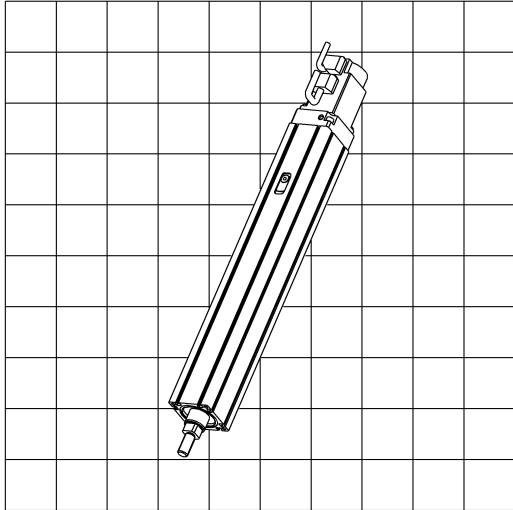


Shibaura Machine



COMPO ARM

BA-III SERIES

MODEL: BET3
BET4
BET5

ACTUATOR INSTRUCTION MANUAL

Original Instructions

Shibaura Machine

Keep this manual nearby for future reference.

Introduction

Before using the COMPO ARM BA-III series, read through and completely understand this instruction manual to assure correct use.

For general information for the COMPO ARM BA-III Series, refer to CA25 Instruction Manual (Basic Part).

CAUTION

1. About application of this product
 - This product is not designed or manufactured to be used in equipment in situations that can affect or endanger human life.
 - When considering this product for operation in special applications (passenger transportation, medical, aerospace, atomic power, electric power, etc.), please contact our sales section.
 - Although this product was manufactured under conditions of strict quality control, you are strongly advised to install safety devices to forestall serious accidents when it is used in facilities where a breakdown in the product is likely to cause a serious accident.
2. This equipment does not have an explosion-proof structure. Take utmost care of the operating environment.
3. All efforts have been made to assure the contents of this manual. If you have any questions, or find any mistakes, however, please contact Shibaura Machine.
4. Shibaura Machine will not be held responsible for any effects caused by using this equipment, regardless of Item 3 above.
5. The contents of this manual are subject to change without prior notice to effect improvements.

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Overview

- This manual describes the axis type expression method, specifications and motor replacement procedures, etc., according to the type of axis.
- For the installation, see the instruction manual (installation of actuator) provided separately.

Chapter 1 Safety

■ 1.1 Cautions for safety

- Before the installation, programming, operation, maintenance and inspection of the equipment, be sure to read through this manual so that you can use the COMPO ARM with safety.
- After you have read this manual, keep it nearby for future reference.

Be sure to observe the instructions for ensuring operation safety of the COMPO ARM.

This manual contain the important information to prevent injury to the operators and persons nearby, to prevent damage to assets and to assure correct use of the equipment.

Make sure that you have well understood the following details (indications and symbols) before reading this manual.

Always observe the information that is noted.

⚠ WARNING : If you have neglected this instruction and caused a handling error, death or serious injury may occur.

⚠ CAUTION : If you have neglected this instruction and caused a handling error, human injury or property damage (damages to houses, household goods and domestic animals) may occur.

CAUTION : This gives a brief description of the major points of operation procedures, precautions and method for effective use of the machine.

⚠ WARNING

- **Install the safety fences to prevent anyone from entering the working envelope of the robot.**

When the door is attached to the safety fence, the robot should be stopped at emergency at the same time that the door has opened.

- **Connect the EMERGENCY STOP pushbutton switch to the emergency stop input terminal of the controller and mount the same switch at an easy-to-operate place in an emergency.**

The EMERGENCY STOP switch must not be reset automatically and cannot be reset negligently by any person.

- **Wiring should be done safely and completely according to the Electrical Installations Technical Requirements and Interior Wiring Requirements of Japan.**

Incorrect wiring will result in an electric shock or a fire.

- **The equipment MUST NOT be repaired or modified without prior written permission from the manufacturer.**

Otherwise, an accident or damage will be caused.

- **Before the maintenance and inspection, be sure to turn off the controller main power switch. Take all necessary measures to prevent anyone other than the worker engaged in adjustment of the robot from negligently turning the power on. (Lock the switch and put a tag showing "DO NOT turn the power on.") Also, DO NOT touch the controller interior ten (10) minutes after the power is turned off.**

Otherwise, you may get an electric shock due to residual voltage of the capacitor.

- **DO NOT touch the motor, heat sink and cement resistor in the controller.**

They are too hot and you may get burnt. Before performing inspection, take enough time to cool them off.

- **DO NOT pour water on the equipment interior or exterior, or drain water from it. Otherwise, you may get an electric shock, or the equipment will be damaged.**

When the equipment has contaminated, wipe it off with a hard squeezed cloth. DO NOT use a thinner, benzine or other organic solvent.

- **DO NOT throw away metals, combustibles or other contaminant into the opening of this equipment.**

A fire or an electric shock will be caused.

- **DO NOT put your finger or hand on the movable part or opening of the equipment.**

Otherwise, you may get injured.

- **When using the actuator in other than the horizontal state, be sure to select the actuator with brake.**

Otherwise, the slider will drop at power OFF, and you will be injured.

⚠ WARNING

- **As the equipment is heavy, make sure of its weight and gravity center position and disconnect the cables when carrying the equipment.**

Also, DO NOT carry the equipment with the slider. Otherwise, the slider will move and you will get injured.

- **DO NOT use this equipment for the living body as a massaging machine.**

Otherwise, you will be injured due to incorrect teaching or mis-operation.

- **Because this equipment does not have a completely sealed structure, during operation, grease or wear-away resin can spray out from the gaps, and liquefied grease can drip from the axis unit.**

If using the equipment for applications in food processing or pharmaceuticals, be sure to implement measures to prevent mixing with these substances.

- **Enter the robot type and initialize the memory correctly.**

Otherwise, the robot may move unexpectedly and you will be injured.

- **DO NOT use this equipment in an atmosphere of inflammable gas or an atmosphere inducing an explosion.**

As this equipment is not explosion-proof, it may explode in the worst occasion.

- **DO NOT damage, break, process, forcibly bend, stretch, place a heavy object on or pinch the cables (power cable, controller cable).**

Otherwise, an electric shock or a fire will be caused.

- **Should an abnormality such as smoke or nasty smell occur, turn the power off immediately and stop using the equipment.**

If the equipment is used continuously, an electric shock or a fire will be caused.

When using the side mounted motor axis in the vertical condition, be sure to check for the belt on a regular basis. Replace the belt every 3,000-hour operation.

If the belt whose service life already ended is used continuously, it may be broken or the slider may drop, and you will be injured.

⚠ CAUTION

- **DO NOT place the equipment at a place where the ambient temperature exceeds 40°C, or where the temperature changes sharply, causing condensing, or where it is exposed to direct sunlight.**

Additionally, if the equipment is installed at a narrow place, the ambient temperature rises due to heat generation in the controller itself or external device, which will result in malfunction or mis-operation of the equipment.

- **DO NOT use the equipment at a place where an impact or vibration is involved. Also, DO NOT use the equipment in an atmosphere where conductive dust, corrosive gas or oil mist generates.**

Otherwise, a fire, electric shock, malfunction or mis-operation will be caused.

- **DO NOT use the equipment at a place where too much dust or dirt exists.**

If the equipment is used at such a place, it may malfunction because this equipment is not dust-proof.

- **DO NOT use repair parts other than those designated by the manufacturer.**

Otherwise, the equipment cannot be operated to its full capacity and will cause malfunction.

- **Mount the robot on a highly rigid frame.**

If rigidity of the frame is not enough, vibration (or resonance) may be caused during the robot operation, adversely affecting the operation.

- **In the case of power failure, this equipment becomes a free running state. When devices or work pieces may be damaged by free running of this machine, use an axis equipped with brake even if the axis is installed horizontally.**

This machine does not have a dynamic brake function.
The brake of this machine is a holding brake. The holding brake cannot be used for deceleration.
If you want to use it as a used for deceleration, please contact us.

- **Do not apply force to the rod that exceeds the maximum speed of this machine.**

It may cause a malfunction.

- **Do not connect or disconnect a connector with the controller turned ON.**

Malfunction may be caused.

- **Take safety measures against fall and scatter of a work piece.**

If collision occurs, the axis decelerates suddenly and a work piece may fall and scatter.

