

LBC Series

High Thrust Linear Actuator Manual

(AC Servo-motor models for Closed-Loop Positioning)

- Thank you very much for your purchasing our LBC series linear actuator.
- Be sure to use sufficient safety measures when installing and operating the equipment so as to prevent an accident resulting in a serious physical injury damaged by a malfunction or improper operation.
- Product specifications are subject to change without notice for improvement purposes.
- Keep this manual in a convenient location and refer to it whenever necessary in operating or maintaining the units.
- The end user of the actuator should have a copy of this manual.



ISO certification



SAFETY GUIDE

For linear actuator series/servo driver system



Read this manual thoroughly before designing the application, installation, maintenance or inspection of the actuator.



Indicates a potentially hazardous situation, which, if not avoided, could result in death or serious personal injury.



Indicates a potentially hazardous situation, which, if not avoided, may result in minor or moderate personal injury and/or damage to the equipment.

LIMITATION OF APPLICATIONS:

The equipment listed in this document may not be used for the applications listed below:

- * Space equipment
- * Amusement equipment
- * Aircraft, aeronautic equipment
- * Machine or devices acting directly on the human body
- * Nuclear equipment
- * Instruments or devices to transport or carry people
- * Household apparatus
- * Apparatus or devices used in special environments
- * Vacuum equipment
- * Instruments or devices to prevent explosion
- * Automobile, automotive parts

Safety measures are essential to prevent accidents resulting in death, injury or damage of the equipment due to malfunction or faulty operation.

NOTICES TO USE AN ACTUATOR

Notices for designing and application: Always read the relating technical documents for the purpose.

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|
WARNING | <ul style="list-style-type: none"> Do not insert your hand, etc. into the operation area of the output rod (output shaft) of the linear actuator. ● High thrust is outputted from the output rod. Inserting your hand into the operation area may cause injury. ● LBC series: Maximum thrust of 12000N (1220kgf) |
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CAUTION | <ul style="list-style-type: none"> Use the actuator and motors only in a specified environment. ● Use the actuator and motors with the following indoor conditions: <ul style="list-style-type: none"> - Ambient temperature: 0 to 40°C - Ambient humidity: 20% to 80%RH (No condensation) - Vibration: 24.5m/S² or less - No water or oil drips - No corrosive or explosive gas |
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CAUTION | <ul style="list-style-type: none"> Install the actuator and motors with the applied equipment precisely following the relating instruction manuals. ● Align the shaft of actuator and motors with the applied equipment precisely following the relating instruction manuals. ● Secure the output rod (output shaft) of the actuator to the paired unit properly according to the technical documents. ● If the alignment is not precise, vibration will occur, resulting in damage to the bearing. |
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Notices for operation: Always read the relating technical documents for the purpose.

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CAUTION | <ul style="list-style-type: none"> Do not apply thrust exceeding the actuator's and motor's maximum thrust. ● Using the actuator by exceeding its maximum thrust may cause lower precision or failure. ● LBC series: Maximum thrust of 12000N (1220kgf) |
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CAUTION | <ul style="list-style-type: none"> Do not plug actuators or motors directly to the commercial power supply. ● An actuator or a motor cannot run without paired driver unit. ● Direct connection to the commercial power supply will damage the actuator or motor, and may cause fire. |
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CAUTION | <ul style="list-style-type: none"> Do not hit actuators and motors. ● As an actuator or a motor houses an encoder, do not hit it with a wooden hammer or others. ● When an encoder is fault, the actuator or the motor runs uncontrollably. |
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CAUTION | <ul style="list-style-type: none"> Do not pull lead wires. ● Pulling lead wires will damage wire connections, causing uncontrolled rotation. |
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CAUTION | <ul style="list-style-type: none"> Do not use the output rod for any purposes involving hitting to stop. ● It may cause damage in the actuator driving system, resulting in failure or a shorter life. |
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CAUTION | <ul style="list-style-type: none"> Do not operate the actuator with wet hands. ● It may cause an electric shock. |
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CAUTION | <ul style="list-style-type: none"> Do not touch the main body during operation. ● The output rod generates high thrust. It may run away due to wrong wiring, etc. ● The surface of the actuator may become very hot during operation. |
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CAUTION | <ul style="list-style-type: none"> The output rod has no self-holding function. ● It cannot hold the load in case of alarm stop or power shutdown. Provide an external function to avoid danger. |
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|
CAUTION | <ul style="list-style-type: none"> Do not repair, disassemble, or modify it. ● It may cause an electric shock, injury, or fire. Also, the initial performance may not be reproduced. |
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NOTICES TO USE A DRIVER UNIT


Notices for designing and application: Always read the relating technical documents for the purpose.

