KYODO YUSHI)
Timing belt	Belt tension	3 months	5.3.4	Refer to later section

Following table describes grease is used for W-axis bearing and reduction gear. Normally, grease lubrication for the reduction gear is not necessary after factory shipment because of less quality change or grease reduction.

Table 5.2 Grease for W-Axis Reduction Gear

Item	Grease/Manufacturer
Bearing (Cross roller bearing)	SK-2 / Harmonic Drive Systems
Reduction gear (Harmonic drive)	SK-2 / Harmonic Drive Systems

5.3.1 Installation Bolt for X-axis and Support Axis(LM guide)

X-axis can be installed to the base by securing with M8 bolt from the outside or with M6 bolt from the inside. For the support axis, attach LM guide to the base directly. For sure fixation of X-axis and the support axis, it is recommended to use all the mounting holes.

Looseness of the installation bolt caused position shift. Therefore, re-tighten the bolt semiannually following procedure below.

- Required Tool

  Torque wrench

- Procedure

  Using a torque wrench, additionally tighten the installation bolts for X-axis and the support axis to the specified torques.

Table 5.3 Recommended Tightening Torque

Item	Bolt Size	Tightening Torque
Support Axis	M5	9.37N·m
X-axis Internal tightening	M6	15.9N·m
X-axis External tightening	M8	38.6N·m

- Required Time

  With Support Axis 40 minutes

  Without Support Axis 10 minutes


CAUTION

Re-tighten the installation bolt one week after the initial operation.

5.3.2 Robot Base Level

Check the robot base level one week after the initial operation and every 6 months thereafter. If the base level is not satisfied flatness causes degrade robot performance.

5.3.3 Lubrication

Lithium soap based grease, Multemp SRL3 grease, is used for ball screw and ball screw spline. Because these bearing and ball screw roll and slide, proper lubrication is required to maintain smooth operation and longer lifetime. Lack of lubrication causes abnormal friction and noise. Or, excessive lubrication may damage the motor and dirt the robot and work-piece.

5.3.3.1 X-axis Ball Screw

- Grease

  Multemp SRL3 (KYODO YUSHI)

- Required Tool

  Cross head driver
  Brush

- Procedure

  ① Turn OFF the power.
  ② Detach (A) End cover by removing (B)M4×8L screw (4pcs.)
  ③ Detach (C) Center cover by removing (D)M4×8L hex. socket head cap screw (4pcs.)
  ④ Brush some grease on the orbital plane of the ball of the ball screw shaft directly.
  ⑤ Move the slider to spread the grease to the entire shaft.
  ⑥ Repeat the steps from ④ to ⑤ for three times and wipe off the extra grease on the ball screw nut.
  ⑦ Attach all covers in reversed sequence.

- Required Time

  7.5 minutes

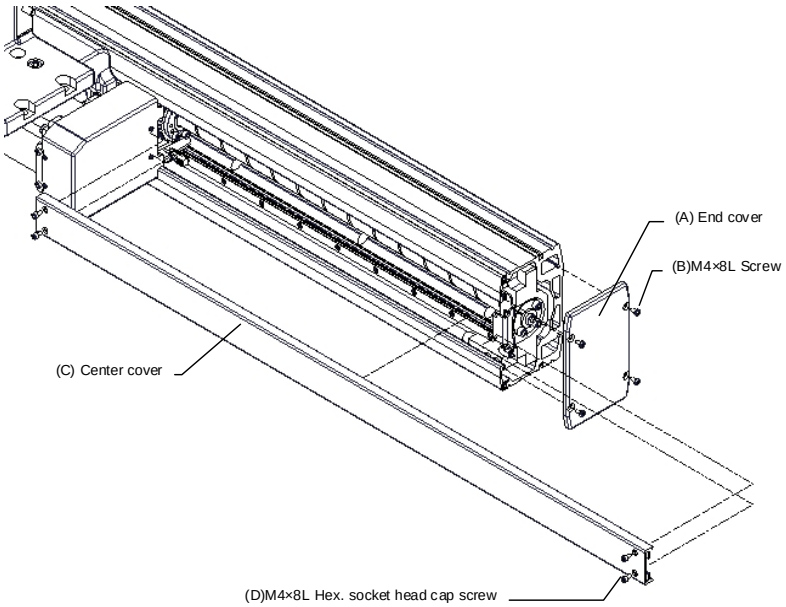


Figure 5.1 Grease Lubrication for X-axis Ball Screw

5.3.3.2 Y-axis Ball Screw

- Grease

  Multemp SRL3 (KYODO YUSHI)

- Required Tool

  Cross head driver
  Brush

- Procedure

  ① Turn OFF the power.
  ② Detach (A) End cover by removing (B)M4×8L screw (4pcs.)
  ③ Detach (C) Center cover by removing (D)M4×8L hex. socket head cap screw (4pcs.)
  ④ Brush some grease on the orbital plane of the ball of the ball screw shaft directly.
  ⑤ Move the slider to spread the grease to the entire shaft.
  ⑥ Repeat the steps from ④ to ⑤ for three times and wipe off the extra grease on the ball screw nut.
  ⑦ Attach all covers in reversed sequence.

- Required Time

  7 minutes

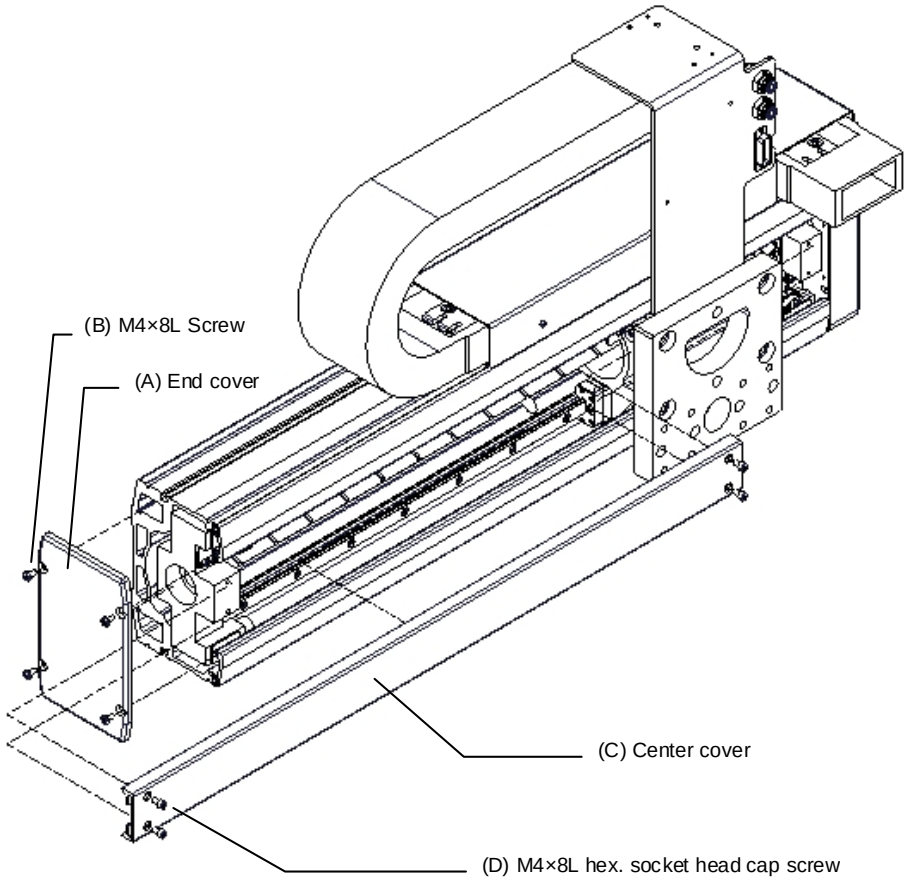


Figure 5.2 Grease Lubrication for Y-axis Ball Screw

5.3.3.3 Z-Axis Ball Screw Spline

Generally, nut rolls and slides on the long stroke screw axis. Check and lubricate the grease every two months. Lack of grease causes abnormal friction and noise.

- Grease

  Multemp SRL3 (KYODO YUSHI)

- Required Tool
  Cross head driver
  Brush

- Procedure
  ① Move Z-axis to the lower end.
  ② Turn OFF the power.
  ③ Brush some grease on the orbital plane of the ball of the ball screw spline directly.
  ④ Turn ON the power on the controller.Then, move Z-axis to the upper end.
  ⑤ Turn OFF the power again.
  ⑥ You can see the ball screw spline. Brush some grease on it directly.
  ⑦ Turn ON the power again.Then, move Z-axis up and down to spread the grease manually.
  ⑧ Repeat the steps from ⑥ to ⑦ for three times and wipe off the extra grease on the ball screw nut.

- Required Time

  5 minutes

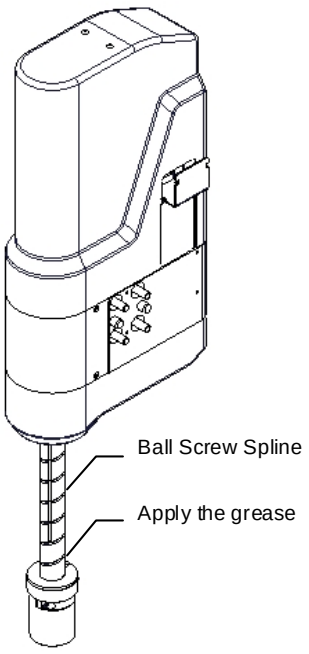


Figure 5.3 Grease Lubrication for Z-Axis Ball Screw Spline

5.3.4 Timing Belt Tension

The timing belt tension is adjusted at the factory shipment. However, the tension becomes low as environment and time passes. In case of short or excessive tension causes noise, poor repeatability, lack of start-up torque, or belt break. Also, if the belt is damaged, replace it immediately.
Tense the tension properly referring table below.

Table 5.4 Timing Belt Tension

Axis	Tension (N)	Belt Width (mm)	Span length (mm)	Unit Weight (g/m)
X-axis	232±10% N	25	126	4.0
Y-axis	98±10% N	12	96	4.0
Z-axis	59±10% N	12	116	2.5
W-axis	125±10% N	20	112.5	4.0
W-axis (High inertia type)	125±10% N	20	110.5	4.0

NOTE

Robot position is drift if the timing belt slip. For quick adjustment, it is recommended to mark original positions of the pulley and belt prior to adjust the timing belt.

5.3.4.1 X-axis Timing Belt

- Required Tool

  Cross head driver
  Hex. wrench (Size 5 mm, 3 mm)
  Spanner (Size 7 mm)
  Sonic tension meter(recommended type : U-507 : Gates Unitta)

- Procedure

  ① Turn OFF the power.
  ② Detach (A) Belt cover by removing (B)M3×6L screw (4pcs.)
  ③ Loosen (C)M6×10L hex. socket head cap screw (4pcs.)
  ④ Adjust the timing belt tension by rotating (D)M4 nut and (E)M4×25L hex. socket head cap screw (2pcs.)
  ⑤ Tighten (C)M6×10L hex. socket head cap screw (4pcs.) (Tightening torque : 16N･m)
  ⑥ Assemble in reversed sequence.
  ⑦ Turn ON the power and A-CAL should be performed. (Refer to "Chapter 7 A-CAL method")

- Required Time

  15 minutes

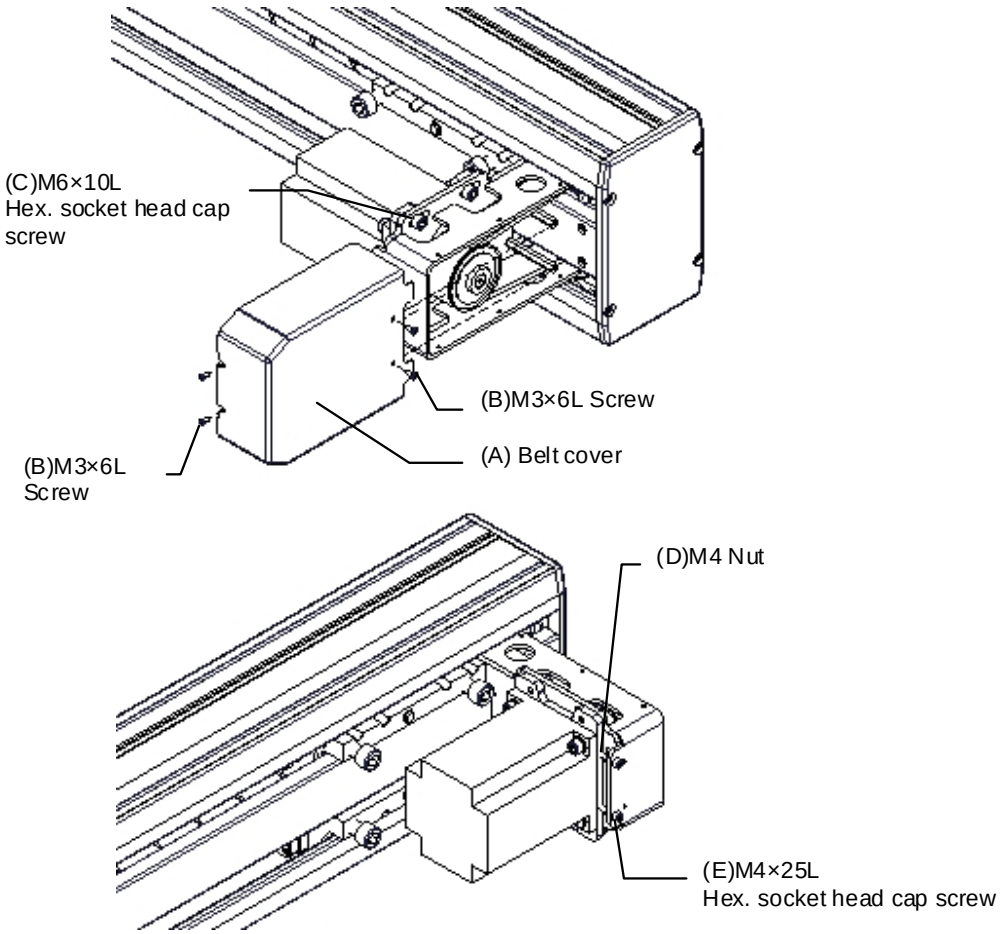


Figure 5.4 X-axis Timing Belt

5.3.4.2 Y-axis Timing Belt

- Required Tool

  Cross head driver
  Hex. wrench (Size 5 mm, 3 mm)
  Spanner (Size 7 mm)
  Sonic tension meter(recommended type : U-507 : Gates Unitta)

- Procedure

  ① Turn OFF the power.
  ② Detach (A) Belt cover by removing (B)M3× 6 L screw (4pcs.)
  ③ Loosen (C)M6×10L hex. socket head cap screw (4pcs.)
  ④ Adjust the timing belt tension by rotating (D)M4 nut and (E)M4×18L hex. socket head cap screw (2pcs.)
  ⑤ Tighten (C)M6×10L hex. socket head cap screw (4pcs.) (Tightening torque : 16N・m)
  ⑥ Assemble in reversed sequence.
  ⑦ Turn ON the power and A-CAL should be performed. (Refer to "Chapter 7 A-CAL method")