- **Perform risk assessment for entire equipment and take required protective measures.**

- **When discarding this product, dispose correctly as an industrial waste.**

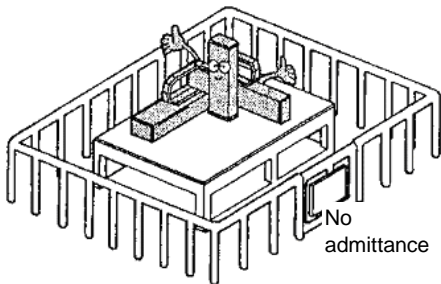
■ 1.2 For your safe operation

When you use the COMPO ARM BA-III series, be sure to take the measures in conformity to the following instruction:

This machine is an industrial robot in conformance to the provisions of Paragraph 31 of Article 36 of the Ordinance on Industrial Safety and Hygiene. Necessary cautions are specified in the "Selection", "Installation", "Use", "Periodic Inspection, etc." and "Education" of the "Technical Guideline on Safety Standards for Use of Industrial Robot" conforming to the Article 28 of the Industrial Safety and Health Law. You are requested to read them carefully and to observe the instructions. The following introduces some of them.

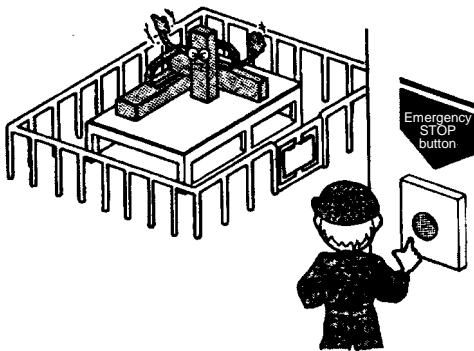
■ 1.2.1 Safety measures

(1) A safety barrier shall be provided to ensure that any person cannot enter the working area of a robot.



1. The barrier shall have sufficient strength to withstand the force generated during the work or environmental conditions. The barrier shall have such a structure that cannot be easily adjusted, removed or cleared.
2. The safety barrier shall be free from any serrated or sharp edge or protrusions.
3. The safety barrier shall be designed in a stationary structure.
4. When a safety barrier is equipped with a door, an interlock shall be provided so that the robot will be stopped by opening of the door.

(2) An emergency stop device shall be installed where the robot can be easily stopped by the operator immediately in the event of emergency.



1. The emergency stop function shall ensure immediate and reliable stop of a robot when the emergency stop button switch has been operated by an operator.
2. The emergency stop button shall be red.
3. The emergency stop device shall be located so that it can be easily pulled, pressed or touched by the operator, and it can block a beam of light.
4. The emergency stop button shall be structured in such a way that it is not automatically reset after having been operated, and cannot be reset carelessly.

(3) For safety, never modify the robot main unit or control device.

■1.2.2 Precautions for installation

Observe the following instructions when installing a robot:

- (1) The robot shall be laid out to ensure the work space required for robot teaching, maintenance and inspection.
- (2) The robot controller, other controllers and stationary operation panel shall be installed outside the movable range and where the operator can watch the robot operations.
- (3) The pressure gauge, hydraulic pressure gauge and other instruments shall be installed in clearly visible positions.
- (4) The electric wiring and hydraulic/pneumatic piping shall be provided with protective covers if they may be damaged.
- (5) To ensure effective operation of the emergency stop device in the event of emergency, emergency stop device switches shall be installed on locations other than the operation panel, as required.

■1.2.3 Precautions for use

Observe the following instructions when using a robot:

[Work within the movable range]

- (1) Work provisions
 - Determine provisions for the following items and perform the work in conformity to them:
 1. Root operation methods and procedures required in the work such as startup method and switch handling method.
 2. Speed of robot main unit in teaching.
 3. Signaling method for work adjustment among more than one operator.
 4. Action to be taken by the operator for each problem.
 5. Procedures for confirming the release of the emergency and safety when restarting the robot operation after the robot operation has been stopped due to the operation of the emergency stop device.
 6. Measures to protect against the hazard due to unexpected operation of the robot described below (in addition to the above items), or the hazard caused by a robot operation error.
 - Indication on the operation panel.
 - Measures to ensure safety of the operator working within the movable range.
 - Working position and posture.
 - Prevention of operation error due to noise.
 - Signaling method for work adjustment with operators of related devices.
 - Error type and evaluation procedure.
 7. The work provisions shall meet the requirements of the robot type, installation site and work.
 8. The work provisions shall be prepared by consultation with the related operators, manufacturer's engineers and industrial safety consultant.
- (2) Indication on the operation panel
 - To ensure that the start switch and selector switch will not be carelessly operated by a person other than the personnel in charge of this work, the switch shall be provided with an easy-to-read indication to show that the work is in progress. Alternatively, the operation panel cover shall be provided with locking or other means.

- (3) Measures to ensure the operation safety of the personnel working within the movable range
Any one of the following measures or other measures on the equal or higher level shall be taken so that you can stop the robot operation immediately in the event of an error when working within the movable range:
1. An adequately authorized supervisor shall be assigned outside the movable range and where the robot operations can be observed. This supervisor shall be exclusively in charge of the supervision and shall be responsible for the following:
 - The supervisor shall cause the emergency stop device to be operated immediately in the event of an error.
 - The supervisor shall ensure that a person other than the personnel in charge of this work is kept outside the movable range.
 2. The emergency stop device switch shall be placed under the control of the person working within the movable range.
 3. A portable operation panel having a structure capable of on/off operation of the power source, oil hydraulic or pneumatic source shall be used in the work.
- (4) Inspection prior to start of the work such as teaching
Prior to start of the work such as teaching, the following items shall be inspected. If any error is detected, immediately repair the trouble or take other required action.
1. Check if the covering or sheathing of the external power source is damaged or not. (This check must be made after the power has been turned off).
 2. Check if the operation of the robot proper is faulty.
 3. Check for the functions of the braking device and emergency stop device.
 4. Check if there is any leakage of air or oil from the piping.
- (5) Cleaning of working tools
When such working tools as a painting nozzle are mounted on the robot proper, and these working tools must be cleaned, it is preferred that these tools should be automatically cleaned so that the number of machines entering the movable range can be minimized.
- (6) Release of residual pressure
Before disassembling the pneumatic components or replacing their parts, release the residual pressure in the drive cylinder.
- (7) Operation check
Perform the verification operation without entering the movable range, wherever possible.
- (8) Illuminance
The illuminance required for operation safety shall be maintained.

[For automatic operation]

- (1) Action before startup
Before starting the robot, check for the following items in advance and determine a signaling method for work adjustment among related operators.
1. Make sure that there is no person within the movable range.
 2. The movable operation panel and tools shall be located at specified positions.
 3. There shall be no error indication for the robot or related devices.
- (2) Action for automatic operation and in the event of an error
1. Make sure that there is an indication to show that the automatic operation is now in progress, after the robot has been started.
 2. When a problem has occurred to the robot or related device and you have to enter the movable range to take emergency measures, stop the robot operation, for example, by operating the emergency stop device before entering the movable range. At the same time, carry a safety plug with you, and ensure that the start switch is provided with the indication to show that the work is now in progress. Take measures so that any other person than the operator in charge of the emergency measures cannot operate the robot.

■ 1.3 Warranty

■ 1.3.1 Warranty period

This product is warranted for one of the following periods whichever comes first.

- (1) For 24 months after shipment from our factory.
- (2) For 18 months after installation at the customer's factory.
- (3) For 4000 hours of operation.

■ 1.3.2 Details of warranty

- (1) This product is warranted. The scope of the warrant includes the specifications and functions described in the Specification, catalog and Instruction Manual. We are not responsible for any secondary or incidental damages caused by the trouble of this product.
- (2) We will repair, on a free-of-charge basis, the trouble caused in the handling or use of the product within the warranty period of this product as described in the Instruction Manual attached to this product. Alternatively, such trouble will be repaired after the product has been returned to our factory. If the problem is solved by a dispatch of service personnel to meet the convenience of the customer, we may claim payment from your company regarding the transportation expenses, lodging expenses or other expenditures not directly related to the repair of the product.

■ 1.3.3 Exemption from responsibility

The following cases shall be excluded from the scope of warrant.