 <p>Always use the driver unit in the specified environment.</p> <ul style="list-style-type: none"> ● The control unit is for indoor use only. Observe the following conditions: <ul style="list-style-type: none"> - Install it with vertical orientation having enough space from other devices. - 0 to 40°C, 95%RH or less (No condensation) - No vibration, no shock - No water or oil drips - No corrosive gas, no explosive gas, no dust, or no powder. 	 <p>Make sufficient noise suppression and grounding.</p> <ul style="list-style-type: none"> ● Electric noise on a signal wire may cause result in unit malfunction or unexpected occurrence of troubles. Keep the following conditions: <ul style="list-style-type: none"> - Separate signal wires from power lines. - Make electric wires short as much as possible. - Actuators and control units should be grounded at one single point having grounding resistance class 3 or more. - Do not use a power line filter into motor circuit.
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Notices for operation: Always read the relating technical documents for the purpose.

 <p>Do not change wiring whenever power supply is active.</p> <ul style="list-style-type: none"> ● Turn power OFF at first, then disconnect or connect connectors or wires. Getting an electric shock or abnormal damage may occur by changing wire during power active. 	 <p>Do not touch a terminal after at least five minutes from power-OFF.</p> <ul style="list-style-type: none"> ● Even after power-OFF, electric charge remains in the control unit. To avoid an electric-shock-accident, inspection must start after five minutes from power-OFF. ● The control unit should be housed in a cabinet box designed not to touch electric parts easily/
 <p>Do not make a withstanding voltage test.</p> <ul style="list-style-type: none"> ● Do not make a withstand test or a voltage resistance test. The test causes damage to the control unit. ● For this type of use, consult with us. 	 <p>Do not operate a control unit by means of power ON/OFF operation.</p> <ul style="list-style-type: none"> ● The frequent power ON/OFF operation may cause deterioration of the electric elements. ● Start/stop operation should be performed by means of input signals.
 <p>In case of power failure, turn off the power of the control unit and driver.</p> <ul style="list-style-type: none"> ● Failure to do so may cause injury or damage to the device due to sudden restart. 	 <p>Do not touch the actuator with wet hands.</p> <ul style="list-style-type: none"> ● It may cause an electric shock.
 <p>Do not repair, disassemble, or modify it.</p> <ul style="list-style-type: none"> ● It may cause an electric shock, injury, or fire. Also, the initial performance may not be reproduced. 	

Abandonment of an actuator and servo driver:

 <p>Abandon an actuator and motor as industrial waste.</p> <ul style="list-style-type: none"> ● Upon disposal, disassemble it as much as possible, separate parts with indicated materials according to the markings, and dispose of them as industrial waste.
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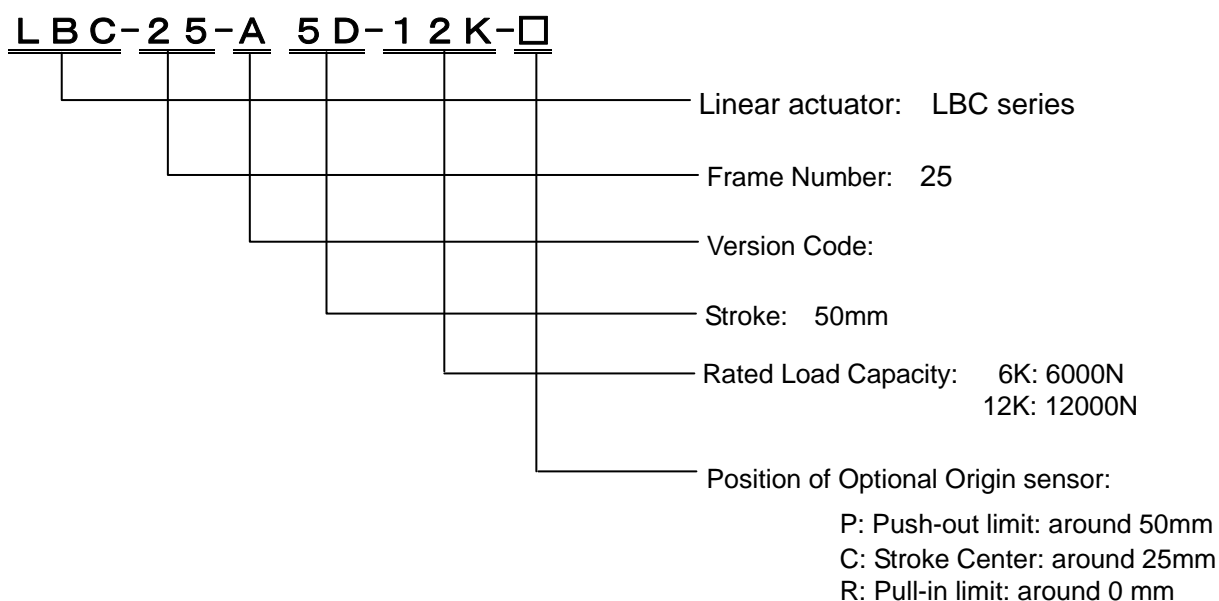
Chapter 1 Overview of the LBC series