- Required Time

  15 minutes

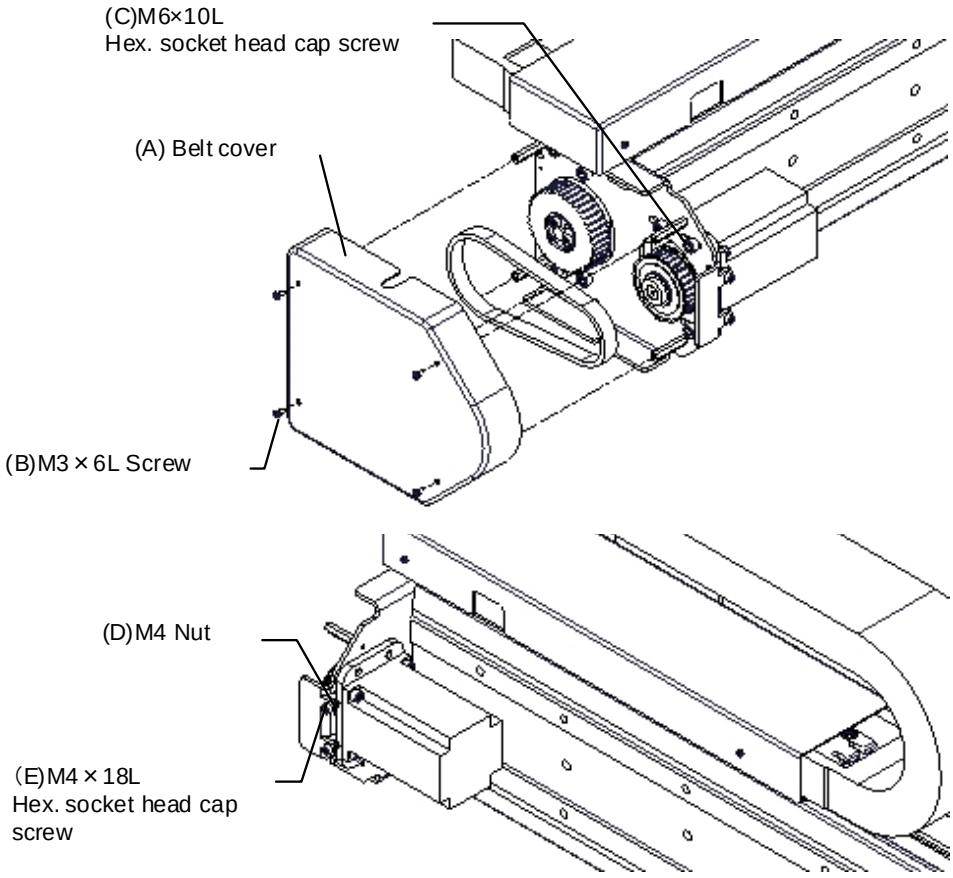


Figure 5.5 Y-axis Timing Belt

5.3.4.3 Z-axis Timing Belt

- Required Tool

  Cross head driver
  Hex. wrench (Size 5 mm, 3 mm)
  Spanner (Size 7 mm)
  Sonic tension meter(recommended type : U-507 : Gates Unitta)

- Procedure

  ① Turn OFF the power.
  ② Detach (A) Under cover by removing (B)M3×6L screw (2pcs.)
  ③ Loosen (C)M4×30L hex. socket head cap screw (4pcs.)
  ④ Adjust the timing belt tension by rotating (D)M4 nut and (E)M4×30L hex. bolt.
  ⑤ Tighten (C)M4×30L hex. socket head cap screw (4pcs.) (Tightening torque : 4.6N･m)
  ⑥ Assemble in reversed sequence.
  ⑦ Turn ON the power and A-CAL should be performed. (Refer to "Chapter 7 A-CAL method")

- Required Time

  15 minutes

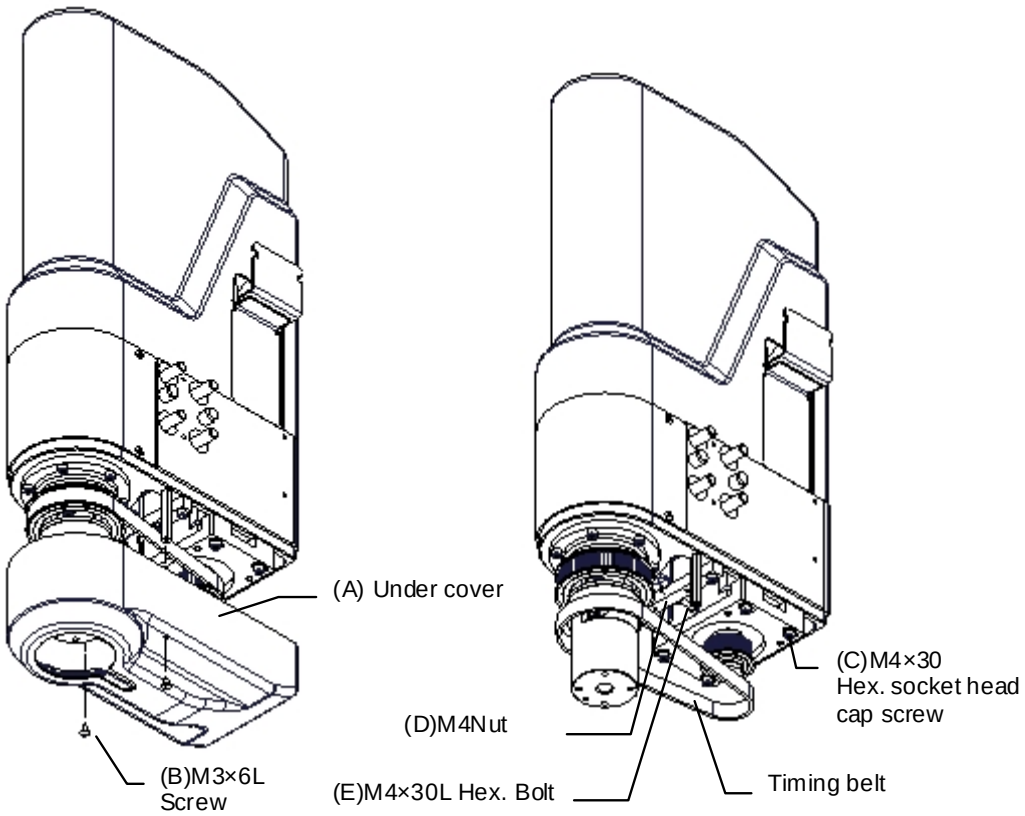


Figure 5.6 Z-axis Timing Belt

5.3.4.4 W-axis Timing Belt

- Required Tool

  Cross head driver
  Hex. wrench (Size 5 mm, 3 mm)
  Spanner (Size 7 mm)
  Sonic tension meter(recommended type : U-507 : Gates Unitta)

- Procedure

  ① Turn OFF the power.
  ② Detach (A) Top cover by removing (B)M3×6L screw (2pcs.)
  ③ Detach (C) Wiring cover by removing (D)M4×10L hex. socket head bolt (2pcs.)
  Cut off the fixed part of wiring if necessary and detach (C) Wiring cover.
  ④ Loosen (E)M4×25L hex. socket head cap screw (2pcs.) and (H)M4×15L hex. socket head cap screw (2pcs.)
  ⑤ Adjust the timing belt tension by rotating (G)M4 nut and (F)M4×25L hex. bolt (2pcs.)
  ⑥ Tighten (E)M4×25L hex. socket head cap screw (2pcs.) (Tightening torque : 4.6N･m)
  ⑦ Assemble in reversed sequence.
  ⑧ Turn ON the power and A-CAL should be performed. (Refer to "Chapter 7 A-CAL method")

- Required Time

  20 minutes

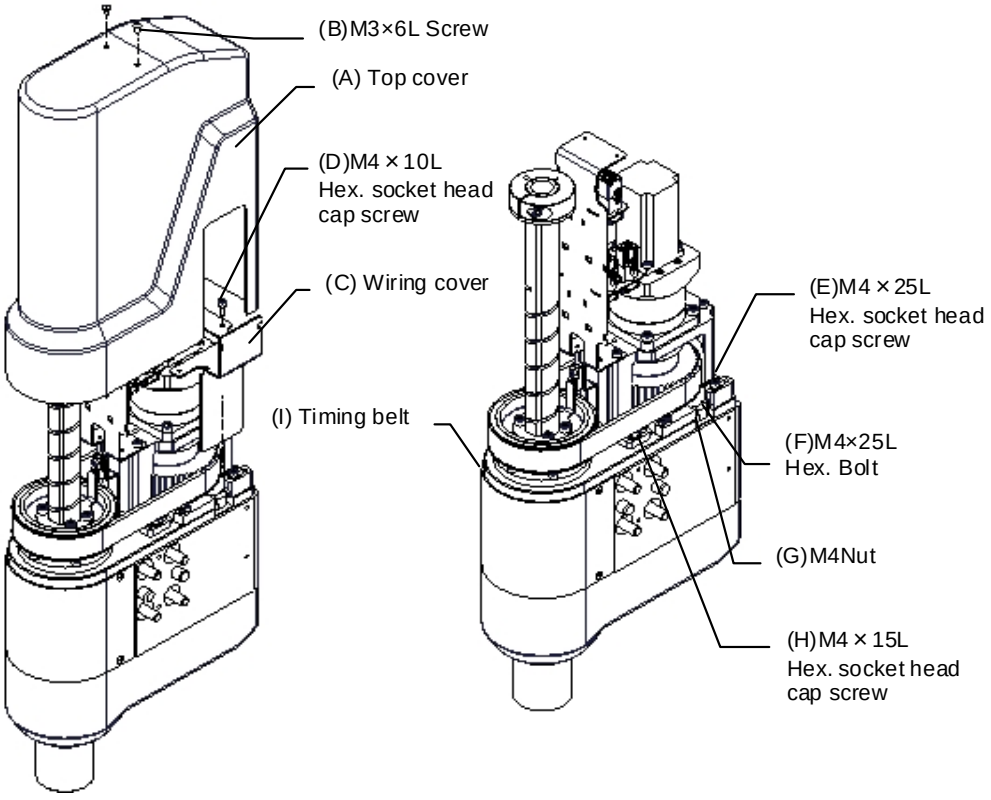


Figure 5.7 W-axis Timing Belt

CHAPTER 6 Adjustment and Replacement

6.1 Sensor Replacement

CAUTION

- Turn OFF the power before replacement.
- Fixing the screw excessively may damage the sensor. Take particular care for the adjustment.

6.1.1 X-axis Sensor Replacement * Option

- Required Item

  Cross head driver
  Hex. wrench (Size 3 mm, 2.5 mm)
  Torque wrench (Size 2.5 mm)
  Sensor (E2S-W26 : Hirata A059-H01-131A)* Option

- Procedure

  ① Turn OFF the power.
  ② Detach (A) Career cover by removing (B)M3×6L screw (4pcs.)
  ③ Detach (C) Connector of the sensor which is connected inside the carrier base.
  ④ Detach (D) End cover by removing (E)M4×8L screw (4pcs.)
  ⑤ Detach (F) Center cover by removing (G)M4×8L hex. socket head cap screw (4pcs.)
  ⑥ Detach (H) Sensor by removing (J)M3×8L hex. socket head cap screw.
  ⑦ Attach new sensor by tightening (J)M3×8L hex. socket head cap screw (Tightening torque : 0.7N·m)
  *Sensor gap=1mm
  ⑧ Assemble (C)Connector and covers in reversed sequence.

- Required Time

  10 minutes

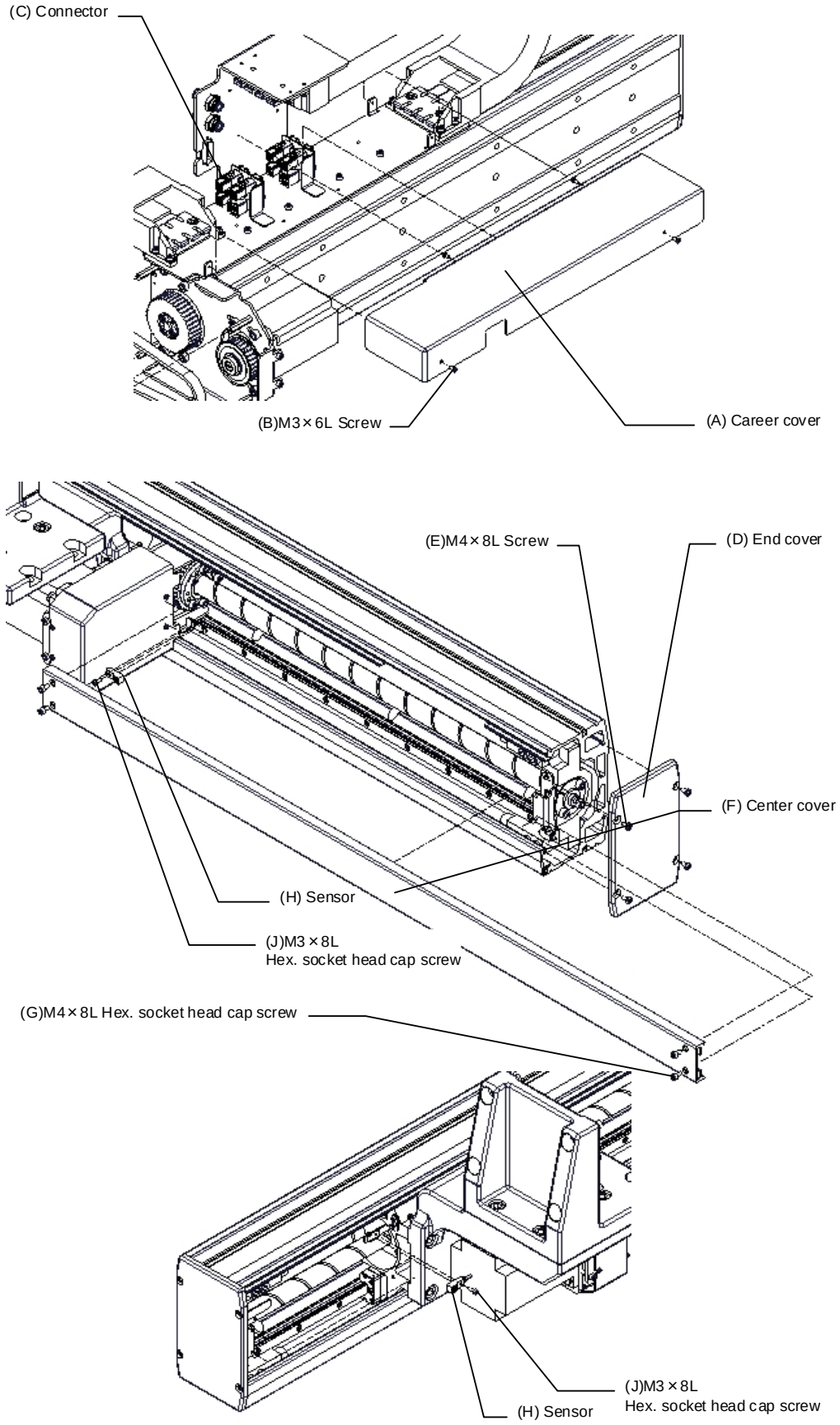


Figure 6.1 X-axis Sensor Replacement

6.1.2 Y-axis Sensor Replacement * Option

- Required Item

  Cross head driver
  Hex. wrench (Size 3 mm, 2.5 mm)
  Torque wrench (Size 2.5 mm)
  Sensor (E2S-W26 : Hirata A059-H01-131A)* Option

- Procedure

  ① Turn OFF the power.
  ② Detach (A) Career cover by removing (B)M3×6L screw (4pcs.)
  ③ Detach (C) Connector of the sensor which is connected inside the carrier base.
  ④ Detach (D) End cover by removing (E)M4×8L screw (4pcs.)
  ⑤ Detach (F) Center cover by removing (G)M4×8L hex. socket head cap screw (4pcs.)
  ⑥ Detach (H) Sensor by removing (J)M3×8L hex. socket head cap screw.
  ⑦ Attach new sensor by tightening (J)M3×8L hex. socket head cap screw (Tightening torque : 0.7N·m)
  *Sensor gap=1mm
  ⑧ Assemble (C)Connector and covers in reversed sequence.