- (1) The trouble and damage caused by the use of the product according to a method not described in the Instruction Manual, or by a careless error in use.
- (2) Problems caused by chronological changes or wear by use (such as natural fading of paints, deterioration of the consumable parts *1).
- (3) Problems caused by sensory phenomena (e.g. generated noise without affecting the function).
- (4) Modification or disassembling not authorized by our company.
- (5) Troubles or damages caused by inadequate maintenance and inspection or improper repair.
- (6) Troubles or damages caused by natural disaster, fire and other external factors.
- (7) Internal data such as programs and points created or modified by the customer.
- (8) Problems caused when this product purchased in Japan is brought to an overseas country.

*1 : Consumable parts are defined as the parts maintenance replacement parts (spare parts) described in the Instruction Manual of each product, and the parts (e.g. backup battery) that must be replaced on a periodic basis.

■ 1.3.4 Precautions

- (1) When you have used the product beyond the specifications of the product, we cannot warrant the basic performances of the product.
- (2) Should you fail to observe the instructions given in "WARNING" and "CAUTION" described in the Instruction Manual, we are not responsible for any personal injury, damages or trouble that may occur.
- (3) Please note that the "WARNING" and "CAUTION" described in the Instruction Manual, and other descriptions are within the scope assumed by our company.
- (4) The numerical values given as technical data are theoretical values as a guideline showing the durability and others. They shall not be construed as indicating warranty. Note that these values are subject to change according to the conditions of use.

Chapter 2 Shipment List

■ 2.1 Shipment list

When the axis proper is shipped, it is composed of the following parts:

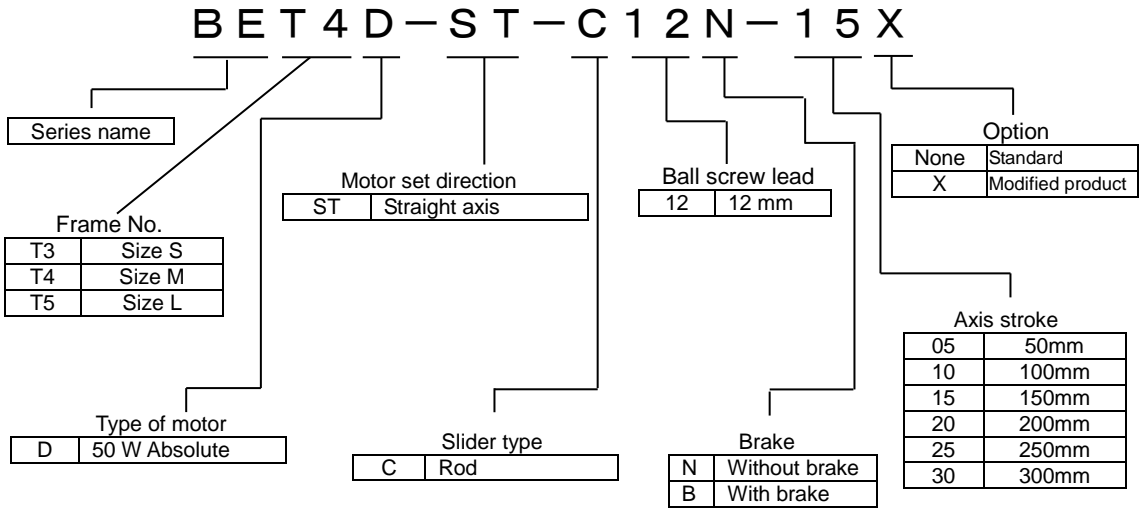
- (1) Actuator (axis)
- (2) Introduction Manual

Chapter 3 Axis Specifications

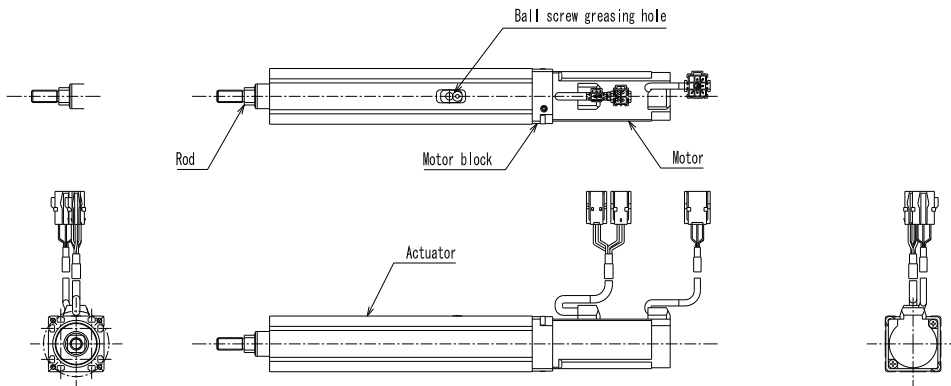
3.1 Axis type and names of individual parts

■ Type of axis

The following shows the axis type:



■ Names of individual parts



■ 3.2 Single axis specification

■ Specifications

Type of axis BET5D-ST-C12□-□□

Motor	AC 50-watt servo motor absolute	
Drive method	Ball screw	φ8 Lead 12 mm
Maximum payload mass (Note 1)	Horizontal	Vertical
	4 kg	1.9 kg
Rated thrust	83 N	
Maximum thrust	249 N	
Maximum speed	600 mm/s	
Repeatability (Note 2)	±0.02 mm	
Resolution	0.01 mm	
Service life (Note 3)	5,000 km	

Type of axis BET4D-ST-C12□-□□

Motor	AC 50-watt servo motor absolute	
Drive method	Ball screw	φ8 Lead 12 mm
Maximum payload mass (Note 1)	Horizontal	Vertical
	7 kg	3.1 kg
Rated thrust	83 N	
Maximum thrust	249 N	
Maximum speed	600 mm/s	
Repeatability (Note 2)	±0.02 mm	
Resolution	0.01 mm	
Service life (Note 3)	5,000 km	

Type of axis BET5E-ST-C12□-□□

Motor	AC 100-watt servo motor absolute	
Drive method	Ball screw	φ12 Lead 12 mm
Maximum payload mass (Note 1)	Horizontal	Vertical
	25 kg	6.5 kg
Rated thrust	166 N	
Maximum thrust	498 N	
Maximum speed	600 mm/s (Note 4)	
Repeatability (Note 2)	±0.02 mm	
Resolution	0.01 mm	
Service life (Note 3)	5,000 km	

Note 1: This model series can bear loads in the axial direction only. No static or dynamic load moments can be applied to the rod. These are values where the axis was used together with a linear guide or similar device and no radial load was applied to the rod.

Note 2: Repeatability in one direction during 7 trials at a constant ambient temperature of 20°C. It is not absolute positioning accuracy. Trajectory accuracy is not guaranteed.

Note 3: This is the calculation value when operated under the load with the maximum loadable weight, at the maximum speed, and at an acceleration of 0.3 G.

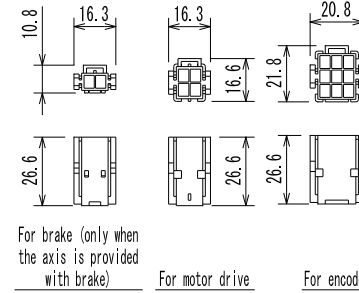
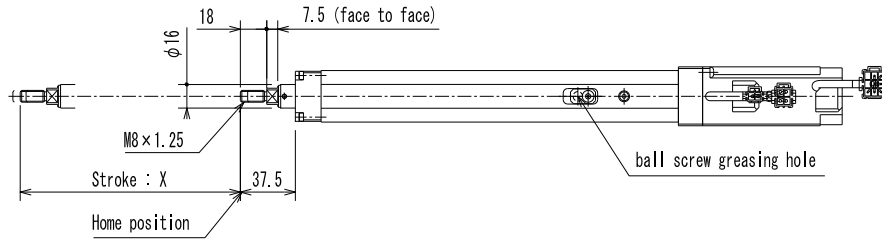
Note 4: The maximum speed of the BET5D-ST-C12*-30 is 470 mm/s.