The LBC series actuators (AC servo-motor model) are linear actuators incorporating a precise trapezoidal screw, a AC motor for closed-loop positioning, and a Harmonic drive® component having small size, high precision, and no backlash. With a dedicated control unit, the actuators offer remarkable preciseness in positioning and the smoothest motion from top speed to extremely low speed responding to input signals.

1-1 Features

- ◆ High thrust ... Maximum thrust: 12000N and 6000N
- ◆ High positioning accuracy, Repeatability: $\pm 5\mu\text{m}$
- ◆ High axial stiffness
- ◆ Closed-loop positioning
- ◆ Compact
- ◆ Self holding

1-2 Ordering information



1-3 Specifications

1-3-1 Actuator specifications

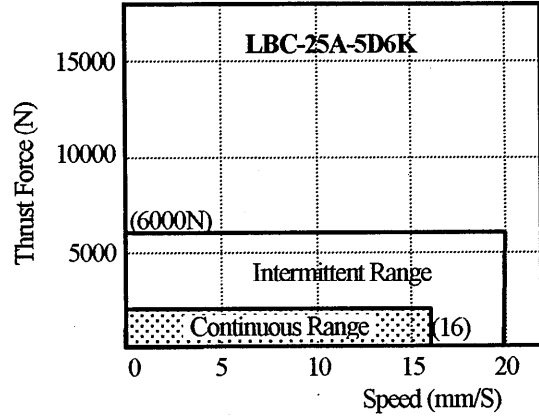
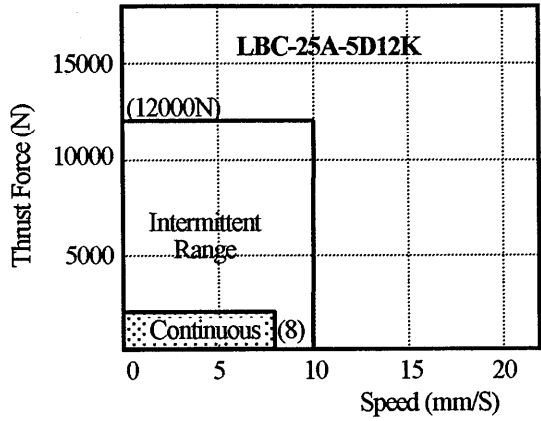
Specifications	Models	
	LBC-25A-5D6K	LBC-25A-5D12K
Maximum load capacity	6000N	12000N
Rated speed	16 mm/sec	8 mm/sec
Maximum speed	20 mm/sec	0 mm/sec
Stroke	±25mm	
Limit switch distance	±27mm	
Mechanical limit	±28mm	
Resolution per encoder pulse (Note 1)	0.32μm	0.16μm
Positioning repeatability (Note 2)	±5μm or less	
Axial stiffness	180N/μm	
Maximum static axial load (Note 3)	14700N	
Maximum static radial load (Note 3)	980N	
Max. dynamic radial load (Note 3)	735N	
Duty cycle (See section 3.3.)	15%ED at max. load	35%ED at max. load
Enclosure, cooling	Totally enclosed, natural cooling	
Lubrication	Grease	
Ambient temperature	0°C to +40°C	
Humidity	20 to 80%RH (No water condensation)	
Storage temperature	-20°C to +60°C	
Shock	294m/s ²	
Vibration	24.5m/s ²	
Installation	All position	
Mass	12.5kg	

Note 1: The values are obtained from the calculation with the screw pitch, the reduction ratio of harmonic drive component, and the resolution of encoder.