- Required Time

  10 minutes

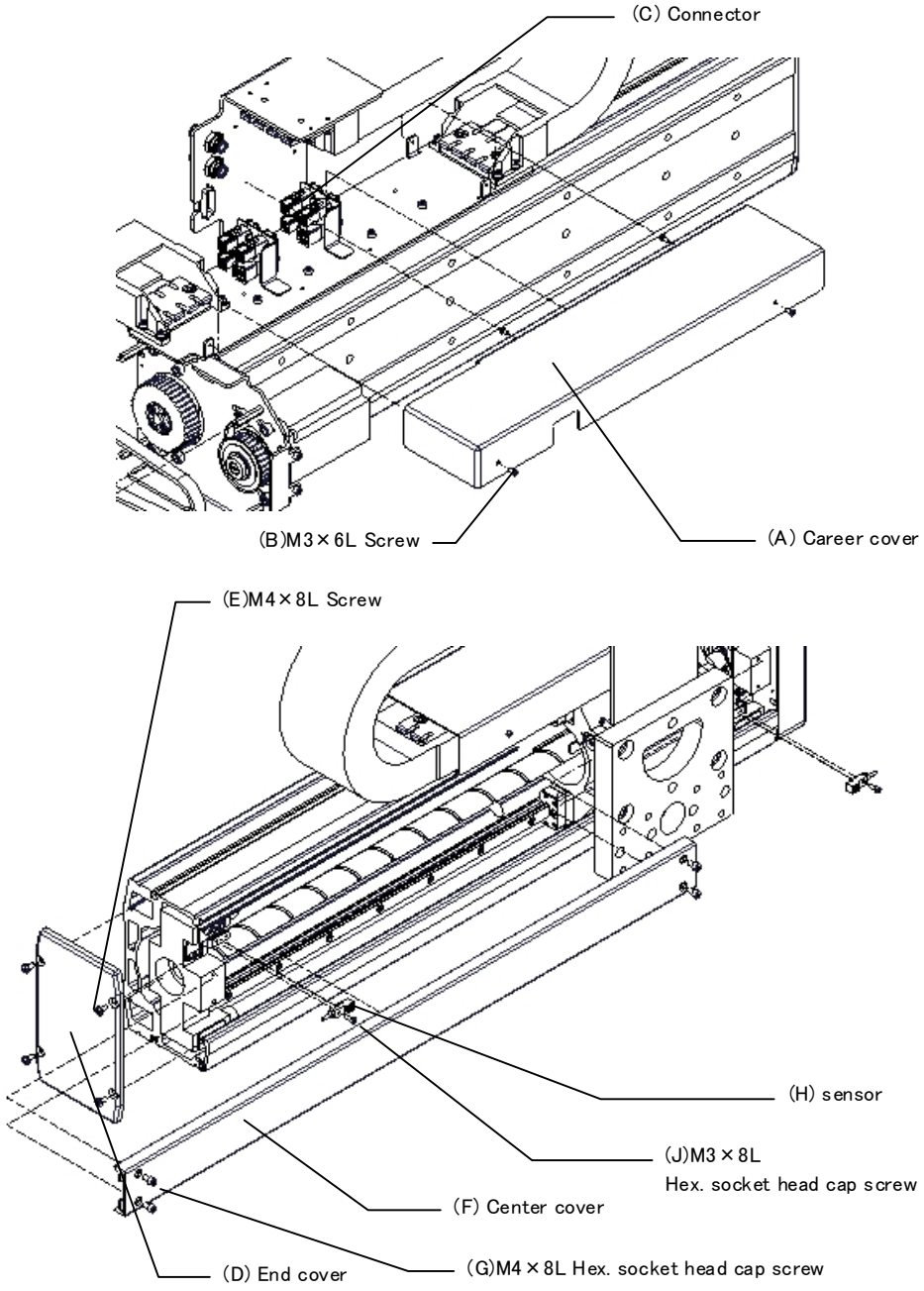


Figure 6.2 Y-axis Sensor Replacement

6.1.3 Z-axis Sensor Replacement

Connect the sensor same as old connection.

- Required Item

  Cross head driver
  Hex. wrench (Size 2.5 mm)
  Torque wrench (Size 2.5 mm)
  Sensor (E2S-Q26 : Hirata A059-H01-111)

- Procedure

  ① Turn OFF the power.
  ② Detach (A) Top cover by removing (B)M3× 6 L screw (2pcs.)
  ③ Disconnect the defective sensor (C)Connector.
  ④ Detach (D) Under cover by removing (E)M3×6L screw (2pcs.)
  ⑤ Detach the defective sensor with (F) Sensor bracket by removing (G)M3×8L hex. socket head cap screw (2pcs.)
  ⑥ Detach (H) Sensor by removing (J)M3×8L hex. socket head cap screw.
  ⑦ Attach new sensor by tightening (J)M3×8L hex. socket head cap screw (Tightening torque : 0.7N･m)
  *Sensor gap=1mm
  ⑧ Assemble (C)Connector and covers in reversed sequence.
  ⑨ Turn ON the power and A-CAL should be performed. (Refer to "Chapter 7 A-CAL method")

- Required Time

  10 minutes

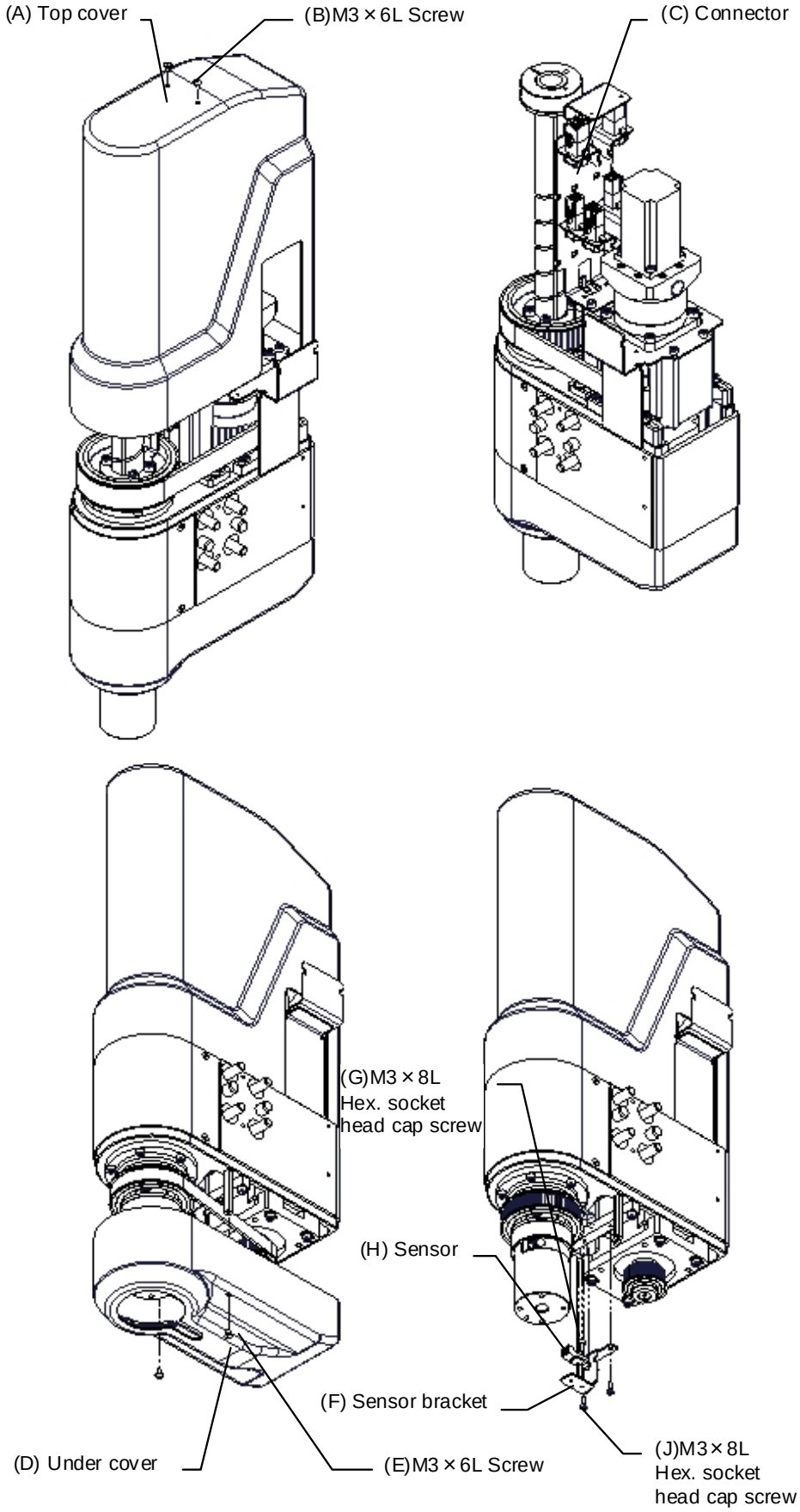


Figure 6.3 Z-axis Sensor Replacement

6.1.4 W-axis Sensor Replacement

Connect the sensor same as old connection.

- Required Item

  Cross head driver
  Hex. wrench (Size 2.5 mm)
  Torque wrench (Size 2.5 mm)
  Sensor (E2S-W26 : Hirata A059-H01-112)

- Procedure

  ① Turn OFF the power.
  ② Detach (A) Top cover by removing (B)M3× 6 L screw (2pcs.)
  ③ Disconnect the defective sensor (C)Connector.
  ④ Detach the defective sensor with (D) Sensor bracket by removing (E)M3×8L hex. socket head cap screw (2pcs.)
  ⑤ Detach (F) Sensor by removing (G)M3×8L hex. socket head cap screw.
  ⑥ Attach new sensor by tightening (G)M3×8L hex. socket head cap screw (Tightening torque : 0.7N･m)
  *Sensor gap=1mm
  ⑦ Assemble (C)Connector and (A) Top cover in reversed sequence.
  ⑧ Turn ON the power and A-CAL should be performed. (Refer to "Chapter 7 A-CAL method")

- Required Time

  10 minutes

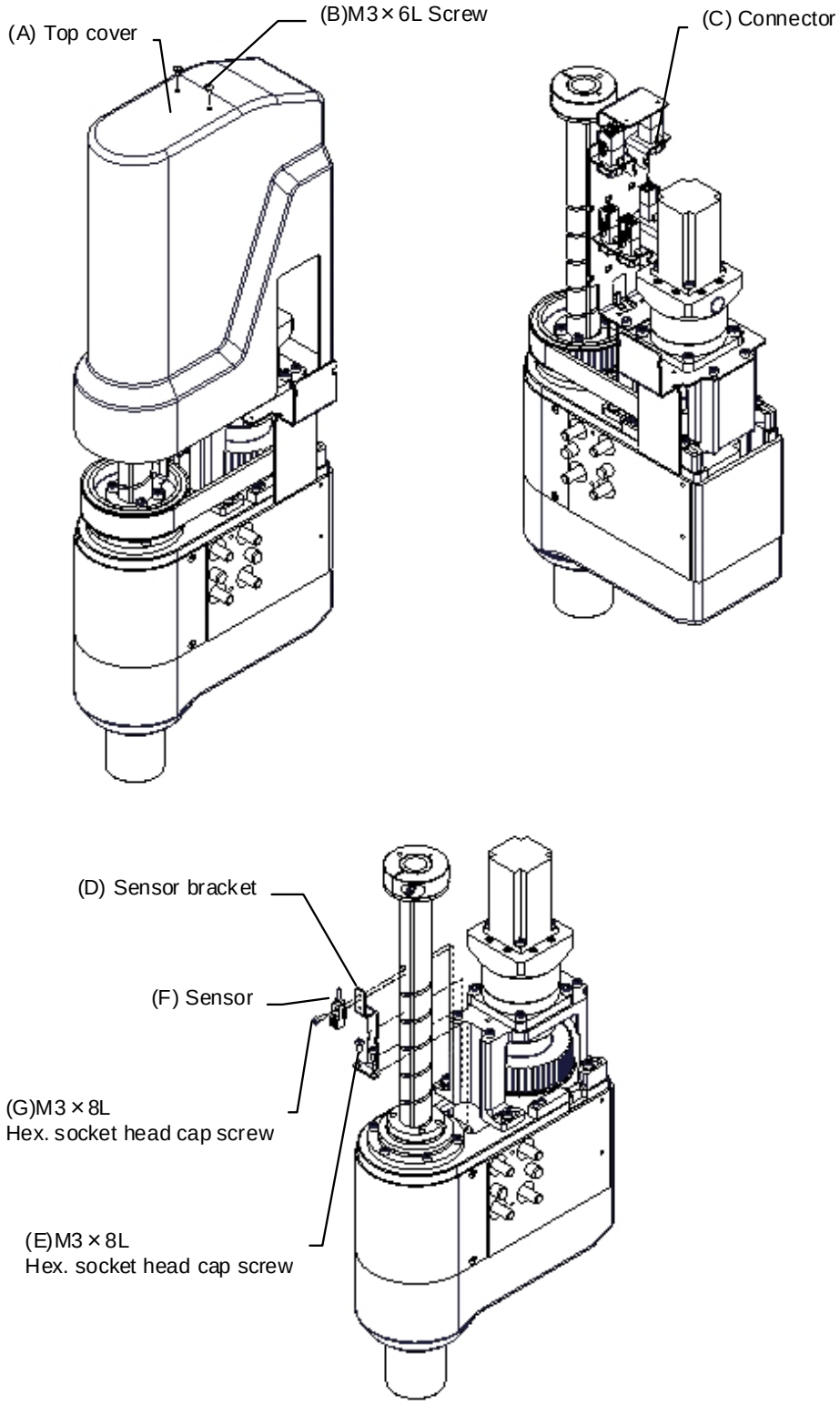


Figure 6.4 W-axis Sensor Replacement

6.2 Timing belt Replacement

6.2.1 X-axis Timing belt Replacement

WARNING | Turn OFF the main power before replacement.