■ Axis dimensions

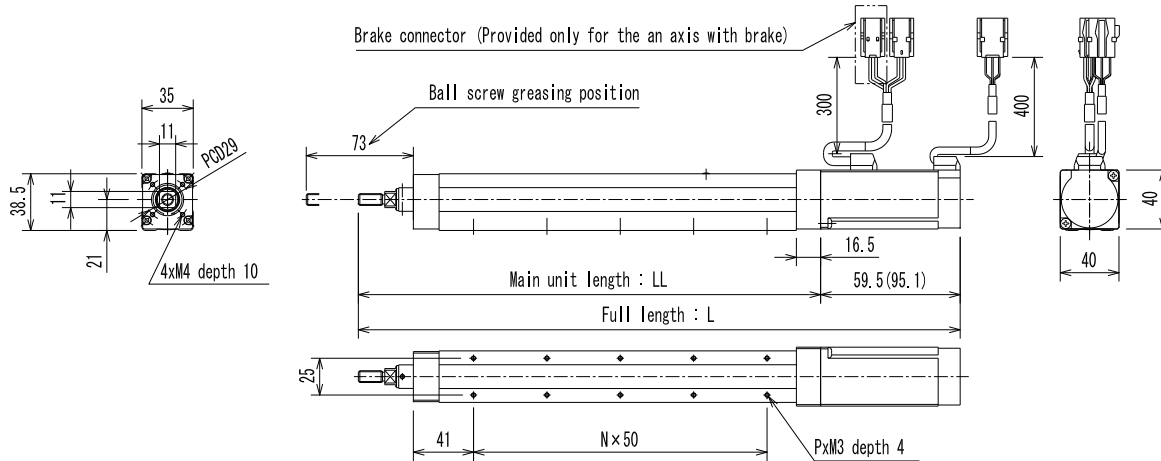
[BET3D-ST-C12*]

Type	Without brake	BET3D-ST-C12N-05	BET3D-ST-C12N-10	BET3D-ST-C12N-15
	With brake	BET3D-ST-C12B-05	BET3D-ST-C12B-10	BET3D-ST-C12B-15
Stroke X (mm)	50	100	150	
Full length L (mm)	274.5 (310.1)	324.5 (360.1)	374.5 (410.1)	
Main unit length LL (mm)	215	265	315	
No. of holes P (q'ty)	6	8	10	
Intervals between mounting holes N	2	3	4	
Weight (kg)	1.0 (1.2)	1.2 (1.4)	1.3 (1.5)	

Note: The value in parenthesis applies to the axis with a brake.



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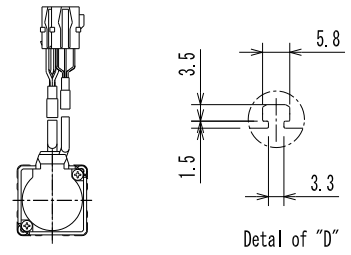
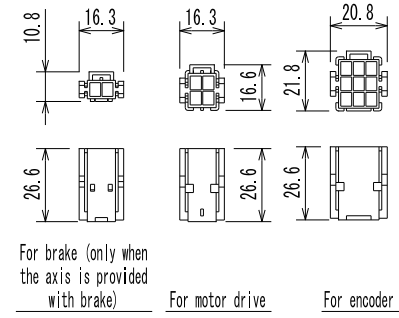
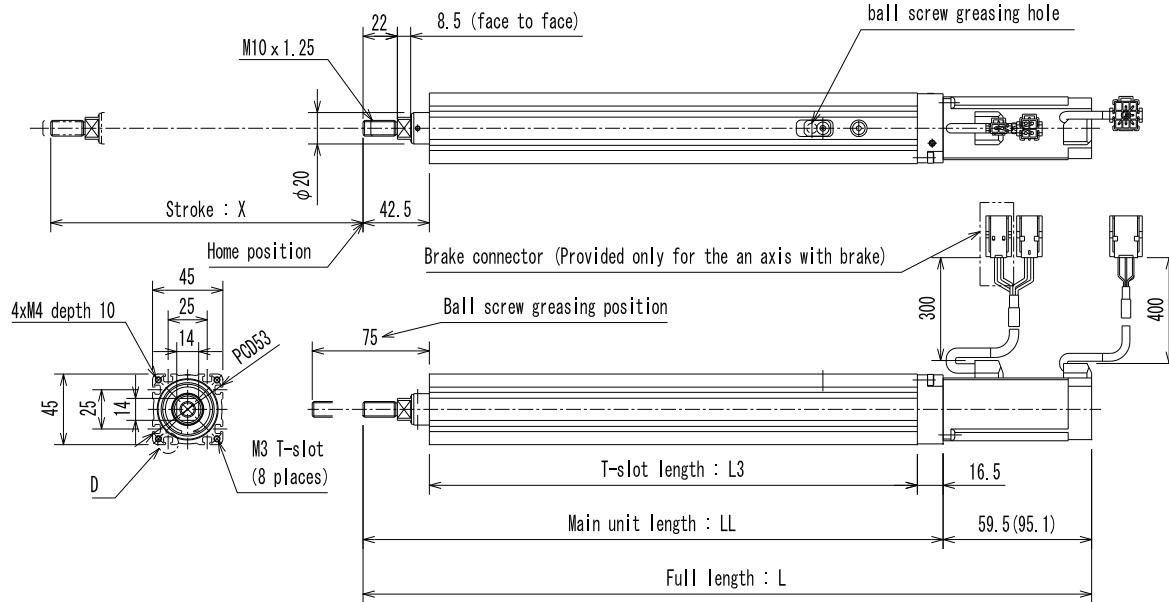


[BET4D-ST-C12*]

Type	Without brake	BET4D-ST-C12N-05	BET4D-ST-C12N-10	BET4D-ST-C12N-15	BET4D-ST-C12N-20
	With brake	BET4D-ST-C12B-05	BET4D-ST-C12B-10	BET4D-ST-C12B-15	BET4D-ST-C12B-20
Stroke X (mm)	50	100	150	200	
Full length L (mm)	281.0 (316.6)	331.0 (366.6)	381.0 (416.6)	431.0 (466.6)	
Main unit length LL (mm)	221.5	271.5	321.5	371.5	
T-slot range L3 (mm)	162.5	212.5	262.5	312.5	
Weight (kg)	1.5 (1.7)	1.8 (2.0)	2.0 (2.2)	2.3 (2.5)	

Note: The value in parenthesis applies to the axis with a brake.

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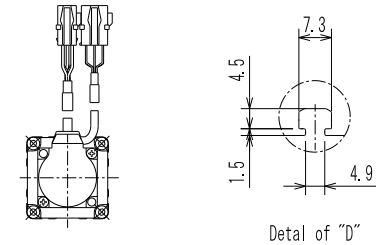
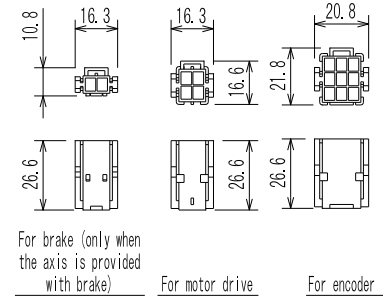
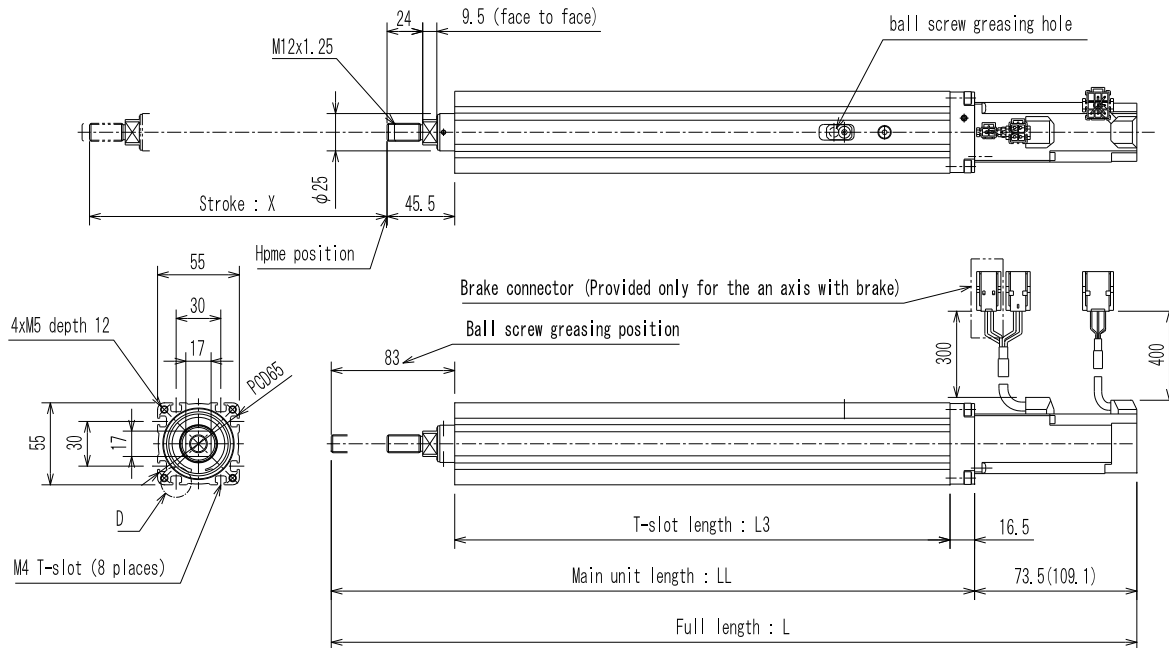