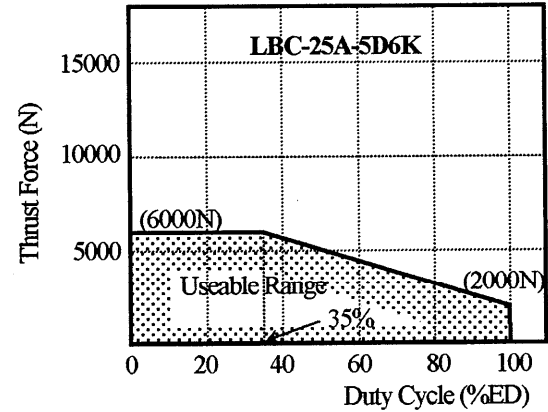
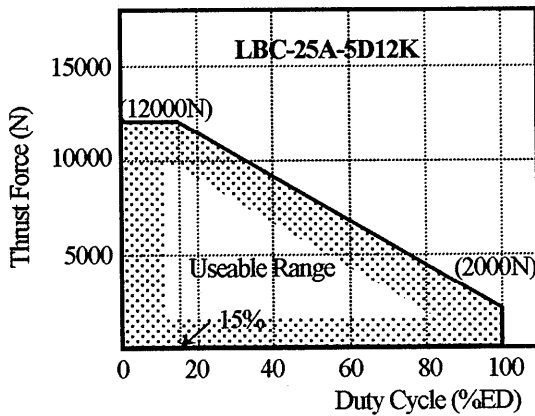
Note 2: The value is obtained by the test under JIS B6201 standard with the maximum payload.

Note 3: Allowable payload for the output rod.

1-3-2 Relationship between thrust and speed



1-3-3 Duty cycle



1-3-4 Control unit specifications

■ HA-655-2B-200

Models		HA-655-2B-200
Specifications		
Driver's nominal current		1.9A
Driver's maximum current		5.7A
Power supply	Main circuit	AC200 to 240V(1 / 3-phase) +10 to -15% 50 / 60Hz
	Control circuit	AC 100 to 115V or AC200 to 240V(1-phase) +10 to -15%
Power Control Method		Sinusoidal PWM control 12kHz
Applicable encoder		Incremental 1000pulse/rev
Ventilation		Self cooling
Installation		Base mount (Wall mount)
Mass		1.5Kg
Control mode		Position mode
Position mode	Command pulse interface	Line driver(compliant with EIA422A standard), open collector
	Command configuration	1-pulse train (step and direction), 2-pulse train (FWD/REV pulses), 2-phase pulse (A-B phase pulses with 90 degree difference)
	Command frequency	Line driver: 500kpps(max) Open collector: 200kpps(max) , limited by actuator's maximum speed
	Input signal	Servo-ON, Error counter·alarm clear, FWD inhibit, REV inhibit, (Every signal is insulated by opt-isolators.)
	Output signal	In-position, alarm, ready, alarm code (4-bit) (Every signal is insulated by opt-isolators.)
Position signal output		Phase-A, -B, -Z; line driver output; Phase-Z: Photo-coupler output
Analog monitor		2ch: motor speed, current command
Protection function		Over current, overload, error counter overflow, over speed, abnormal regeneration, Encoder failure, over voltage, communication error, CPU failure, memory failure,
Regeneration		Built-in resistor (power: 40W Max) External resistor is acceptable.
Functions		Monitoring, self diagnosis, electronic gear, JOG operation, trapezoidal speed profile, and etc.
Allowed Environment		Operating temperature: 0 to 50°C Storage temperature:-20 to 85°C Operating/storage humidity: below 95%RH (No condensation) Vibration resistance: 4.9 m/s ² (10 to 55Hz) Impact resistance: 98m/s ²