- Required Item

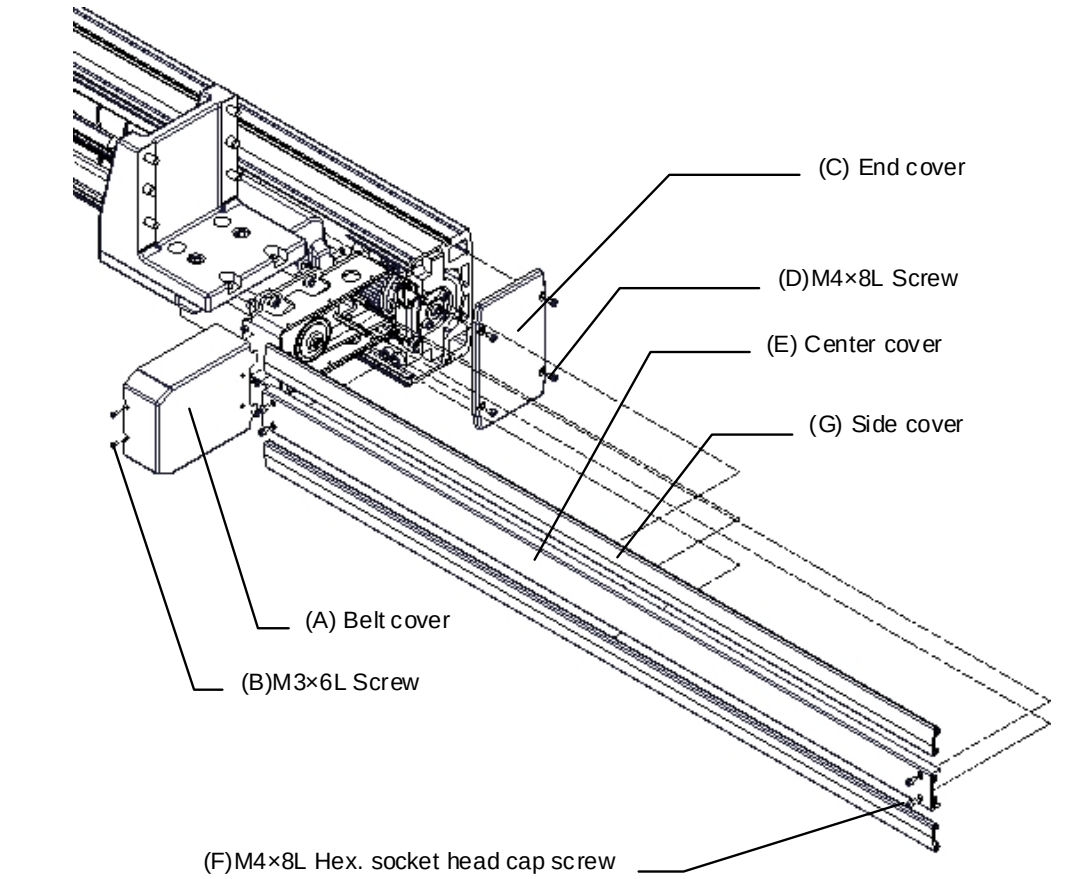
  Cross head driver
  Hex. wrench (Size 6 mm, 5 mm, 2.5 mm)
  Spanner (Size 7 mm)
  Timing belt (430-EV5GT-25 : Gates Unitta)
  Sonic tension meter (recommended type : U-507 : Gates Unitta)

- Procedure

  ① Turn OFF the power.
  ② Detach (A) Belt cover by removing (B)M3×6L screw (4pcs.)
  ③ Detach (C) End cover by removing (D)M4×8L screw (4pcs.)
  ④ Detach (E) Center cover by removing (F)M4×8L hex. socket head cap screw (4pcs.)
  ⑤ Detach (G) Side cover.
  ⑥ Detach (H) Center cover bracket by removing (J)M4×8 L hex. plates with bolt holes (2pcs.)
  ⑦ Detach (K) Shaft plate by removing (L)M8×20L hex. socket head cap screw.
  ⑧ Detach (M) Set collar by removing (N)M6×22L hex. socket head cap screw (3pcs.)
  ⑨ Detach (P) Stopper bracket by removing (Q)M8×60L hex. socket head cap screw (4pcs.) and (R) Plate nut (2pcs.)
  ⑩ Loosen (S)M6×10L hex. socket head cap screw (4pcs.)
  ⑪ Loosen (T)M4 nut and (U)M4×25L hex. socket head cap screw.
  ⑫ Detach (V) Timing belt and replace it with a new one.
  ⑬ Adjust the timing belt tension by rotating (T)M4 nut and (U)M4×25L hex. socket head cap screw. (Refer to "Table 5.4 Timing Belt Tension")
  ⑭ Tighten (S)M6×10L hex. socket head cap screw (4pcs.) (Tightening torque : 4.6N・m)
  ⑮ Assemble (M) Set collar, (K) Shaft plate, brackets, and covers in reversed sequence.
  ⑯ Turn ON the power and A-CAL should be performed. (Refer to "Chapter 7 A-CAL method".)

- Required Time

  60 minutes



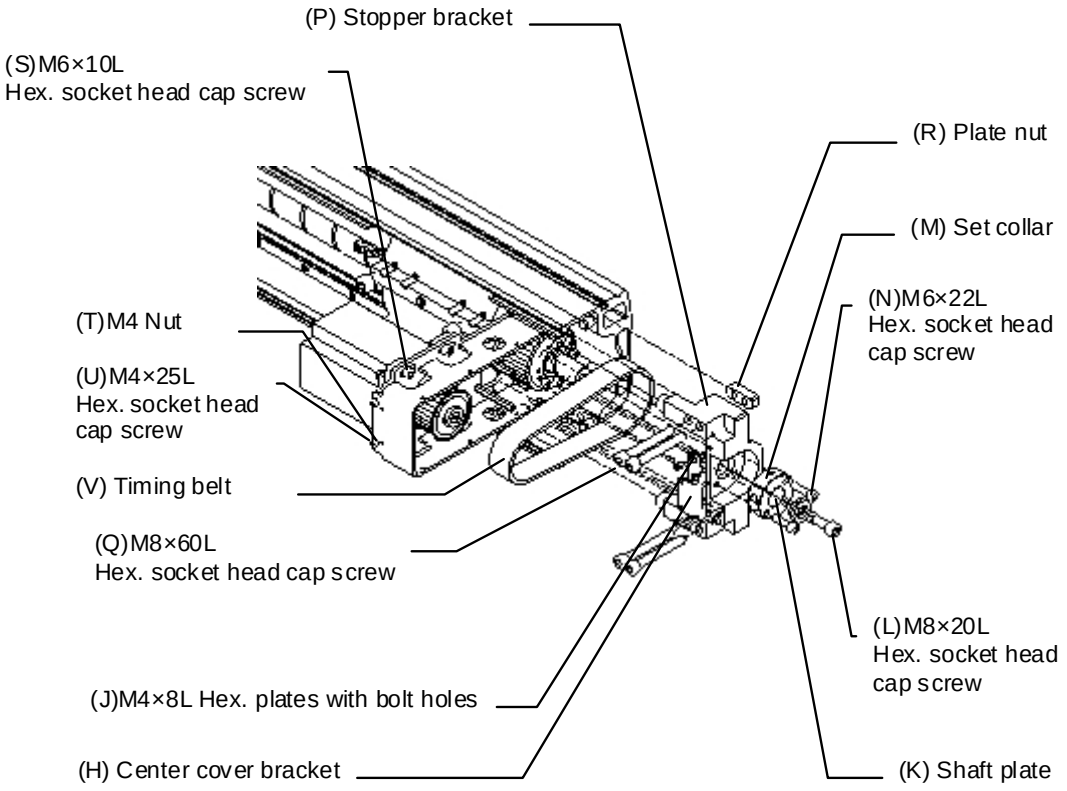


Figure 6.5 X-axis Timing belt Replacement

6.2.2 Y-axis Timing belt Replacement

WARNING | Turn OFF the main power before replacement.

- Required Item

  Cross head driver
  Hex. wrench (Size 5 mm, 4 mm, 3 mm)
  Spanner (Size 7 mm)
  Timing belt (370-EV5GT-12 : Gates Unitta)
  Sonic tension meter (recommended type : U-507 : Gates Unitta)

- Procedure

  ① Turn OFF the power.
  ② Detach (A) Belt cover by removing (B)M3×6L screw (4pcs.)
  ③ Loosen (C)M6×10L hex. socket head cap screw (4pcs.)
  ④ Loosen (D)M4 nut and (E)M4×18L hex. socket head cap screw.
  ⑤ Detach (F) Timing belt and replace it with a new one.
  ⑥ Adjust the timing belt tension by rotating (D)M4 nut and (E)M4×18L hex. socket head cap screw. (Refer to "Table 5.4 Timing Belt Tension")
  ⑦ Tighten (C)M6×10L hex. socket head cap screw (4pcs.) (Tightening torque : 16N・m)
  ⑧ Assemble (A) Belt cover in reversed sequence.
  ⑨ Turn ON the power and A-CAL should be performed. (Refer to "Chapter 7 A-CAL method")

- Required Time

  60 minutes

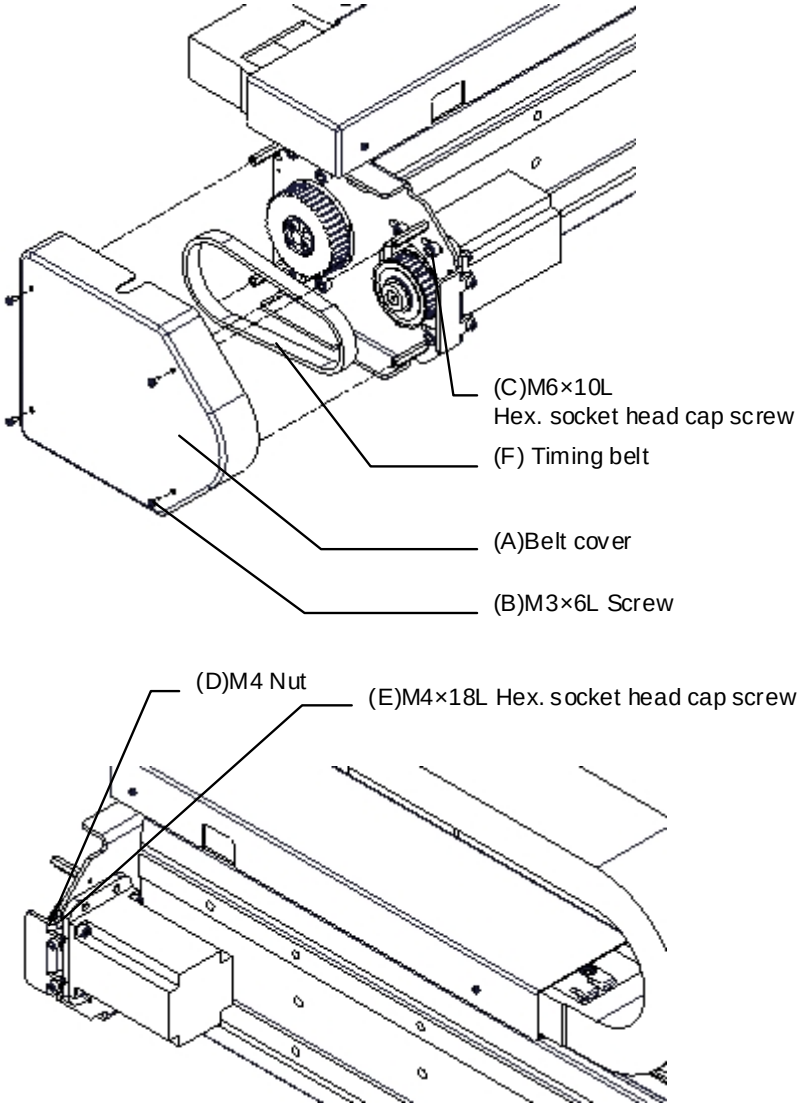


Figure 6.6 Y-axis Timing belt Replacement

6.2.3 Z-axis Timing belt Replacement

WARNING

Turn OFF the main power before replacement.

WARNING

If the belt is detached, Z-axis will fall. Provide a fall prevention countermeasure, such as jigs, beforehand.

- Required Item

  Cross head driver
  Hex. wrench (Size 3 mm)
  Spanner (Size 7 mm)
  Timing belt (387-3GT-12 B737N1 : Gates Unitta)
  Sonic tension meter (recommended type : U-507 : Gates Unitta)

- Procedure
  ① Turn OFF the power.
  ② For fall prevention, install a jig which supports from below or the like.
  ③ Detach (A) Under cover by removing (B)M3×6L screw (2pcs.)
  ④ Loosen (C)M4×30L hex. socket head cap screw (4pcs.)
  ⑤ Loosen (D)M4 nut and (E)M4×30L hex. socket head cap screw.
  ⑥ Detach (F) Timing belt and replace it with a new one.
  ⑦ Adjust the timing belt tension by rotating (D)M4 nut and (E)M4×30L hex. socket head cap screw. (Refer to "Table 5.4 Timing Belt Tension")
  ⑧ Tighten (C)M6×30L hex. socket head cap screw (4pcs.) (Tightening torque：4.6N･m)
  ⑨ Assemble (A) Under cover in reversed sequence.
  ⑩ Turn ON the power and A-CAL should be performed. (Refer to "Chapter 7 A-CAL method")
- Required Time

  45 minutes

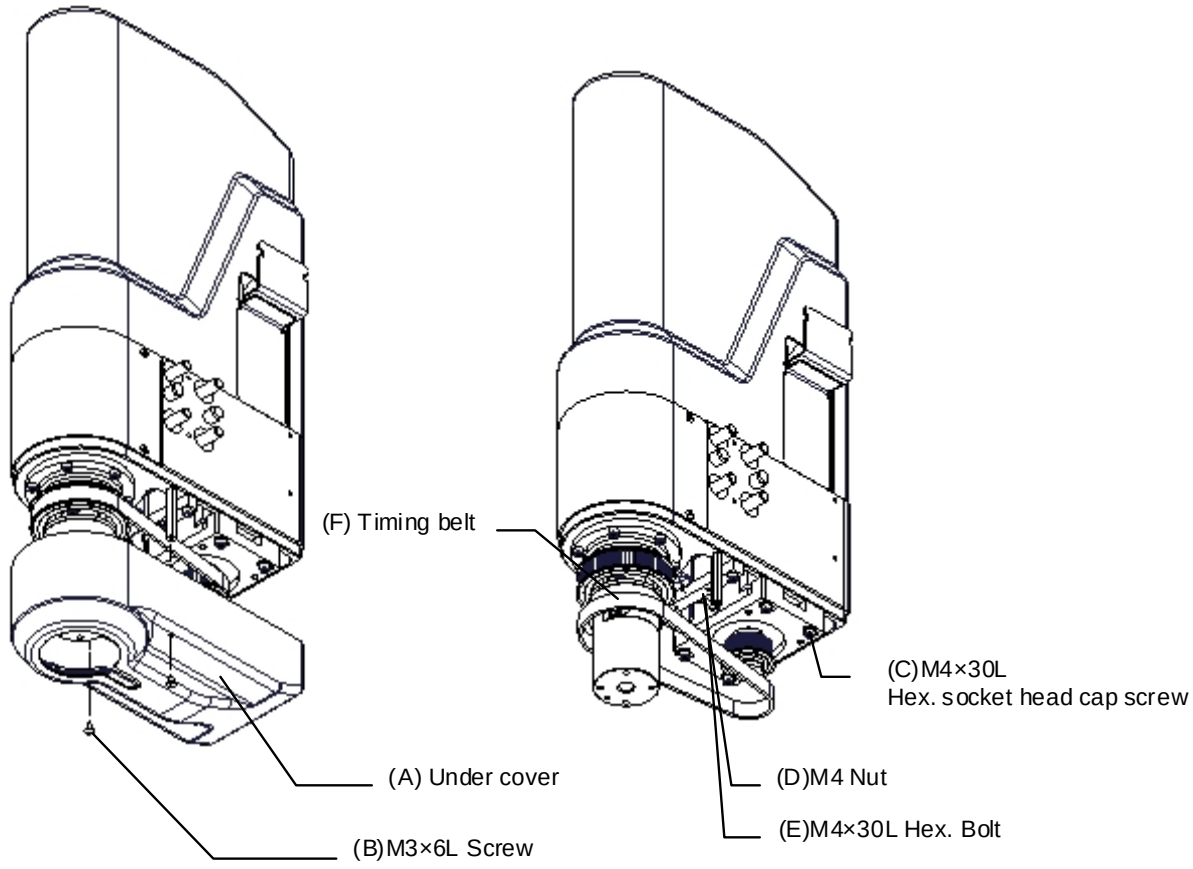


Figure 6.7 Z-axis Timing belt Replacement

6.2.4 W-axis Timing belt Replacement

WARNING | Turn OFF the main power before replacement.