[BET5E-ST-C12*]

Type	Without brake	BET5E-ST-C12N-05	BET5E-ST-C12N-10	BET5E-ST-C12N-15	BET5E-ST-C12N-20	BET5E-ST-C12N-25	BET5E-ST-C12N-30
	With brake	BET5E-ST-C12B-05	BET5E-ST-C12B-10	BET5E-ST-C12B-15	BET5E-ST-C12B-20	BET5E-ST-C12B-25	BET5E-ST-C12B-30
Stroke X (mm)	50	100	150	200	250	300	
Full length L (mm)	318.5 (354.1)	368.5 (404.1)	418.5 (454.1)	468.5 (504.1)	518.5 (554.1)	568.5 (604.1)	
Main unit length LL (mm)	245.0	295.0	345.0	395.0	445.0	495.0	
T-slot range L3 (mm)	183.0	233.0	283.0	333.0	383.0	433.0	
Weight (kg)	2.2 (2.4)	2.6 (2.8)	3.0 (3.2)	3.3 (3.5)	3.7 (3.9)	4.1 (4.3)	

Note: The value in parenthesis applies to the axis with a brake.

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Chapter 4 Installing Actuator (Axis)

4.1 Installing Actuator (Axis)

- This chapter describes the basic installation procedures for the axis and peripheral equipment.
- Installation shall comply with the instructions of this Chapter. If the installation procedure is incorrect, robot performance cannot be achieved. Not only that, the service life may be seriously reduced.

CAUTION Precautions for installation

● Environment of installation site

- (1) The ambient environment for operation shall comply with the following requirements:
 - Ambient temperature Working temperature: 0°C to 40°C
Transportation and storage temperature: -10°C to 50°C
 - Relative humidity: 30 to 90%RH without dew condensation
 - Altitude: 1000 m or less
 - Vibration 0.98 m/s² or less
 - Dust: Free from conductive dust or dirt
 - Gas: Free from flammable or corrosive gas
 - Magnetic field: Free from a nearby device that may generate magnetic field
 - Radiation: Not in the radiation controlled area
 - Others: Without greasy fume
- (2) This product is not designed as an explosion proof structure. Do not use it in a dusty place. Further, take sufficient care of the environment since it is not explosion-proof.
- (3) Do not use it in a place with an organic solvent or white kerosene..
Of guide or ball screw grease is melted. It may cause malfunction.

● Precautions in installation

- (1) Do not allow the product to fall down or be collided with other object during the transportation.
- (2) Install the product where maintenance and inspection are easier.
- (3) Install the controller within the range where it can be reached from the robot proper by a standard cable.
- (4) Installation
 - Install the product on a horizontal installation base.
 - The installation base shall have the length that allows only the frame portion to be mounted.
 - The installation base shall be made of a steel plate having a thickness of 9 mm or more where the plate has a machined surface with flatness of 0.1mm or less. Install this product on this base to correct the bend and twist of the axis frame and to reinforce the axis frame.

● installation

Install the actuator on the set base, using the taps and T-slots on the bottom surface of the actuator.

CAUTION

- The play of the rod becomes larger near the stroke end. When using near the stroke end, vibrations and noise may occur under certain conditions.
- Be sure to connect so that the rod axis center and load/movement direction are aligned. If they are not aligned, twisting can occur in the rod, which can result in damage to the axis unit.
- When using an external guide, make the connection between the rod tip and load so that there is no twisting no matter where the stroke is positioned.

● Installing the controller cable

Installing the controller cable to the axis according to the actuator instruction manual.

Insert the connector for the axis side of the controller cable into the connector for the axis body (for motor power, encoder, origin sensor, brake (only with brake is connected)) until it is locked, and connect it securely.

Insert the motor power connector for the controller side of the cable into the connector on the surface of the controller until it is locked, and then connect it securely. Insert the encoder connector into the connector on the surface of the controller and fix it with screws.

For the connector on the controller side, also refer to the CA25 instruction manual (Basic part).



- Before energizing, be sure to check that there are no connector connection leaks or connection errors.
- When connecting or fixing the connector, do not apply excessive force to the cable.

■ 4.2 Robot type for each Axis

The robot type is indicated by the 6-digit numerals specified for each robot type.

If this setting is made, various parameter values suited to the axis to be used can be automatically set. The input procedure is given in Section 4.2 of the CA25 Instruction Manual (Basic Part).

[BET3D/BET4D/BET5E Robot Type]

(1) When using as a rod type axis (normal operating procedure)

	Lead (mm)	Type of axis	Robot type
BET3D	12	BET3D-ST-C12□-□□	600240
BET4D	12	BET4D-ST-C12□-□□	600250
BET5E	12	BET5E-ST-C12□-□□	601900

■4.3 Parameter values

The parameters of this product are available in two types -- parameter 1 and parameter 2 -- depending on the frequency of use. The relationship between each parameter and the robot type is illustrated below:

Setting the robot type allows the parameters on the circled portion on the left to be automatically changed.

■4.3.1 Values of parameter 1 for each robot type

This parameter has a higher frequency of use.

- Straight axis (Rod movement type)

Automatic setting	Robot type		600240	600250	601900
			(Lead 12)	(Lead 12)	(Lead 12)
	Software limit value (upper limit)		0000.00	0000.00	0000.00
	Software limit value (lower limit)		0000.00	0000.00	0000.00
○	Servo gain Position/Speed	Position	30	30	24
		Speed	25	25	38
	Pass area		0200		
○	Origin offset value		0000.00	0000.00	0000.00
	Sequence of Return to Origin		1 (Note)	1 (Note)	1 (Note)
	JOG speed	L(Low speed)	010	010	010
		H(High speed)	050	050	050
	JOG inching movement		00.01	00.01	00.01

(Note) The Sequence of Return to Origin varies according to the combination format, installation conditions and others. The customer is requested to set it in conformity to your operation conditions.

The initial value is common at "1" for all robot types. Thus, if there is no change, simultaneous origin return of all axes can be achieved.

CAUTION

Regarding the servo gain value, the initial value is automatically set by the input of the robot type, but the conditions vary depending on the specifications of the axis (stroke, grease change, etc.), the installation state of the axis, the load mounting state, etc. Since it will change, change the set value if it is necessary to shorten the cycle time or if abnormal noise is generated due to the oscillation of the servo motor. For the servo gain, please also check the section of ■ 5.1 "Servo gain setting". For details on how to change the servo gain setting, refer to Sections 13.3.3 and 13.3.4 of the CA25 Operation Manual (Basic Part).

■4.3.2 Values of parameter 2 for each robot type

• Straight axis (Rod movement type)

Automatic setting	Parameter		Robot type			
			600240 (Lead 12)	600250 (Lead 12)	601900 (Lead 12)	
	Axis display		X	X	X	
	In position data value		00.05	00.05	00.05	
	Overflow data value		20000	20000	20000	
○	Feed forward data value		02000	02000	02000	
○	Direction of motor rotation		1	1	1	
○	Maximum speed		600	600	600	
○	Return to origin speed	(L) Low speed	002.0	002.0	002.0	
		(M) Medium speed	020.0	020.0	020.0	
		(H) High speed	100.0	100.0	100.0	
○	Return to origin method		2	2	2	
○	Origin sensor logic		0	0	0	
	High speed return to origin position		0020.00	0020.00	0020.00	
○	Lead		12.000	12.000	12.000	
○	Encoder division number		2768	2768	2768	
○	Encoder pulse multiplier		4	4	4	
	Encoder type (Note)		a	a	a	
	Task and axis combination		[1]	[0]	[0]	[0]
	Task order of priority		[1]	[1]	[1]	[1]
	Task coordinate table		999	999	999	999
	Task step number		5000	0000	0000	0000

(Note) The encoder type cannot be set in this robot type since setting for each axis is not available.
See Section 13.4.17 of the CA25 Instruction Manual (Basic Part).