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■ HA-675-2B-200

Models	HA-675-2B-200	
Specifications		
Driver's nominal current	1.9A	
Driver's maximum current	5.7A	
Power supply	Main circuit	AC200 to 240V(1 / 3-phase) +10 to -15% 50 / 60Hz
	Control circuit	AC 100 to 115V or AC200 to 240V(1-phase) +10 to -15%
Power Control Method	Sinusoidal PWM control 12kHz	
Applicable position sensor	Incremental 1000pulse/rev	
Ventilation	Self cooling	
Installation	Base mount (Wall mount)	
Mass	1.5Kg	
Input signal	Clear, Servo-ON, Originating, Interlocking, Start, Stop, Addressing, Emergency stop, Origin signal, FWD-limit, REV-limit, (Every signal is insulated by opt-isolators.)	
Output signal	Ready, Motion finish, Originated, Alarm, Alarm code (4-bit), Current address (Every signal is insulated by opt-isolators.)	
Position signal output	Phase-A, -B, -Z; line driver output	
Analog monitor	2ch: motor speed, current command	
Protection function	Emergency stop inputs, FWD and REV limits, Over current, Overload, Over voltage, Error counter overflow, Over speed, Regenerative failure/main power voltage failure, Encoder failure, CPU failure, Memory failure.	
Regeneration	Built-in resistor (power: 40W Max) External resistor is acceptable.	
Functions	Monitoring, Self diagnosis, JOG operation, Trapezoidal speed profile, S-curve speed profile, Compound speed profile, Indexing.	
Operation program	Operate by the teach box. (Program write, read and modify) Connector for connection to the teach box: CN3	
	Operate by PC (dedicated program software: PSF-670) (Program write, read and modify) Connector for connection to the personal computer: CN3	
Allowed Environment	Operating temperature: 0 to 50°C Storage temperature:-20 to 85°C Operating/storage humidity: below 95%RH (No condensation) Vibration resistance: 4.9 m/s ² (10 to 55Hz) Impact resistance: 98m/s ² Atmosphere: metal powder, dust, oil mist and corrosive gas are not allowed.	

1-3-5 Stroke limit switches

Model	D2JW-01K31 (Manufactured by OMRON Co., Ltd.)
Contact Capacity	DC30V, 100mA for resistance load
Contact type	1C
Life	100,000 times or more
Cable	0.14mm ² 5 core wire shield cable

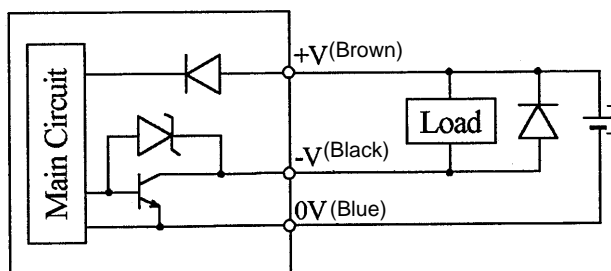
Lead Color	Switch location	Type
Green	Push-out end (+)	Normal Open (NO)
White	Push-out end (+)	Normal Close (NC)
Brown	Pull-in end (-)	Normal Open (NO)
Red	Pull-in end (-)	Normal Close (NC)
Black	Common	-

Note: Refer to Omron's catalog for the details.

1-3-6 Origin sensor (Optional)

Model	GXL-8F (Manufactured by SUNX Co., Ltd.)
Positioning Repeatability	Less than 0.04mm
Power Source	12~24VDC ± 10%
Current Consumption	Less than 15mA
Output	NPN transistor open collector Maximum current: 100mA Voltage: 30VDC or below
Cable	0.08mm ² 3 core wire cable (Oil, heat and low temp. resistant)
Cable extension	Up to 100m with 0.08mm ² (or thicker) cable

Lead Color	Designation
Brown	+V
Black	Output
Blue	0V



Note: Refer SUNX'S catalog for the details.