- Required Item

  Cross head driver
  Hex. wrench (Size 4 mm, 3 mm)
  Timing belt (475-EV5GT-20 : Gates Unitta)
  Sonic tension meter (recommended type : U-507 : Gates Unitta)

- Procedure

  ① Turn OFF the power.
  ② Detach (A) Top cover by removing (B)M3×6L screw (2pcs.)
  ③ Loosen (C)M4 nut and (D)M4×25L hex. socket head cap screw.
  ④ Detach (E) W-axis Motor unit by removing (F)M4×15L hex. socket head cap screw (2pcs.) and (G)M4×25L hex. socket head cap screw(2pcs.).
  Cut off the fixed part of wiring if necessary and detach (E) W-axis Motor unit.
  ⑤ Remove (J) M4×10L hex. socket head cap screws to detach (I) Driving pulley.
  ⑥ Detach (H) Timing belt and replace it with a new one.
  ⑦ Adjust the timing belt tension by rotating (C)M4 nut and (D)M4×25L hex. socket head cap screw (2pcs.) (Refer to "Table 5.4 Timing Belt Tension")
  ⑧ Assemble (E) W-axis Motor unit and (A) Top cover in reversed sequence.
  ⑨ Turn ON the power and A-CAL should be performed. (Refer to "Chapter 7 A-CAL method")

- Required Time

  45 minutes

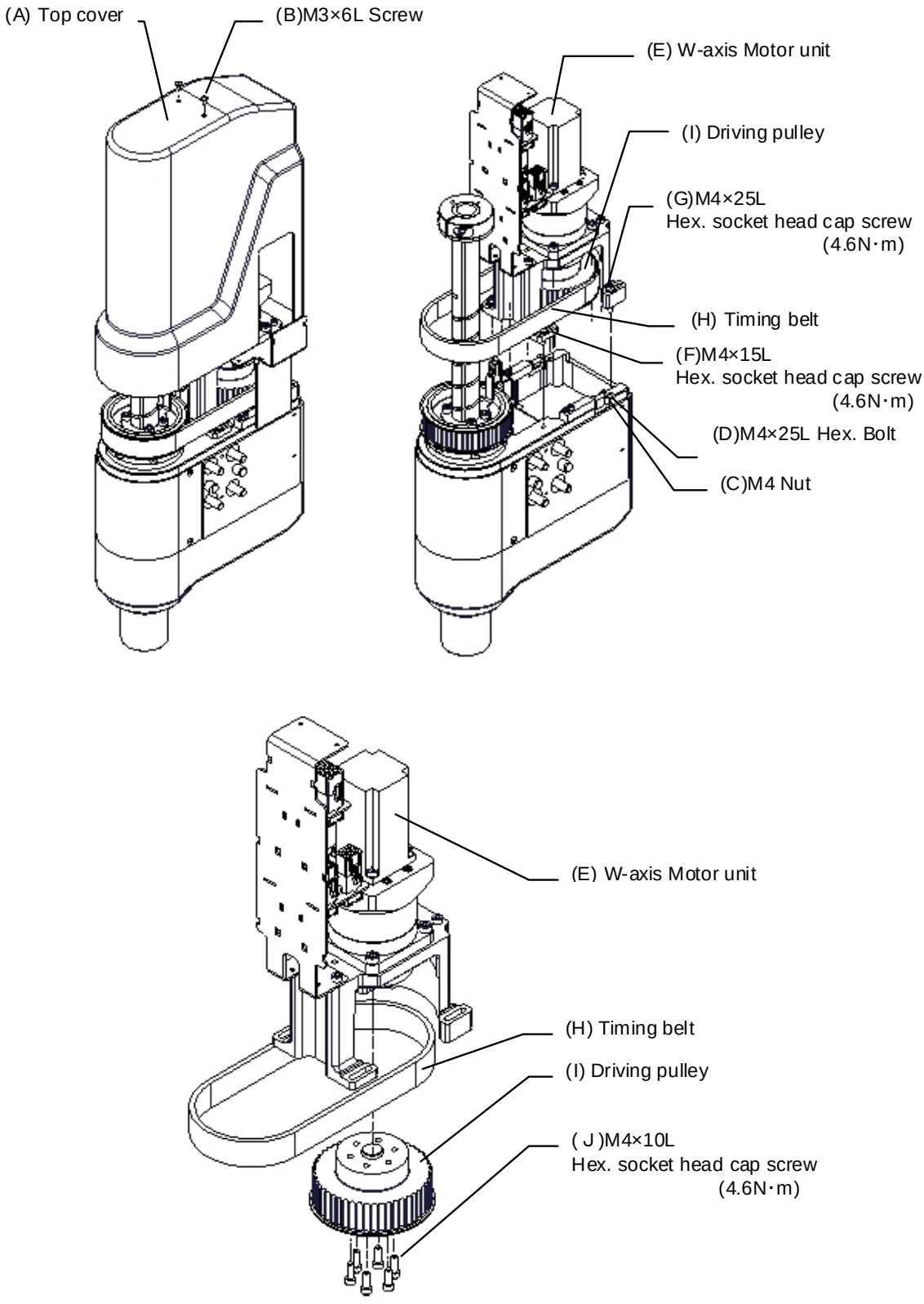


Figure 6.8 W-axis Timing belt Replacement

6.3 Motor Replacement

6.3.1 X-axis Motor Replacement

WARNING

- Turn OFF the main power before replacement.
- Origin position detection encoder and motor are provided as an unit. Therefore, robot position will be drift after the motor replacement.

- Required Item

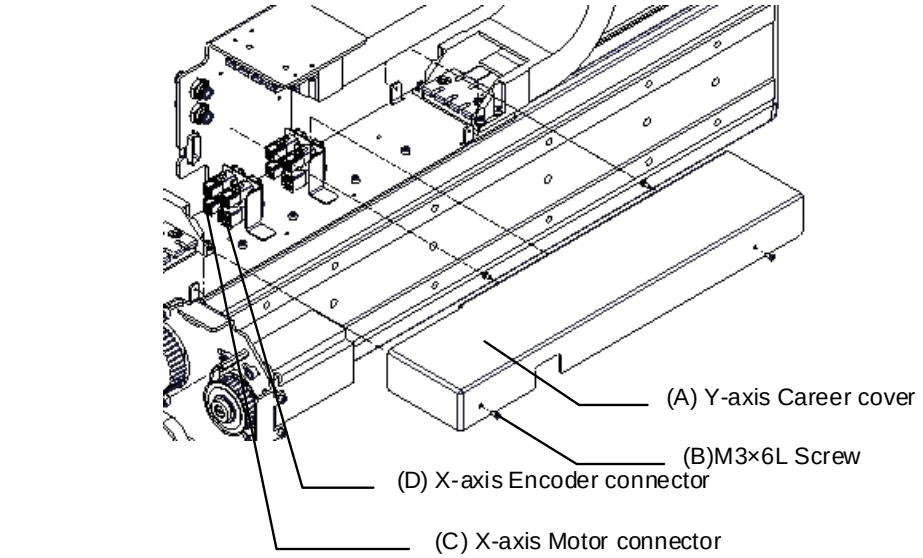
  Cross head driver
  Hex. wrench (Size 6 mm, 5 mm, 3 mm, 2.5 mm)
  Motor(R2AA08075FXP11 : Hirata A059-H01-107)
  Sonic tension meter(recommended type : U-507 : Gates Unitta)

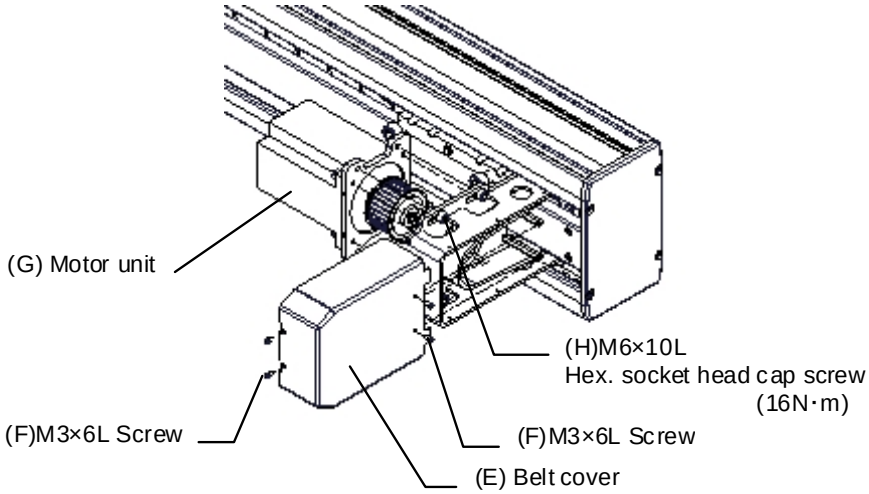
- Procedure

  ① Turn OFF the power.
  ② Detach (A) Career cover by removing (B)M3×6L screw (4pcs.)
  ③ Disconnect the connectors of (C) X-axis Motor and (D) X-axis Encoder.
  ④ Detach (E) Belt cover by removing (F)M3×6L screw (4pcs.)
  ⑤ Detach (G)Motor unit by removing (H)M6×10L hex. socket head cap screw (4pcs.)
  ⑥ Detach (J)Motor base, (K) Metal washer, (L) Driving pulley, and (M) Parallel key from the defective motor.
  ⑦ Attach (J)Motor base, (K) Metal washer, (L) Driving pulley, and (M) Parallel key to new motor.
  ⑧ Assemble the motor unit, connectors, and covers in reversed sequence. (Adjust the timing belt tension properly referring 5.3.4 Timing Belt Tension.)
  ⑨ Turn ON the power and A-CAL should be performed. (Refer to "Chapter 7 A-CAL method")

- Required Time

  60 minutes





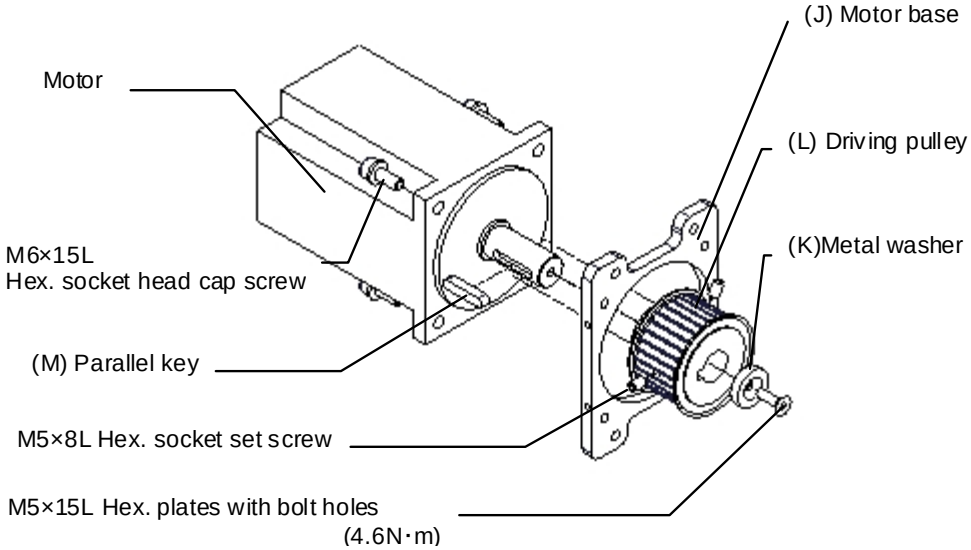


Figure 6.9 X-axis Motor Replacement

6.3.2 Y-axis Motor Replacement

WARNING

- Turn OFF the main power before replacement.
- Origin position detection encoder and motor are provided as an unit. Therefore, robot position will be drift after the motor replacement.

- Required Item

  Cross head driver
  Hex. wrench (Size 6 mm, 5 mm, 3 mm, 2.5 mm)
  Motor(R2AA06040FXP11 : Hirata A059-H01-108)
  Sonic tension meter(recommended type : U-507 : Gates Unitta)

- Procedure

  ① Turn OFF the power.
  ② Detach (A) Career cover by removing (B)M3×6L screw (4pcs.)
  ③ Disconnect the connectors of (C) Y-axis Motor and (D) Y-axis Encoder.
  ④ Detach (E) Belt cover by removing (F)M3×6L screw (4pcs.)
  ⑤ Detach (G)Motor unit by removing (H)M6×10L hex. socket head cap screw (4pcs.)
  ⑥ Detach (J)Motor base, (K) Metal washer, (L) Driving pulley, and (M) Parallel key from the defective motor.
  ⑦ Attach (J)Motor base, (K) Metal washer, (L) Driving pulley, and (M) Parallel key to new motor.
  ⑧ Assemble the motor unit, connectors, and covers in reversed sequence. (Adjust the timing belt tension properly referring 5.3.4 Timing Belt Tension.)
  ⑨ Turn ON the power and A-CAL should be performed. (Refer to "Chapter 7 A-CAL method")

- Required Time

  60 minutes

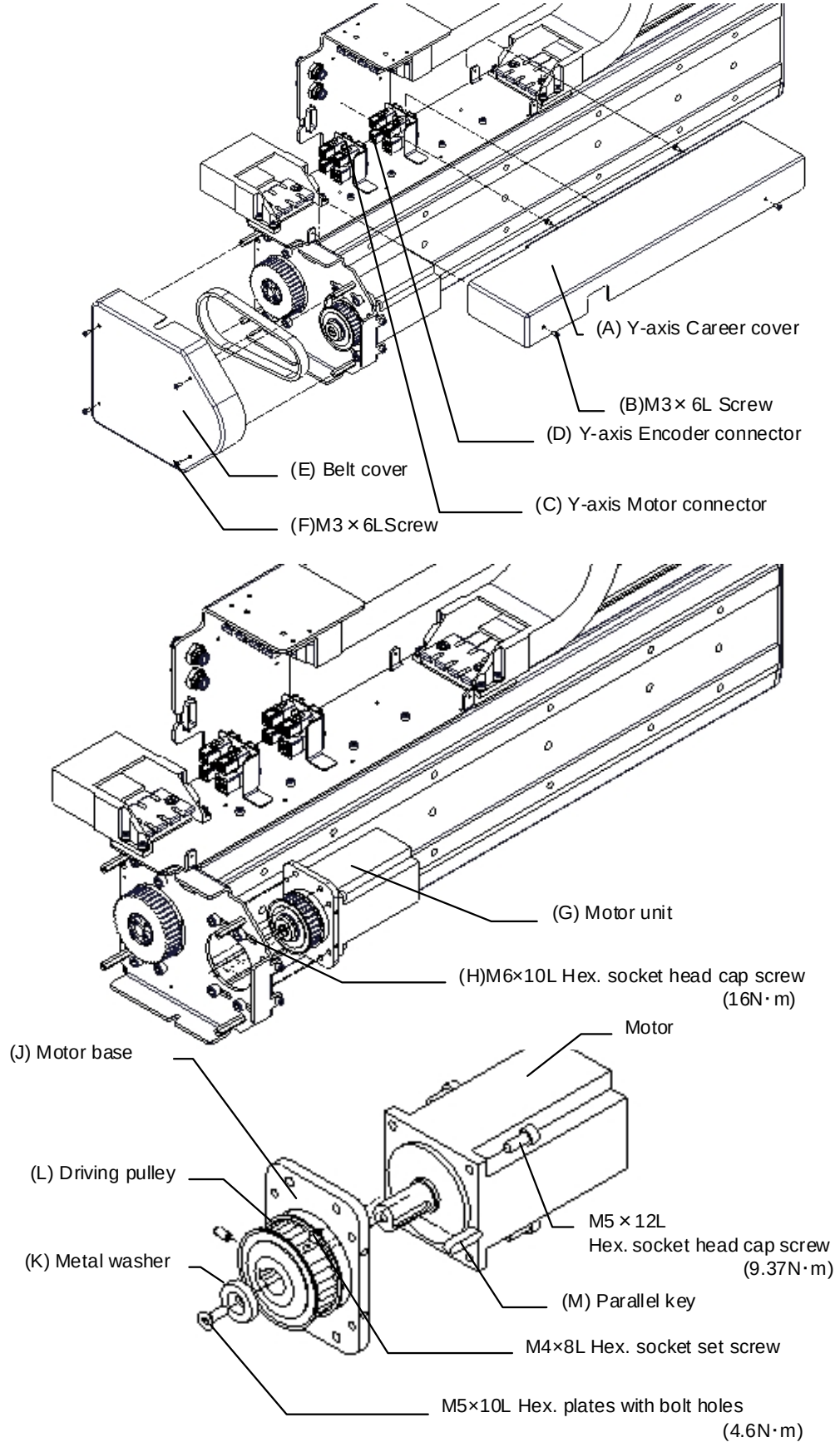


Figure 6.10 Y-axis Motor Replacement

6.3.3 Z-axis Motor Replacement

CAUTION

- Connect the connector same as old connection.
- Origin position detection encoder and motor are provided as an unit. Therefore, robot position will be drift after the motor replacement. To correct the positions, re-teach all of the positions.
- Adjust the timing belt tension after the motor replacement referring the previous section describes timing belt tension.