Chapter 5 Precautions for Use

■5.1 Servo gain setting

In the actuator, in order to facilitate the parameter setting work of the controller, the initial parameters for operating the component arm are automatically set by setting the "robot type" (6 digit number) determined for each model to the controller.

The initial value of the servo gain that is automatically set is set to a value that does not cause abnormal noise or vibration in single-axis or combination operation with no load to maximum load. Therefore, the operation cycle time tends to be slower overall. Also, in the initial value state, the cycle time may be longer than that of the old model. The servo gain value is designed to be adjusted by the customer according to the operating conditions and load conditions, such as when shortening the cycle time. Please adjust the servo gain value by referring to ■5.1.1 "Servo gain setting value and operating condition".

For details on how to change the servo gain setting, refer to Sections 13.3.3 and 13.3.4 of the CA25 Operation Manual (Basic Part).

For the robot type setting value, refer to ■4.2 "Robot type for each Axis", and for the initial parameter value set by the robot type setting, refer to ■4.3 "Parameter values".

■5.1.1 Servo gain setting value and operating condition

The relationship between the servo gain setting value and the operating state is as follows.

(1) Position gain (P)

- When the set value is reduced
 - Positioning completion will be delayed (cycle time will be longer).
 - If the position gain is set too small, an error such as an "overflow error" may occur during operation (especially during acceleration) and operation may not be possible.
 - The positioning and holding force of the slider is reduced (rigidity is reduced).
(When the servo is turned on and the slider operation is stopped (servo holding state), it becomes easier to move when an external force is applied to the slider part.)
 - In the case of elevating operation specifications, if an emergency stop is applied while the operation is stopped with the servo on, the amount of drop of the slider will increase.

- When the set value is increased
 - Positioning is completed faster. (cycle time is shorter)
 - Deceleration stop becomes faster, and shaking when deceleration stop becomes larger.
(Especially when the combination specification or when the distance from the slider to the load is long, the shaking becomes large.)
 - Immediately before deceleration stops, shaking will occur due to speed fluctuations.
(It behaves like shaking just before it stops, especially when the load is heavy.)
 - If it is made excessively large, abnormal noise will be generated due to the oscillation of the servo motor.
 - The positioning holding force of the slider part increases. (the rigidity increases) (it becomes difficult to move even if an external force is applied to the slider part when the servo is ON and the slider operation is stopped (servo holding state).)
 - In the case of a belt drive axis, the teeth of the belt may come off due to faster deceleration, and a position error may occur. (Especially when the load is heavy, it is likely to occur)
 - By shortening the cycle time, "overload error" and abnormalities due to overheating of the motor are more likely to occur.

(2) Speed gain (V)

- When the value is reduced
 - If it is made too small, an error such as "overflow error" may occur during operation (especially when accelerating) and operation may not be possible.
 - The positioning and holding force of the slider is reduced. (Rigidity decreases)
- When the value is increased
 - Abnormal noise is generated due to the oscillation of the servo motor.
(Depending on the installation state and load conditions, when the servo is turned on, abnormal noise may occur in the slider operation stop state (servo holding state) or operation state.)

CAUTION

The relationship between gain value and operation described above is an example of a general condition. Other states may appear depending on the combination state, load conditions, operating conditions, and the combination of position gain and speed gain settings.

■ 5.1.2 About adjustment of servo gain

When adjusting the servo gain, refer to the contents described in ■ 5.1.1 "Servo gain setting value and operating condition" and set according to the following description.

(1) Speed gain setting

The initial value of speed gain usually does not need to be changed.

If it is changed, please set as follows.

By increasing the speed gain, the holding rigidity of the slider part becomes stronger, but abnormal noise is more likely to occur.

1. Be sure to perform the confirmation operation.

Increase the speed gain value by 1 or 2 until abnormal noise occurs during operation or stop.

(If there is an abnormal noise such as motor oscillation at the initial value due to load conditions, etc., first lower the speed gain value before put into practice.)

2. Decrease the speed gain value by 1 from the state where abnormal noise is generated until there is no abnormal noise, etc., and determine the upper limit of the speed gain.

3. Set the value (* 1) lowered by "2" from the determined upper limit value as the speed gain setting value.

After setting, operate continuously. Make sure that no abnormal noise is generated during operation or stop. If abnormal noise occurs, lower the set value.

* 1: If the upper limit of the speed gain value that does not cause an abnormality is "20", set "2" lowered, "18".

(2) Position gain setting

To increase the position gain value, set as follows.

By increasing the position gain, the cycle time will be shortened, but shaking and abnormal noise will be more likely to occur when decelerating and stopping.

1. Be sure to perform the confirmation operation.

Increase the position gain value by 3 to 5 until abnormal noise or abnormalities such as shaking begin to occur during operation.

2. Decrease the position gain value by 1 or 2 from the state where an abnormality has occurred to the state where there is no abnormality, and determine the upper limit of the position gain.

3. Set an integer value (* 2) that is 10% lower than the determined upper limit value as the position gain value.

After setting, check that there are no abnormalities in continuous operation. If there is something abnormalities, lower the set value.

* 2: If the upper limit of the position gain value that does not cause an abnormality is "35", lower it by 10% and round down to the nearest whole number, and set "31" as the set value. (The gain setting can only be set to an integer value)

CAUTION

- Checking the operation while energizing is dangerous work. Be sure to take the safety measures described in the section of ■ 1.2 "For your safe operation".
- If you accidentally change the parameter settings that you did not intend, the behavior may be unexpected. Be sure to check the items to be changed before implementing.
- If the parameter value is changed significantly, vibration / shaking or abnormal noise may occur. Be sure to change the value little by little and check the operation.

- Abnormalities such as vibration and abnormal noise may occur due to resonance, so check the operation from the low speed range used for return to origin operation and "JOG" operation to the high speed range used for continuous operation.
- By shortening the cycle time, an "overload error" or an abnormality due to overheating of the motor may occur. If an error occurs, consider changing the motor capacity or operating conditions.
- For the combined specification axes, adjust the servo gain for all axes.
If all the axes have not been adjusted, the amount of deviation in the operation trajectory of the interpolation operation may increase or the positioning may be delayed due to the operation of the axis that has not been adjusted.

Chapter 6 Maintenance

■ 6.1 Precautions for inspection and maintenance work

(1) Precautions for inspection and maintenance work

Observe the following instructions at the time of inspection and maintenance:

1. The robot shall be inspected and maintained by the personnel having a sufficient level of skill and experience.
If such personnel are not available, contact the manufacturer and request implementation of the relevant work or education of the person in charge.
2. Use adequate illumination.
3. The start switch of the stationary operation panel or some other similar portion shall be provided with a notice board to indicate that the inspection and maintenance work is currently in progress.
Before entering the fence and enclosure, lock the open power switch to turn off power completely. If the access of the fence or enclosure is provided with a safety plug, be sure to carry the related plug with you.
4. If you have to enter the fence and enclosure for inspection and inspection of the control circuit, turn off the drive power source.
5. If you have to operate the industrial robot in the inspection and maintenance work within the guard fence and enclosure, you are recommended to take the following measures:
 - Two persons should be engaged in the work in cooperation with each other. This means that role assignment should be made in such a way that one person supervises the work of the other person during the work.
 - It is required to select such a speed that contact with the robot can be avoided in the event of a possible operation error of the robot. Determine the speed suited for the relevant work.
 - Take care of the robot operation during the work. Press the emergency stop button immediately when an unexpected operation has been detected.
6. Before starting disassembly of the pressure gauge or replacement of the parts, release the residual pressure of the cylinder.
7. Before starting disassembly of the hydraulic and pneumatic systems or replacement of parts, take a sufficient care to avoid deposition or mixture of foreign substances such as dust.