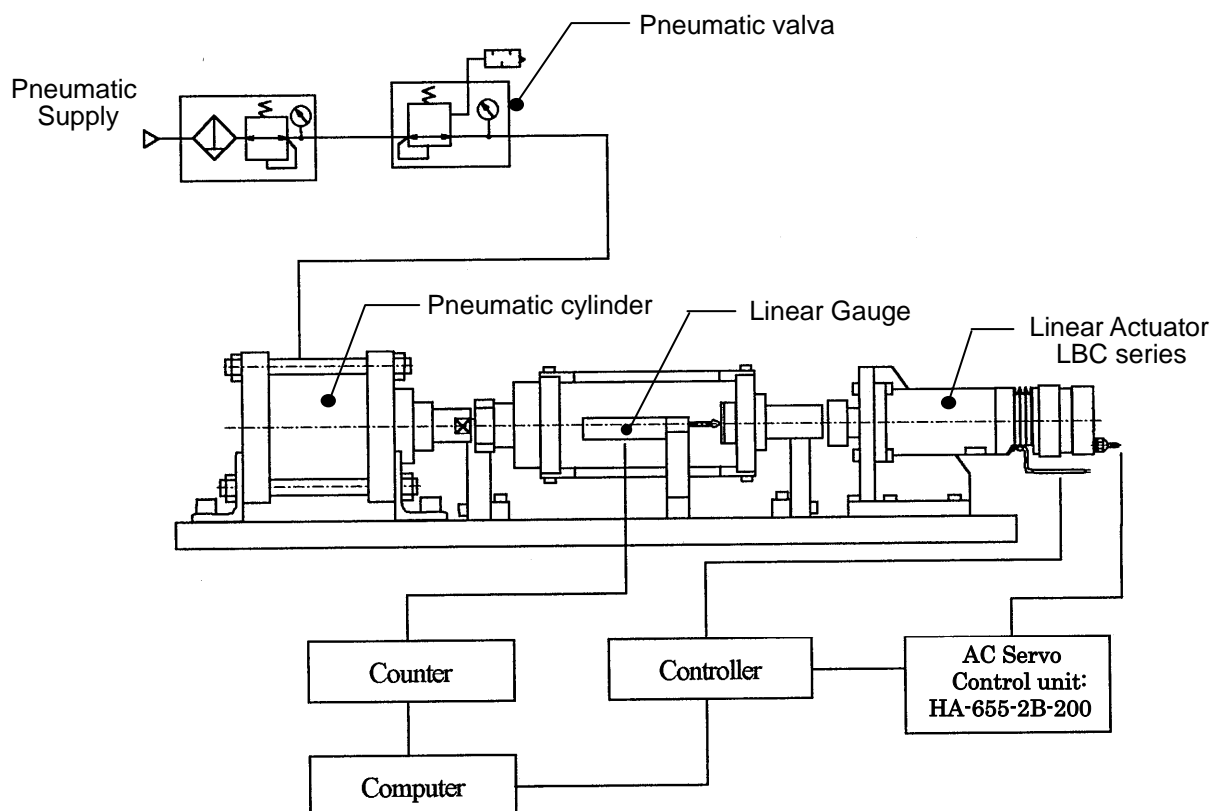
1-3-7 Motor and encoder leads connection with the control unit

Motor Lead	
Color	Name
Red	Phase-U
White	Phase-V
Black	Phase-W
Green	Ground
Blue	-
Yellow	-

Encoder Lead	
Color	Name
Red	DC5V
Black	0V
Green	Phase-A
Green/White	Phase- \bar{A}
Gray	Phase-B
Gray/White	Phase- \bar{B}
Yellow	Phase-Z
Yellow/White	Phase- \bar{Z}
Brown	Phase-U
Brown/White	Phase- \bar{U}
Blue	Phase-V
Blue/white	Phase- \bar{V}
Orange	Phase-W
Orange/White	Phase- \bar{W}
Shield	Ground