WARNING

If the belt is detached, Z-axis will fall. Provide a fall prevention countermeasure, such as jigs, beforehand.

- Required Item

  Cross head driver
  Hex. wrench (Size 4 mm, 3 mm)
  Motor(R2AA06020FCP11 : Hirata A059-H01-109)
  Sonic tension meter(recommended type : U-507 : Gates Unitta)

- Procedure

  ① Turn OFF the power.
  ② Detach (A) Top cover by removing (B)M3×6L screw (2pcs.)
  ③ Disconnect the connectors of (C)Motor line and (D)Encoder line for Z-axis.
  ④ Detach (E) Under cover by removing (F)M3×6L screw (2pcs.)
  ⑤ Detach (G)Motor unit by removing (H)M4×30L hex. socket head cap screw (4pcs.). Detach (J) Timing belt at the same time.
  ⑥ For fall prevention, install a jig which supports from below or the like.
  ⑦ Detach (K)Motor base, (L) Metal washer, (M) Driving pulley, and (N) Parallel key from the defective motor.
  ⑧ Attach (K)Motor base, (L) Metal washer, (M) Driving pulley, and (N) Parallel key to new motor.
  ⑨ Assemble the motor unit, connectors, and covers in reversed sequence. (Adjust the timing belt tension properly referring 5.3.4 Timing Belt Tension.)
  ⑩ Turn ON the power and A-CAL should be performed. (Refer to "Chapter 7 A-CAL method")

- Required Time

  45 minutes

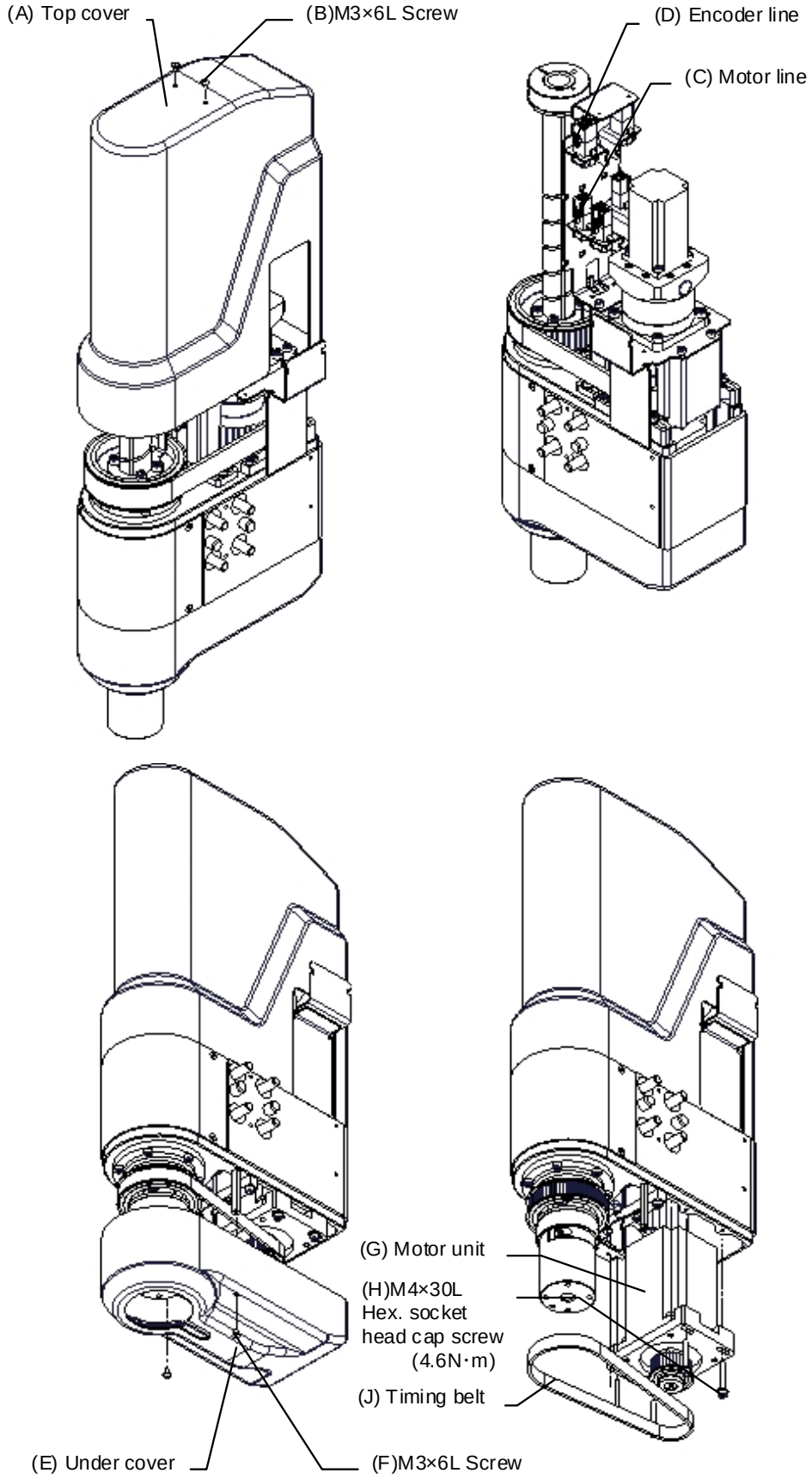


Figure 6.11 Z-axis Motor Replacement 1

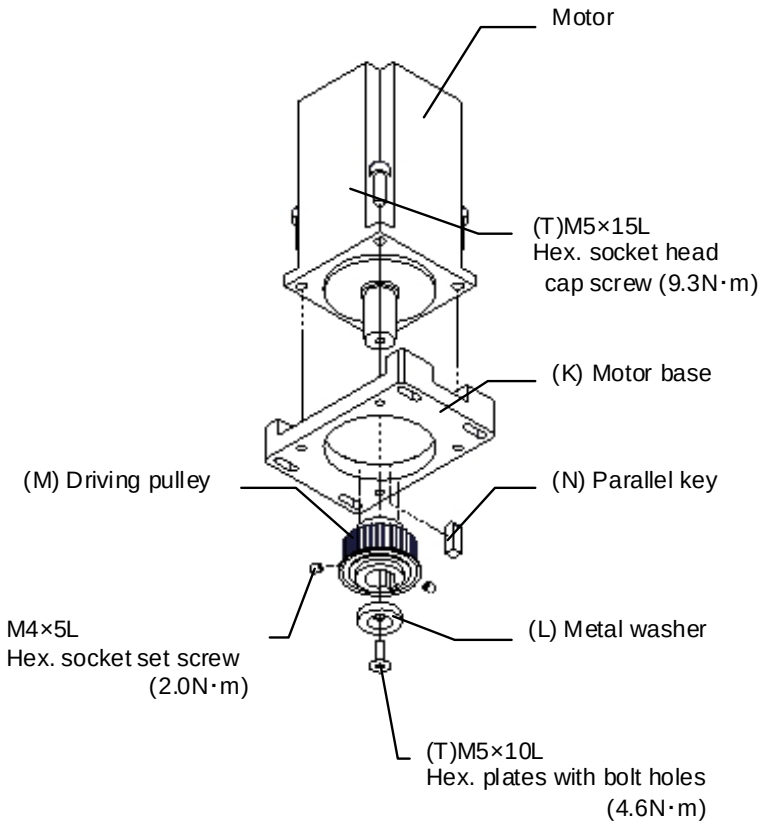


Figure 6.12 Z-axis Motor Replacement 2

6.3.4 W-axis Motor Replacement

CAUTION

- Connect the connector same as old connection.
- Origin position detection encoder and motor are provided as an unit. Therefore, robot position will be drift after the motor replacement. To correct the positions, re-teach all of the positions.
- Adjust the timing belt tension after the motor replacement referring the previous section describes timing belt tension.

- Required Item

  Cross head driver
  Hex. wrench (Size 4 mm, 3 mm)
  Motor(R2AA04010FXP1C : Hirata A059-H01-110)
  Sonic tension meter(recommended type : U-507 : Gates Unitta)

- Procedure

  ① Turn OFF the power.
  ② Detach (A) Top cover by removing (B)M3×6L screw (2pcs.)
  ③ Disconnect the connectors of (C)Motor line and (D)Encoder line for W-axis.
  ④ Detach (E)Motor by removing (F)M4×15L hex. socket head cap screw (4pcs.). At the same time, remove (G) Cap, and from the

hole, loosen the bolt (M3 hex. socket head bolt) of the set collar in the reduction gear.

⑤ Replace the motor with a new one.

⑥ Assemble the motor, connectors, and covers in reversed sequence. (Adjust the timing belt tension properly referring 5.3.4 Timing Belt Tension.)

⑦ Turn ON the power and A-CAL should be performed. (Refer to "Chapter 7 A-CAL method")

- Required Time

  45 minutes

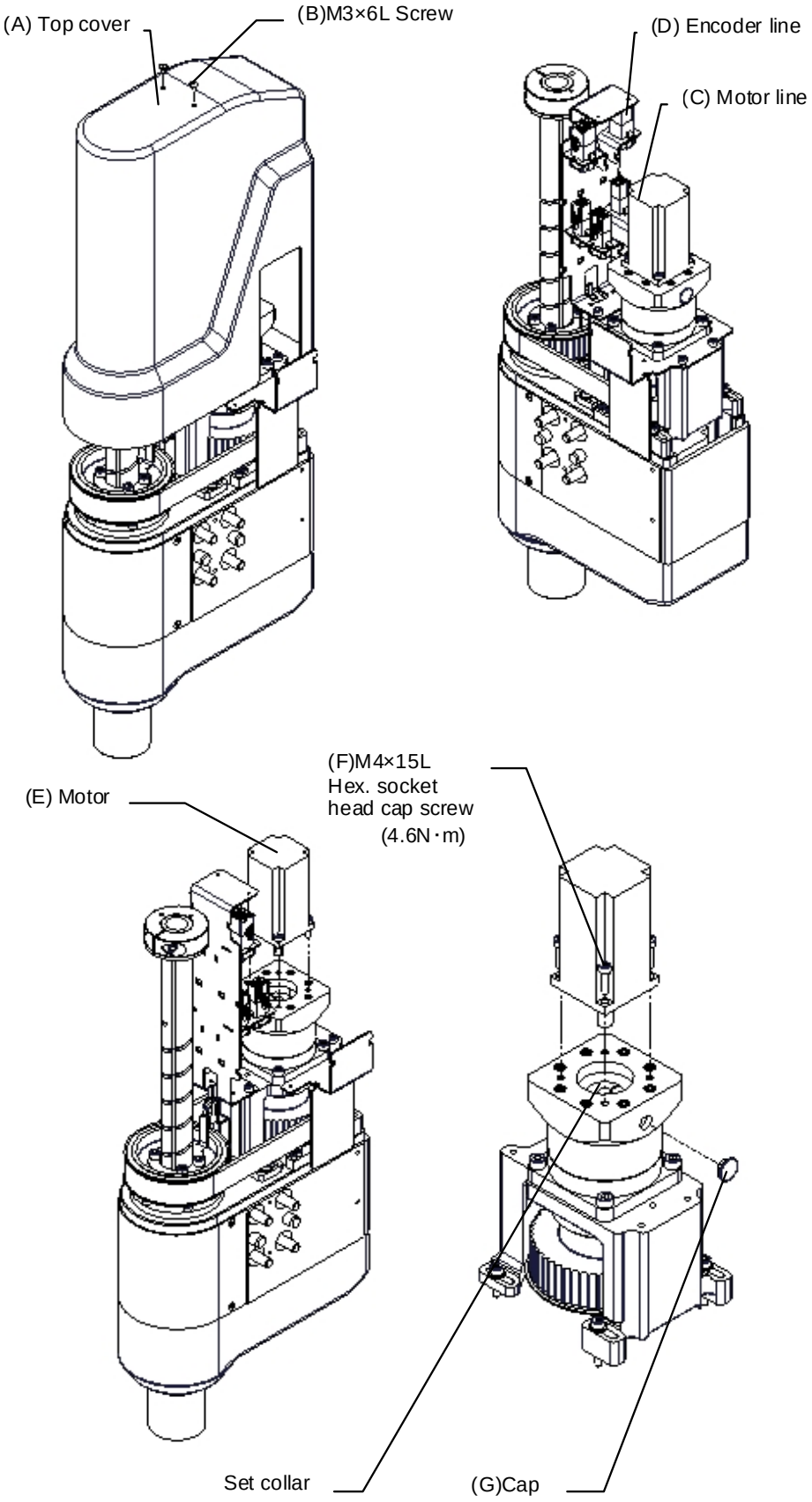


Figure 6.13 W-axis Motor Replacement

6.4 Battery Replacement

WARNING

Never remove the batteries except when replacing them. If you remove any of them, the memory of robot position data may be lost.

This product uses absolute-type encoder as a position detector of each axis. Therefore, count data in the encoders should be backed up with batteries at the time of power failure.

In this equipment, the batteries for all axes are allocated inside the carrier base, and each of the batteries is connected to each axis through a connector.

The power consumption of the batteries is displayed on the servo driver inside the controller. Although the life-span of the batteries is estimated for about 5 years normally, it varies depending on the use condition. Replace them early when the battery voltage becomes 3.2 V or lower.

Use the lithium battery "H-3344 (Hirata-manufactured)" for replacement. There usually is no need for A-CAL.

- Required Tool

  Cross head driver

- Replacement part

  Battery H-3344 (Hirata -manufactured)

- Procedure
  ① Turn OFF the power.
  ② Detach (A) Career cover by removing (B)M3×6L screw (4pcs.)
  ③ Cut off the fixed part of (C) Battery to detach (C) Battery.
  ④ Remove (D) Connector and replace the battery with a new one.
  ⑤ Assemble the new battery and (A) Career cover in reversed sequence.
  ⑥ Turn ON the power and A-CAL should be performed. Refer to "Chapter 7 A-CAL method".

- Required Time

  10 minutes

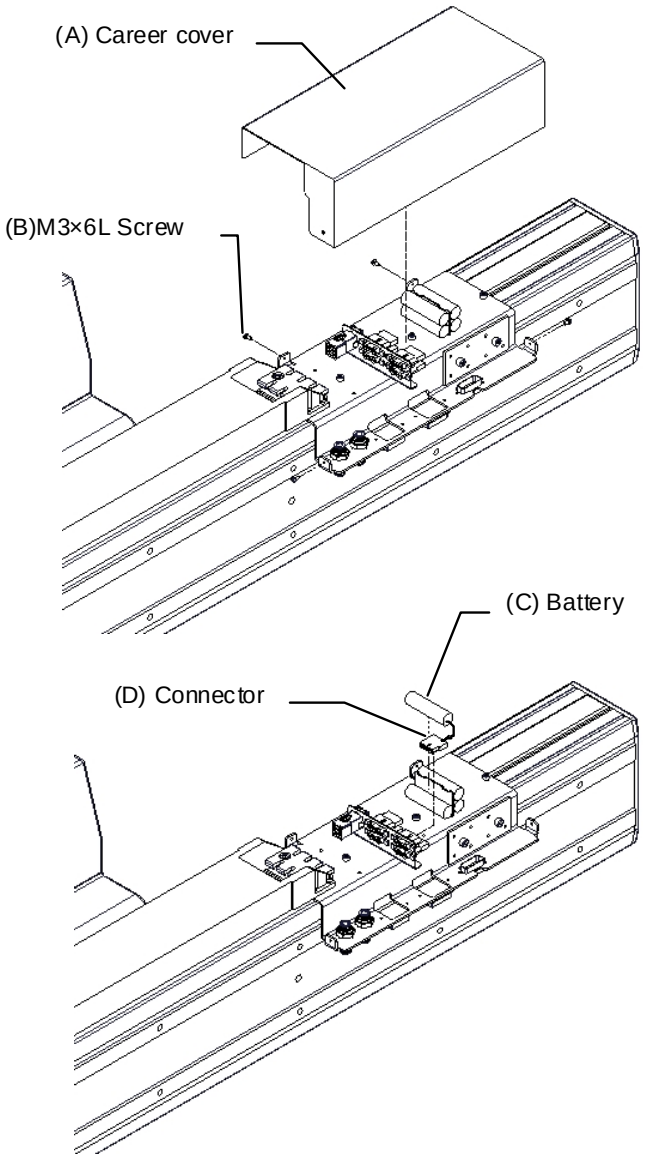


Figure 6.14 Battery Replacement

CHAPTER 7 A-CAL method

A-CAL (Automatic origin calibration) is the operation which automatically performs origin calibration of each axis of the mechanical section (robot) and control section (controller). You do not need to perform A-CAL basically because normally, it has been already performed at shipment from our factory. However, when you replace a motor or disconnect an encoder line, you need to perform A-CAL.