(2) Action to be taken subsequent to inspection and maintenance work

1. After termination of the inspection or maintenance work, the inspection or maintenance worker shall carry the tools back to the original position.
2. After termination of the maintenance work, be sure to perform a test run to verify the result. The test run shall be performed from outside the fence and enclosure in principle.
3. After action of item 2 has been taken, the inspection or maintenance worker shall report termination of the inspection or maintenance work to his superior.

■ 6.2 Inspection before starting the work

- (1) Before starting your work with the robot, make sure of the following:
 1. Brake device function
 2. Emergency stop device function
 3. Contact preventive equipment and robot interlock function
 4. Related devices/robot interlocking function
 5. Possible damage of the external wiring and piping
 6. Error of supply voltage and hydraulic and pneumatic pressures
 7. Operation error
 8. Abnormal noise and vibration
 9. Contact preventive equipment state
- (2) This inspection shall be conducted outside the movable range wherever possible.

■ 6.3 Periodic inspection

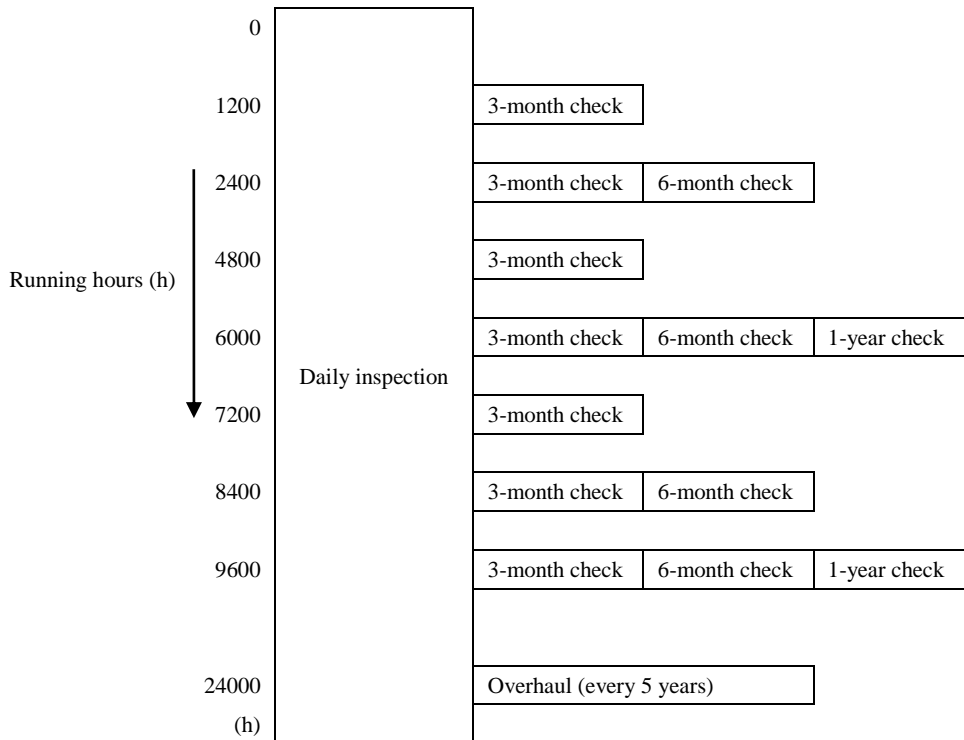
Giving consideration to the robot installation site, frequency of use and durability of the parts, determine the inspection standards including the inspection item, inspection procedure, evaluation criteria and implementation period for the following items. Start inspection in conformity to these standards.

1. Looseness of major parts
 2. Greasing and other possible errors of the movable parts
 3. Power transmission component trouble
 4. Hydraulic and pneumatic system error
 5. Electric system error
 6. Operation failure detecting function error
 7. Encoder error
 8. Servo system error
- [Controller inspection locations]
9. Check that the power supplied to the controller is within the operating range (rated voltage $\pm 10\%$).
 10. Inspect the ventilation holes of the controller, and remove any adhering dirt, dust, or other foreign objects.
 11. Inspect the controller cable (from controller to axis), and check that there is no looseness in the screws and other parts.
 12. Check that there is no looseness in the controller mounting screws and other parts.
 13. Inspect the connectors (motor output connector, encoder input connector, teach pendant connector) and check for any looseness, rattling, or other potential problems.

■ 6.4 Maintenance Schedule

Perform the pre-work inspection before starting work on a daily basis.

Periodic inspections and maintenance performed after a certain period of time should be performed in units of 1200 hours (operating hours). Also, please carry out overhaul every 24000 hours (operating hours).



Regular Inspection interval (reference)

When the system is operated for 16 hours per day: $1,200 \text{ hours} \div 16 \text{ hours} \div 25 \text{ days} = 3 \text{ months}$

When the system is operated for 24 hours per day: $1,200 \text{ hours} \div 24 \text{ hours} \div 25 \text{ days} = 2 \text{ months}$

When the system is operated for 16 hours per day, regular inspection should be conducted every three months. However, if the running hours per day are increased, regular inspection must be done at shorter intervals.

■6.4.1 Maintenance and inspection items by schedule

Determine the schedule for Inspection before starting the work and periodic inspection and maintenance.

(1) Inspection at Power OFF

Description	Inspection point	I: Inspection before starting the work S: Semi-annual inspection				Q: Quarterly inspection A: Annual inspection	
		I	Q	S	A		
Make sure that all bolts are completely tightened and secured. If there are any loosened or unsecured bolts, re-tighten them.	Tool set bolts	○	○	○	○		
	Robot installation bolts	○	○	○	○		
Make sure that the cables and tubing are not damage.	Cables and air tubing	○	○	○	○		
Check each axis operation. Move each axis by hand for check.	Entire robot			○	○		
Clean the contaminant, if any. Make sure that no cut or scratch is found. Refer to ■6.5	Entire robot	○	○	○	○		
Please check the condition of the grease. Greasing Refer to ■6.6	Ball screw and linear guide	○	○ Greasing	○ Greasing	○ Greasing		

(2) Inspection at Power ON

Description	Inspection point	I: Inspection before starting the work S: Semi-annual inspection				Q: Quarterly inspection A: Annual inspection	
		I	Q	S	A		
Push each axis by hand in the servo ON condition to make sure that the rod is secured.	rod				○		
Make sure that no abnormal vibration or noise is caused.	Entire robot	○	○	○	○		
Make sure that the teaching points are in place.	Positioning of rod		○	○	○		
Replace the batteries for position detection with new ones.	Battery for encoder backup (Attached to CA25 controller)	Replace every 3 years					
Operation check of emergency stop device and safety devices.	Emergency stop switch Safety fence switch	○	○	○	○		
Anomaly confirmation of supply voltage, supply hydraulic pressure and air pressure.	Power-supply voltage, Hydraulic pressure and air pressure	○	○	○	○		

(3) Overhaul

Description	Maintenance parts	Every 5 years
Check the consumable parts and replace as necessary.	Motor, Controller cable (When used in movable), Battery for encoder backup	○

Depending on the device, add necessary items and perform inspection and maintenance.

■ 6.5 Cleaning

Clean the robot proper.

Clean the robot proper in conformity to the following steps:

1. Turn off the power switch and remove the power plug.
2. Use waste cloth or such to remove the dust and dirt from the frame etc.
3. Check the robot for scratches, wear and other abnormalities.
If there are scratches or wear, repair the parts or arrange for parts.
4. After cleaning it, supply grease according to the greasing step.

■ 6.6 Greasing

Greasing procedure

1. Use the jog operation to significantly extend the rod out to the range where the ball screw can be greasing in Table 6.1.
By significantly extending the rod to the range where the ball screw can be greasing, the ball screw can be greasing from the ball screw greasing hole (areas when not within the range where the ball screw can be greasing are blocked by internal parts, and so greasing of the ball screw is not possible).
2. Turn off the drive power.
3. Remove the lid of the ball screw greasing hole on the axis.