1-4 Testing system and standard for testing

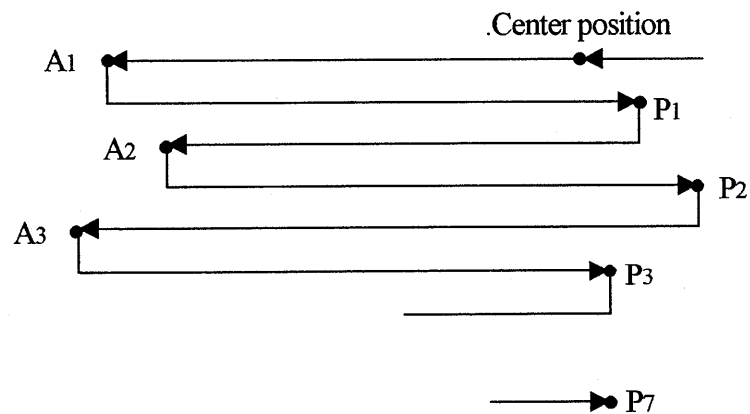
1-4-1 Testing system



1-4-2 Standard for repeatability testing

■ Repetitive positioning accuracy

- A. The actuator is loaded the maximum value.
- B. Actuator rod moves toward pushing direction until the stroke center (around 25mm position).
- C. The rod moves 5mm toward pushing direction. The position is named [A1].
- D. The rod draws 5mm toward pulling, direction, and the position is measured. The position is named [P1].
- E. The rod moves 5mm toward pushing direction [A2]. Then it draws 5mm toward pulling direction, and the position is measured. The position is named [P2].
- F. Above push-pull motion is repeated seven times in total. Then seven positions [P1, P2, ..., P7] are measured. The local repetitive accuracy is obtained as a half of difference from the maximum measured value to the minimum value.



$$\text{Repetitive Accuracy} = \pm \frac{P \text{ max.} - P \text{ min.}}{2}$$

- G. Above test are repeated at positions at around 7mm and 32mm. The repetitive positioning accuracy is the maximum value of three local accuracy data.

1-5 Mechanical Characteristics

1-5-1 Allowable loads

(1) Maximum static axial load (F_{oa})

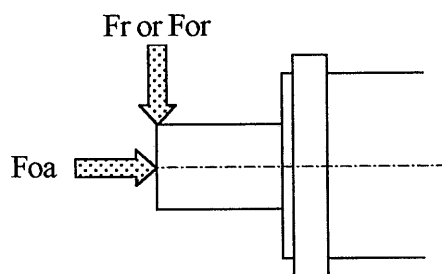
The load shows the allowable limit of the thrust load (push and pull) for the actuator while it stops by servo-lock status or no power supply. The value is 14700N.

(2) Maximum static radial load (F_{or})

The load shows the allowable limit of the radial load to the tip of the rod at its maximum extended position (+25mm) while it stops. The value is 980N.

(3) Max. dynamic radial load (F_r)

The load shows the allowable limit of the radial load to the tip of the rod at its maximum extended position (+25mm) while it is moving. The value is 735N.

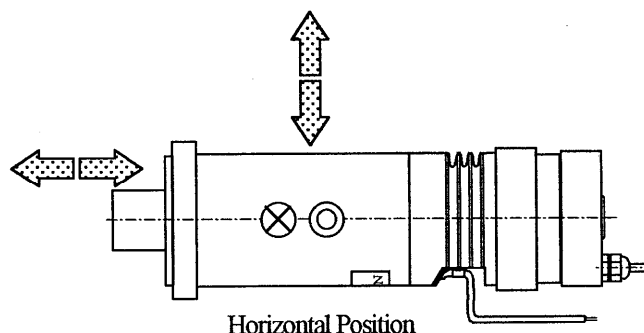


1-5-2 Axial stiffness of output rod

The axial stiffness shows a value of the axial thrust applied to the rod when the distance from the fixing flange surface to the rod tip has $1\mu\text{m}$ compression or expansion depending on the thrust direction. The value is $180\text{N}/\mu\text{m}$.

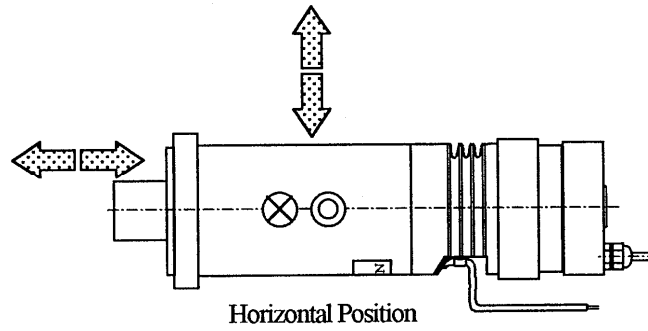
1-5-3 Impact

When the actuator is installed horizontally and impacted the side face from three dimensions, the actuator withstands impact of 294 m/s^2 (acceleration) three times.