This chapter describes A-CAL method for PF1000.

A-CAL method employs "in-situ A-CAL" method which uses a jig to fix at a place and remembers the place as the origin. A-CAL method differs according to each axis or situation. Follow the instructions below to perform it:

- A-CAL method of X,Y- axis (Press it against stopper + in-situ A-CAL)
- A-CAL method of Z,W-axis (Sensor A-CAL)


NOTE

You can set A-CAL from "MAINTENANCE" → "MAINTENANCE DATA" → "A-CAL CHECK" in the system generation (S.G.). It is "in-situ A-CAL" when A-CAL CHECK is 0 and "Sensor A-CAL" when A-CAL CHECK is 33.

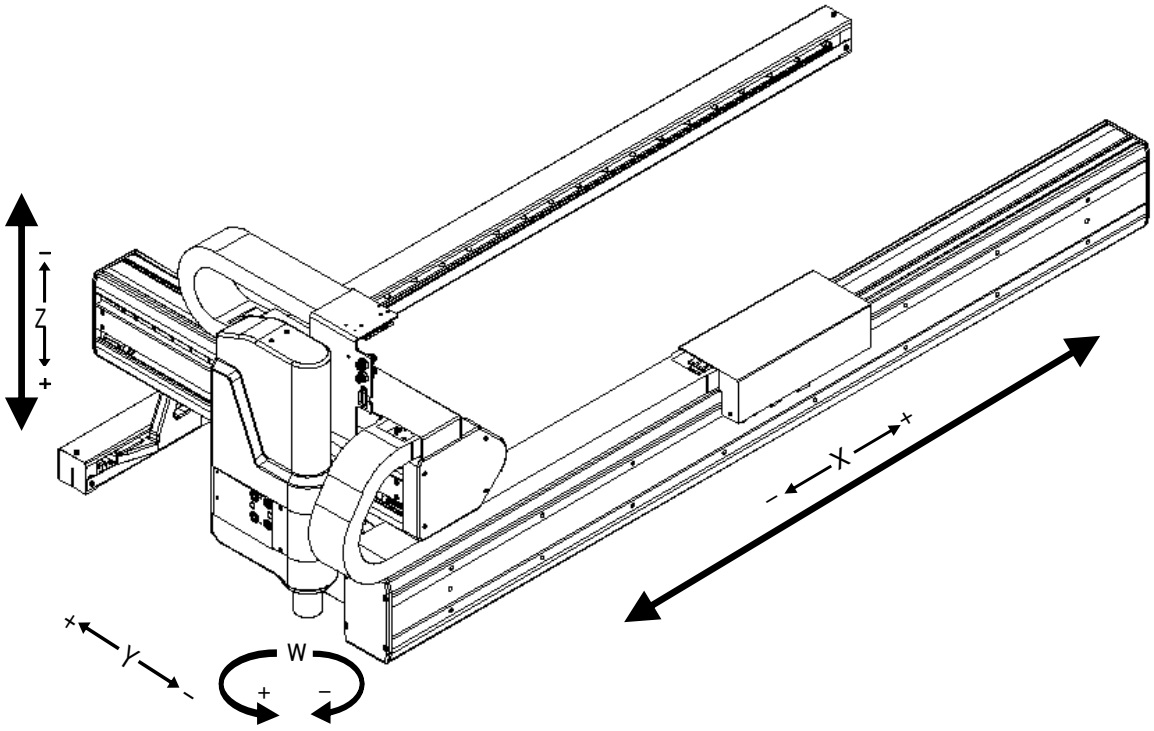


Figure 7.1 Axis composition

7.1 A-CAL method of each axis

A-CAL is required in two kinds of cases: in the case of motor replacement (in the case that servo driver "U" error occurred) and the other cases. The A-CAL method of this robot employs in-situ A-CAL method which uses a jig to fix at a place and remembers the place as origin and Sensor A-CAL method which uses Sensor. A-CAL method differs according to each axis or situation. Follow the instructions below to perform it:

- "in-situ A-CAL" : refer to "7.2 Execution of in-situ A-CAL"
- "Sensor A-CAL" : refer to "7.3 Execution of Sensor A-CAL "

7.1.1 A-CAL method of X,Y-axis

Follow the procedure below for A-CAL method of X,Y-axis:

- Required Tool
  None
- Procedure
  ① Connect the teach pendant, turn on the controller, and confirm that the robot is ready to operate safely.
  ② In the case of motor replacement (in the case that servo driver "U" error occurred), follow "7.2 Execution of in-situ A-CAL" to perform in-situ A-CAL against the axis on which "U" error occurred.[i]
  ③ Move X, Y-axis to around 0st (origin) in TEACH mode.[ii]
  ④ Switch to KEY-IN mode and turn off the controller.
  ⑤ Push X,Y-axis toward the origin and press it firmly against the mechanical stopper on the origin side.
  ⑥ Turn on the controller.
  ⑦ Switch to TEACH mode and perform in-situ A-CAL against one required axis of X,Y-axes according to "7.2 Execution of in-situ A-CAL".
  ⑧ Switch to KEY-IN mode and turn off the controller.
  ⑨ Wait for about 10 seconds and turn on the controller again.
  ⑩ Switch to TEACH mode and confirm that the current coordinate of the axis on which A-CAL was performed is 0.0.
  * After the execution of A-CAL, confirm it before you operate X,Y-axis in TEACH mode or manually.
  ⑪ Switch to KEY-IN mode.
  ⑫ If necessary perform coordinate offset in all the axes on which A-CAL was performed.
  Input a value which can be gotten by subtracting the following value from the current INITIAL value for each axis.[iii]
  X-axis : INITIAL A
  Y-axis : INITIAL B
  ⑬ Check for abnormalities, such as abnormal sound, vibration, interference, at operation in TEACH or CHECK mode.
  ⑭ Check robot position at the position which will become the reference.
  * It is recommended to prepare for position check, such as marking the origin position, in case of accidental motor replacement.
  ⑮ Check automatic operation gradually from low speed and complete the procedure.
- Required Time
  30 minutes

[i] In-situ A-CAL will clear "U" error and enable the robot to operate tentatively.
[ii] The operation may be restricted by "AREA LIMIT".
Refer to the separate volume "9XX SERIES TEACH PENDANT OPERATION MANUAL", "CHAPTER 6 SYSTEM GENERATION, 6.2 LIMIT GROUP ", "6.2.2 AREA LIMIT ".
[iii] Refer to the separate volume "9XX SERIES TEACH PENDANT OPERATION MANUAL", "CHAPTER 6 SYSTEM GENERATION, 6.5.1 ADJUST GROUP", "AR TYPE ADJUST".

7.1.2 A-CAL method of Z,W-axis

- Required Tool
  None
- Procedure
  ① Connect the teach pendant, turn on the controller, and confirm that the robot is ready to operate safely
  ② In the case of motor replacement (in the case that servo driver "U" error occurred), follow "7.2 Execution of in-situ A-CAL" to perform in-situ A-CAL. [i]
  ③ Move Z, W-axis to around 0st (origin) in TEACH mode. [ii]
  ④ Switch to TEACH mode and perform Sensor A-CAL against Z,W-axes according to "7.3 Execution of Sensor A-CAL ".
  ⑤ Switch to TEACH mode and confirm that the current coordinate of Z,W-axis is 0.0.
  * If necessary switch to KEY-IN mode and perform Z,W-axis coordinate offset. [iii]
  ⑥ Check for abnormalities, such as abnormal sound, vibration, interference, at operation in TEACH or CHECK mode.
  ⑦ Check robot position at the position which will become the reference.
  * It is recommended to prepare for position check, such as marking the origin position, in case of accidental motor replacement.
  ⑧ Check automatic operation gradually from low speed and complete the procedure.
- Required Time
  20 minutes

[i] In-situ A-CAL will clear "U" error and enable the robot to operate tentatively.
[ii] The operation may be restricted by "AREA LIMIT".
Refer to the separate volume "9XX SERIES TEACH PENDANT OPERATION MANUAL", "CHAPTER 6 SYSTEM GENERATION, 6.2 LIMIT GROUP ", "6.2.2 AREA LIMIT ".
[iii] Refer to the separate volume "9XX SERIES TEACH PENDANT OPERATION MANUAL", "CHAPTER 6 SYSTEM GENERATION, 6.5.1 ADJUST GROUP", "AR TYPE ADJUST".

7.2 Execution of in-situ A-CAL

(1) Check of initial state (only at motor replacement)

① Turn ON the controller.

② Confirm that "U" is on the seven-segment display of servo driver for the axis of which the motor was replaced, as shown below. (Refer to the following document for the position of servo driver.)
Refer to the separate volume "CONTROL EQUIPMENT INSTRUCTION MANUAL, CHAPTER 3 EQUIPMENT CONFIGURATION".

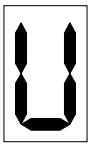


Figure 7.2 Seven-segment display of servo driver (at motor replacement)

(2) Setting of in-situ A-CAL (A-CAL CHECK = 0)

① Put the teach pendant into KEY-IN mode.

When you switch the controller mode to MANUAL and press FUNC HIGH + F1 key, it becomes KEY-IN mode. In the case of AUTO mode, when you press FUNC HIGH + key 9 key, it becomes KEY-IN mode.

② Press FUNC HIGH + s.g 7 key to display system generation menu.

③ Set "MAINTENANCE" → "MAINTENANCE DATA" → "A-CAL CHECK" to 0.[i]

NOTE

During the subsequent operation, you need to keep pressing the deadman switch on the teach pendant. If you take your hand off the deadman switch, it will bring the robot to an emergency stop.

(3) Switch the mode of controller to MANUAL, and push either FUNC HIGH + F2 key to put it into TEACH mode or FUNC HIGH + F3 key to put it into CHECK mode.

[i] Refer to the separate volume "9XX SERIES TEACH PENDANT OPERATION MANUAL", "CHAPTER 6 SYSTEM GENERATION, 6.3.3 MAINTENANCE DATA", "A-CAL CHECK".

(4) Execution of in-situ A-CAL

① Press FUNC HIGH + A-CAL key to display A-CAL axis selection screen. Normally, the diagonally shaded portion will be displayed.

Figure 7.3 Selection of A-CAL axis (Case of X-axis A-CAL)

② Press the axis key to set the left data of the axis to perform A-CAL action to ON and the data of the axes not to perform A-CAL action to OFF.

③ After selecting the axis to perform A-CAL, keep pressing A-CAL key until A-CAL action is completed.

④ When A-CAL action is completed, a buzzer sounds displaying "A-CAL COMPLETED". When it will not be completed for some reason, a buzzer sounds displaying "A-CAL INCOMPLETE". When A-CAL action will not be completed, repeat the procedure from 1).

⑤ When A-CAL action is completed on all the axes, "A-CAL" LED will light.

(5) Check of normal completion of A-CAL

① Check the current position data of the axis which A-CAL action was performed[i] and take a note.

② Turn off the power.

③ Turn on the power again.

④ Confirm that the seven-segment LED of servo driver is as shown below.

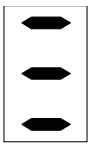


Figure 7.4 Seven-segment display of servo driver (after A-CAL)

⑤ Compare the current data of the axis which A-CAL action was performed and the data written down at ① (data before power-off). When the error of the two data is less than 100 pulse, A-CAL action was performed normally. When the error of the two data is 100 pulse or more, repeat the procedure from (4).

(6) In-situ A-CAL is completed.

[i] Change the set value of the coordinate displayed on the teach pendant to "9" (counter display). Refer to the separate volume "9XX SERIES TEACH PENDANT OPERATION MANUAL", "CHAPTER 5 POSITION DATA, 5.1.7 MODE DISPLAY CHANGE".

7.3 Execution of Sensor A-CAL

(1) Setting of Sensor A-CAL (A-CAL CHECK = 33)

① Put the teach pendant into KEY-IN mode.

When you switch the controller mode to MANUAL and press FUNC HIGH + F1 key, it becomes KEY-IN mode. In the case of AUTO mode, when you press FUNC HIGH + key 9 key, it becomes KEY-IN mode.

② Press FUNC HIGH + s.g 7 key to display system generation menu.

③ Set "MAINTENANCE" → "MAINTENANCE DATA" → "A-CAL CHECK" to 33.[i]

④ Perform the procedure from Step (3) of "7.2 Execution of in-situ A-CAL".


NOTE

During the subsequent operation, you need to keep pressing the deadman switch on the teach pendant. If you take your hand off the deadman switch, it will bring the robot to an emergency stop.


NOTE

Depending on the detecting position of the sensor, the robot may become misaligned. Check its teaching after A-CAL.

[i] Refer to the separate volume "9XX SERIES TEACH PENDANT OPERATION MANUAL", "CHAPTER 6 SYSTEM GENERATION, 6.3.3 MAINTENANCE DATA", "A-CAL CHECK".

CHAPTER 8 Parts List

Following tables describe parts list for PF1000 series robot.

Table 8.1 Parts List

No	Parts	Part No. & Drawing No.	Axis name	Qty.*1		Manufacturer
				2heads	1 head	
1	Motor(750W)	R2AA08075FXP11・A059-H01-107	X	2	1	Hirata
2	Motor(400W)	R2AA06040FXP11・A059-H01-108	Y	2	1	Hirata
3	Motor(200W With brake)	R2AA06020FCP11・A059-H01-109	Z	2	1	Hirata
4	Motor(100W)	R2AA04010FXP1C・A059-H01-110	W	2	1	Hirata
5	Reduction gear	HPG-14A-21-F0ABK（A5B3720）	W	2	1	Hirata
6	Sensor(Option)	E2S-W26・A059-H01-131A	X	1	1	Hirata
7	Sensor(Option)	E2S-W26・ A059-H01-131A	Y	2	1	Hirata
8	Sensor	E2S-Q26・A059-H01-111	Z	2	1	Hirata
9	Sensor	E2S-W26・A059-H01-112	W	2	1	Hirata
10	Timing belt *Operation : 13,000 hours	430-EV5GT-25 370-EV5GT-12 387-3GT-12B737N1 475-EV5GT-20	X Y Z W	2 2 2 2	1 1 1 1	Hirata
11	Ball screw	W2016-76PSSX-C5Z40 W2016-77PSS-C5Z40 W2009-488PSS-C5Z40 W2006-811PSS-C5Z40	X Long 2heads X Long 1head X Short Y	1 - - 2	- 1 1 1	Hirata
12	Ball screw spline	PW2503-33TS9U-C5T25	ZW	2	1	Hirata
13	LM guide	SHS15R4QZUUC1+1560L-Ⅱ(G=30) SHS15R2QZUUC1+1560L-Ⅱ(G=30) SHS15R2QZUUC1+860L-Ⅱ(G=10) SHS15R2QZUUC1+610L-Ⅱ(G=35) SHS20V4QZUUC1E+1680L-Ⅱ(G=30) SHS20V2QZUUC1E+1680L-Ⅱ(G=30) SHS20V2QZUUC1E+980L-Ⅱ(G=10)	X Long 2heads X Long 1head X Short Y Support (X Long 2heads) Support (X Long 1head) Support (X Short)	1 - - 2 1 - -	- 1 1 1 - 1 1	Hirata
14	Encoder battery	H-3344	All axes	8	4	Hirata

*1 The quantities are per robot.