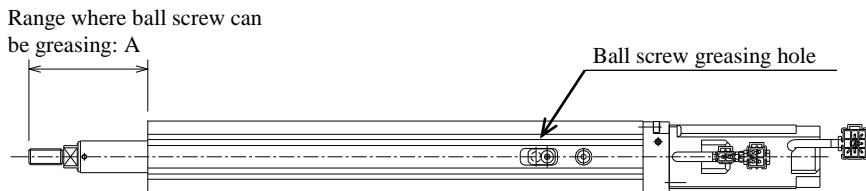


Table 6.1 Range Where Ball Screw Can Be greasing

Axis type	Distance A
BET3D-ST-C12*-.**	73 mm or more
BET4D-ST-C12*-.**	75 mm or more
BET5E-ST-C12*-.**	83 mm or more

4. Greasing from the ball screw greasing hole by following the information in the table and figure.

Greasing position	Type of grease (manufacturer)	Inspection and greasing intervals	Volume of grease
Ball screw	AFF Grease (THK)	Every 3 months	grease 1 cc per 100 mm stroke from the ball screw greasing hole.

5. Wipe off any oil that is oozing out or discolored.
6. Reattach the lid of the ball screw greasing hole.

■ 6.7 Adjusting Home Position

Adjust the origin position by following the procedure below.

- (1) Turn off the power.
- (2) Remove the hex socket head cap screw (M4) on the motor block top surface.
Move the rod forward and backward by hand, and align the positions of the holes where the coupling tightening screw securing the motor axis (hex socket head bolt (M2.5)) and the above hex socket head cap screw were removed. (Use a narrow rod or other implement to check the bolt of the coupling inside the motor block from the hole.) Tighten the coupling tightening screw securing the motor axis.
If the coupling tightening screw is at a position where it cannot be loosened in an axis model with brake, use the jog operation to slightly turn the motor axis until the bolt holding the motor axis is aligned with the hole position.
(See section 16.5 of the CA25 Operating Manual (Basic).)

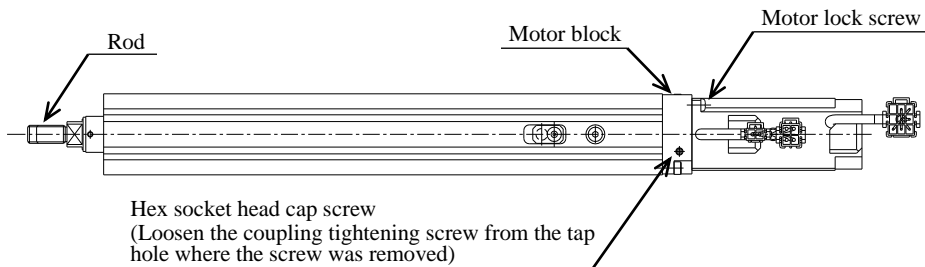


Fig. 6.7-1

- (3) Remove the two motor lock screws, and remove the motor from the axis unit.
- (4) Temporarily connect the motor and controller, and then connect the teach pendant to the controller, and turn on the power. For the connection procedure, see section 2.5.4 of the CA25 Operating Manual (Basic).
- (5) Set the servo gain (position/speed) in parameter group 1 to "0". For the setting procedure, see sections 13.3.3 and 13.3.4 of the CA25 Operating Manual (Basic).
- (6) Set the origin return system value in parameter group 2 to "3".
- (7) Perform the origin return operation, and wait until the motor comes to a stop.

- (8) Press in the rod to its most retracted position, and from this position, slowly pull out the rod by hand to extend it to the position where the coupling notch is parallel with the surface of the coupling tightening hole (position where the coupling tightening screw is tightened). Measure the distance A at this position.

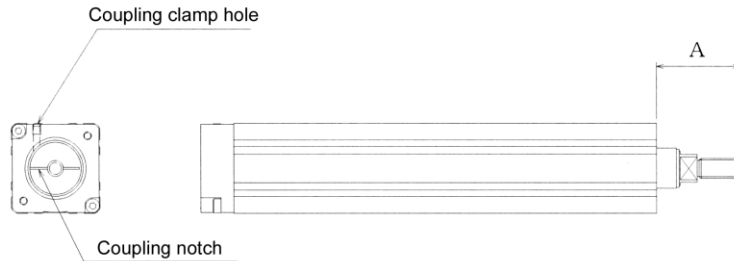


Fig. 6.7-2

- (9) Calculate the correction value from the formula below.
Correction value = A – Origin position

Table 6.2 Origin Positions for Each Axis

Axis type	Origin position
BET3D-ST-C12*_*_*	37.5
BET4D-ST-C12*_*_*	42.5
BET5E-ST-C12*_*_*	45.5

- (10) Drive the motor to the correction value found in step (9).

The motor can be driven in one of two ways.

- (a) Execute by creating a program.

- 1) Set the soft limit value (negative) to -5 . For the setting procedure, see section 13.3.2 of the CA25 Operating Manual (Basic).
- 2) Create and execute the program below using the teach pendant. The program is an example for reference only. For details on program input and execution, see chapter 5 of the CA25 Operating Manual (Basic).

Program	Description
0001 SPD V=01	The low speed is selected from the speed table.
0002 ACC 05	The low acceleration/deceleration is selected from the acceleration/deceleration table.
0003 MOVP V=00 a S NO=001 CNT[00] POST	Movement is performed to the correction position. The calculated correction value is entered to position table 001.
0004 END	This exits the program.

- (b) Execute manually. This method cannot be executed using a motor with brake.

- 1) Turn off the servo.
- 2) Switch the display of the teach pendant to monitor mode. For the switching procedure, see section 14.4 of the CA25 Operating Manual (Basic).
- 3) Turn the motor axis slowly by hand, and set to the correction value found in step (9).

- (11) Turn off the controller power, mount the motor to its original position, and tighten the coupling tightening screw.
(Tightening torque: 1.0 N·m)

CAUTION Be sure to always turn off the controller before tightening the coupling tightening screw.
Do not shift the motor axis and coupling from the stopped position.

- (12) Turn on the power again, return the servo gain (position/speed) to its original value, and set the origin return system value in parameter group 2 to "2".
- (13) Turn the power off and on again, perform the origin return operation, and check whether the rod position is as shown in Table 6.2.
- (14) If the driving to the correction value was executed using method (a) in step (10), return the soft limit value (negative) to its original value. Also, delete the program that was added.

6.8 Changing Home Position

- (1) Set the value of the motor rotation direction in parameter group 2 to "0".
- (2) Adjust the origin position. The adjustment procedure is identical to that in section 6.4, but the calculation method of the correction value is different.
Extend the rod to its most extended position, and from this position, slowly return the rod by hand so that it is extended to the position where the coupling notch is parallel with the surface of the coupling tightening hole (position where the coupling tightening screw is tightened). Measure the distance A to this position.



Fig. 6.8-1

- (3) Calculate the correction value from the formula below.
Correction value = Reference value + Axis stroke – A

Table 6.2 Origin Positions for Each Axis

Axis type	Reference value
BET3D-ST-C12*_*_*	37.5
BET4D-ST-C12*_*_*	42.5
BET5E-ST-C12*_*_*	45.5

- (4) The origin position is the position where the reference value + axis stroke rod is extended.

■ 6.9 Changing the Drawing-out Direction

To change the drawing-out direction of the motor, perform the same procedure as section 6.7, "Adjusting the Origin Position". When mounting the motor, turn it to the required direction and mount.

■ 6.10 Replacement of ball screw

- If the replacement of ball screw needs to be replaced, contact our sales office closest to your company. It must not be replaced by the customer.
- This replacement is performed for each axis. It should be noted that this replacement cannot be made inside the device or in the combined state.

■ 6.11 Bolt and screw tightening torque

For the tightening torque of bolts, etc., tighten the parts not described in the work procedure, etc. with the values in the table below.

Name	Screw size	Tightening torque (N·m)	Remarks
Hexagon socket head cap screw	M4	2.45	

Chapter 7 Spare Parts

■7.1 Spare Parts

When a trouble has occurred to the robot proper and you have found it out at an earlier stage, you cannot repair it if you have no repair parts. Accordingly, you are recommended to keep spare parts on hand.

No.	Parts number	Parts name	Remarks
1	A5300001	BA3-50W AC servo motor	For straight axis BET3/BET4 (50W)
2	A5300002	BA3-50W AC servo motor with brake	For straight axis with brake BET3/BET4 (50W)
3	A5300003	BA3-100W AC servo motor	For straight axis BET5 (100W)
4	A5300004	BA3-100W AC servo motor with brake	For straight axis with brake BET5 (100W)

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