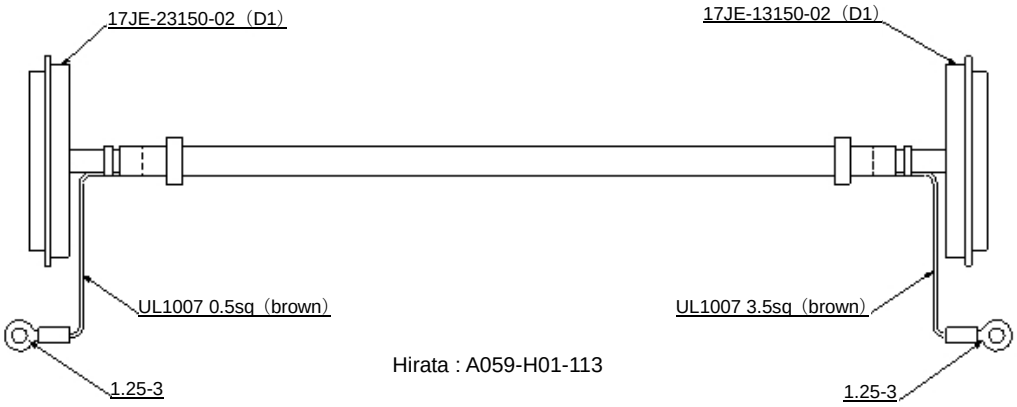
CHAPTER 9 Application Guide

9.1 Cable and Pneumatic Hose for Application

The robot is equipped with fifteen core electric line cable and pneumatic hose for your application.

Electric line cable： 15 cores (0.2mm² Current 2A max.)

Pneumatic hose ： φ6×2 pcs.



Pin No.	Wiring color
1	Black
2	White
3	Red
4	Green
5	Yellow
6	Brown
7	Blue
8	Orange
9	Gray
10	Purple
11	Black
12	White
13	Red
14	Green
15	Yellow

Same wiring arrangement in both sides

Figure 9.1 Wiring diagram for application

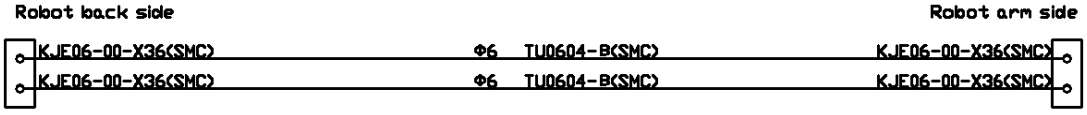


Figure 9.2 Air hose diagram for application

Using other application except above described, connect them not to interfere to robot operation.

APPENDIX

APPENDIX A　Inertia Travelling Speed

Following figure describes reference time for each axis travelling at the condition of factory shipment (Speed: 100%, Acceleration/Deceleration: 100%)

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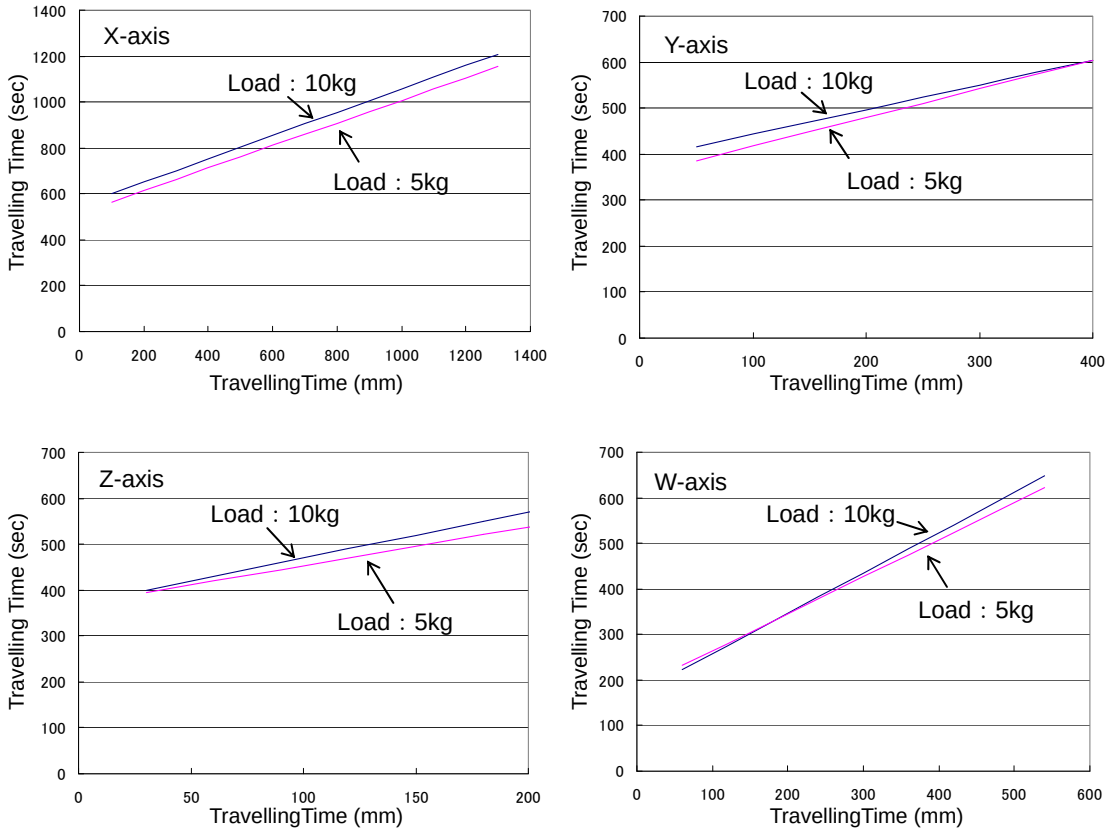


APPENDIX B　Moment Calculation

APPENDIX B.1　Calculation Method

(1) When designing your application, check the robot type of each single axis referring tables in CHAPTER 3 Series Configuration.

(2) Calculate the moment MA, MB, MC for the each single axis.

(3) Confirm the moment is not exceeding the rated payload in following table.
*A moment over its allowed payload may cause damage.

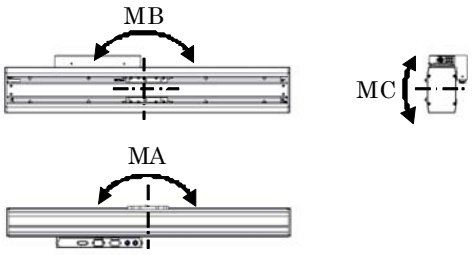


Figure B. 1 Moment Direction

APPENDIX B.2　Calculation Example

APPENDIX B.2.1　Calculation Example 1

- If the robot configuration is “CRW-U1515-1350-400-200”.

(1) Calculation for the moment will be;

X-axis moment:　MAX=0　MBX=W×L1＋MBSX
MCX=W×L2＋MCSX

Y-axis moment:　MAY=0　MBY=W×L3
MCY=W×(L4+K)＋MBSX

Z-axis moment:　MZ=F1×(L6＋K)+F2×L7

- MBSX: Moment caused by Z-axis dead weight (X-axis MB direction) = 16.0 N･m （Refer to Table A.4.）
- MCSX: Moment caused by Y-/Z-axis dead weight (X-axis MC direction) = 133.8 N･m （Refer to Table A.4.）

(2) Confirm that the values calculated in (1) do not exceed the values in Tables B. 1 and 2 Allowed Moment for Each Axis.

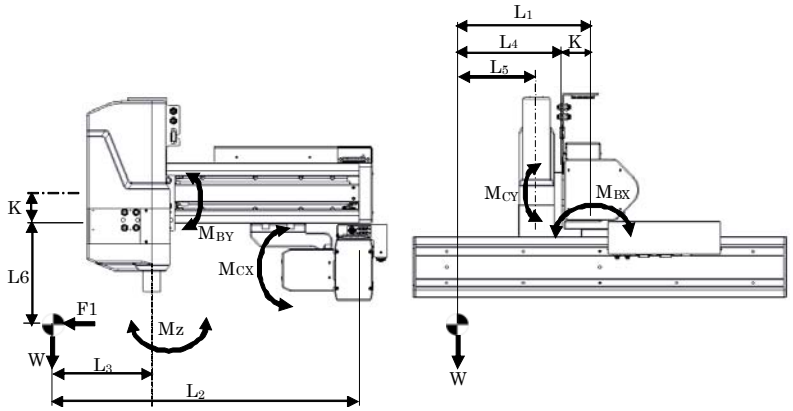


Figure B. 2 Calculation Example 1 of Moment

APPENDIX B.2.2 Calculation Example 2

- If the robot configuration is "CRW-U1515-1350-400-200-S"

(1) Calculation for the moment will be;

X-axis moment: MAX=0 MBX=W×L1+MBSX
MCX=0

Y-axis moment: MAY=0 MBY=W×L3
MCY=W×(L4+K)

Z-axis moment: MZ=F1×(L6+K)+F2×L7

(2) Confirm that the values calculated in (1) do not exceed the values in Tables B. 1 and 2 Allowed Moment for Each Axis.

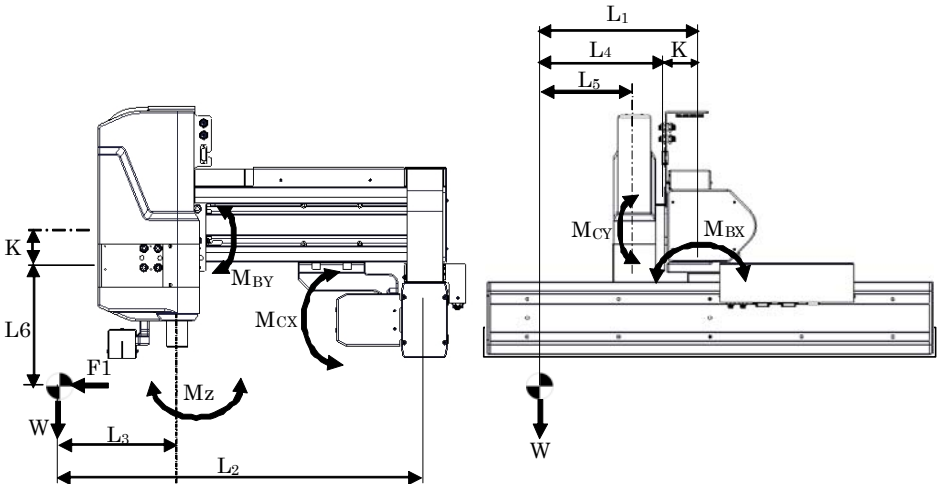


Figure B. 3 Calculation Example 2 of Moment

Table B. 1 Allowed Moment for Each Axis

Axis	Moment Direction	Static Load Moment (N·m)	Dynamic Load Moment (N·m)	
			Standard Life Time *1)	Life Time at 5000km
X	MAX	655.6	5.3	20.5
	MBX	801.7	5.3	20.5
	MCX	737.4	6.5	25.2
Y	MAY	655.6	5.9	20.5
	MBY	801.4	5.9	20.5
	MCY	737.4	7.2	25.2
Support	MAZ	53.0	0.02	0.17
	MBZ	53.0	0.02	0.17
	MCZ	10.9	0.005	0.034

*1) Standard life time: X-axis…294000km, Y-axis…213900km, Support Axis…294000km

Table B. 2 Allowed Moment Direction for Mz

Mz=F1×(L1+K)+F2×L2

Moment Direction	Static Load Moment(N·m)	Dynamic Load Moment(kgf·m)		
		Standard Life Time*2)	Life Time 5000km	K(m)
Mz	28.7	0.44	2.87	0.0825

*2) Standard life time:213900km

Table B. 3 MCSX Moment(Moment caused by Y-/Z-axis dead weight)

(N・m)

MCSX	133.8*3)

*3) Y-axis stroke is 400 mm.
In the case of robots with support axis,
MCSX will not be generated.

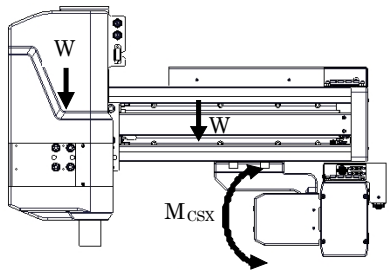
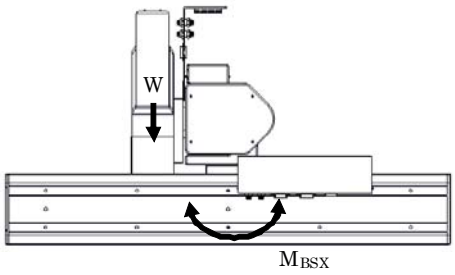


Table B. 4 MBSX Moment(Moment caused by Z-axis dead weight)

(N・m)

MBSX	16.0*4)

*4) In the case of robots with support axis,
MBSX will not be generated.



APPENDIX C Allowed Inertia Capacity

When using W-axis, a tip tool with work-piece shall be within the allowed inertia.
*A load beyond the limit causes damage to controllers and motors as well as deterioration in accuracy and noise.

APPENDIX C.1 Inertia Calculation Method

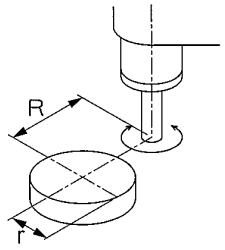
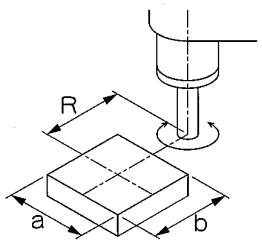
Refer to following instruction to calculate the inertia.

(1) Calculate the inertia referring APPENDIX C.2 W-Axis Load Inertia Calculation.

(2) Calculate the allowed inertia referring APPENDIX C.3 Allowed Inertia at Over-Hang only in case of moving X-/Y-axis and rotating W-axis simultaneously.

(3) Confirm the allowed inertia value is not exceeding the value at step (1).

APPENDIX C.2 W-axis Load Inertia Calculation

Cylindrical Object	Rectangular Object	
		J : Load Inertia(kg.m^2) W : Load Weight (kg) R : Over-hang distance (m) r : Radius of column (m) a : Length of object (m) b : Width of object (m)
$J = W \cdot R^2 + \frac{W}{2} \cdot r^2$	$J = W \cdot R^2 + \frac{W}{12} \cdot (a^2 + b^2)$	

For W-axis, pay attention not to exceed the load when attaching pneumatic hose and electric line cable.

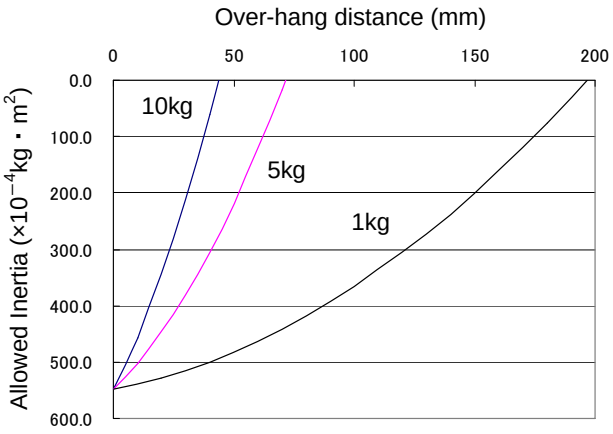
Table C. 1 W-axis Allowed Inertia

Normal Type	548.3×10^{-4}kg·m^2
High Inertia Type : Option	2643×10^{-4}kg·m^2

APPENDIX C.3 Allowed Inertial at Over-Hang.

When moving X-/Y-axis and rotating W-axis simultaneously, allowed inertia becomes smaller as the over-hang distance becomes longer as follows.

【Normal Type】



【High Inertia Type】