1-5-4 Vibration

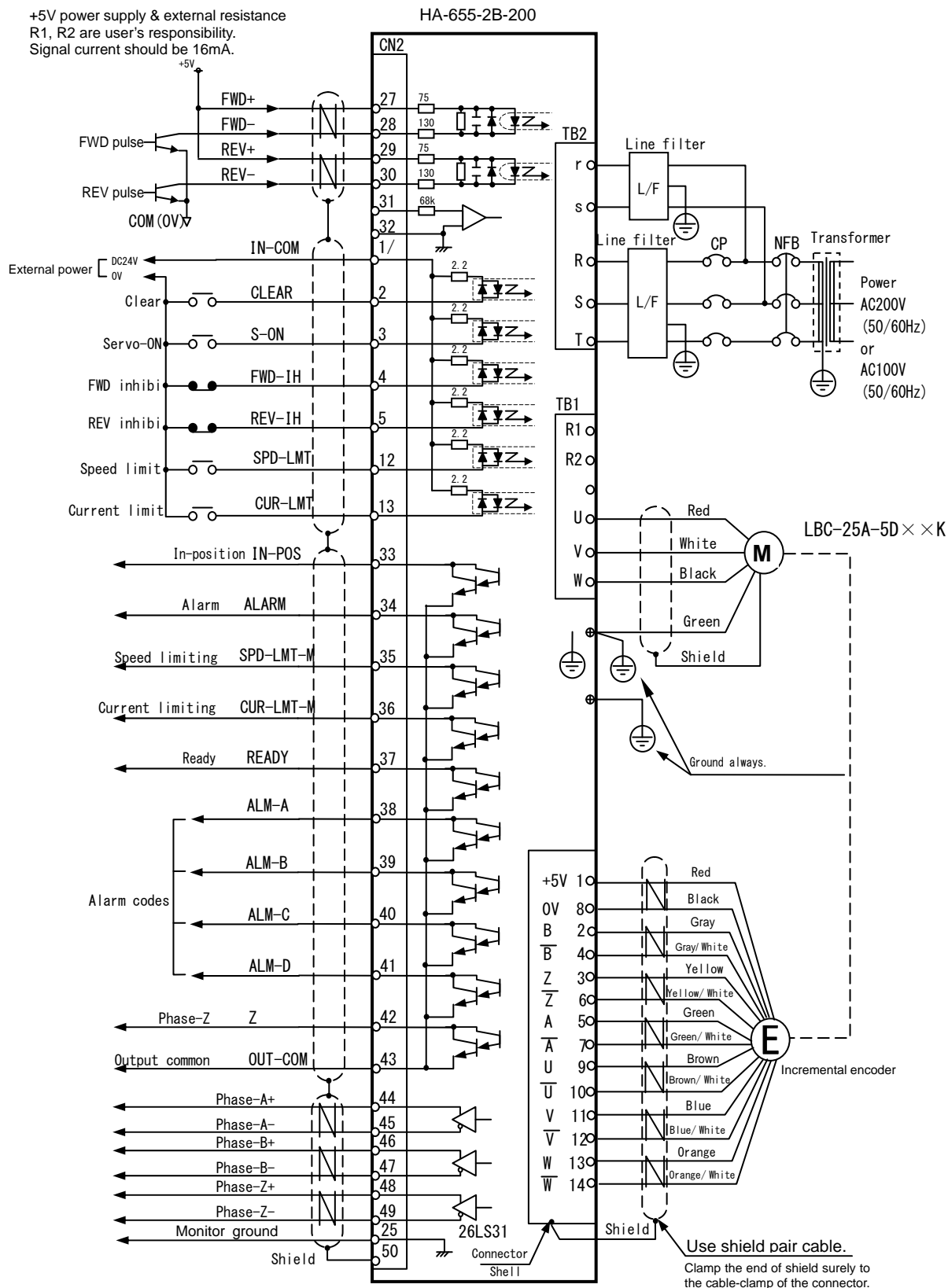
When the actuator is installed horizontally and vibrated from three dimensions, the actuator withstands vibration of 24.5 m/s^2 (acceleration) at frequency from 10 to 400Hz.



Chapter 2 Connections

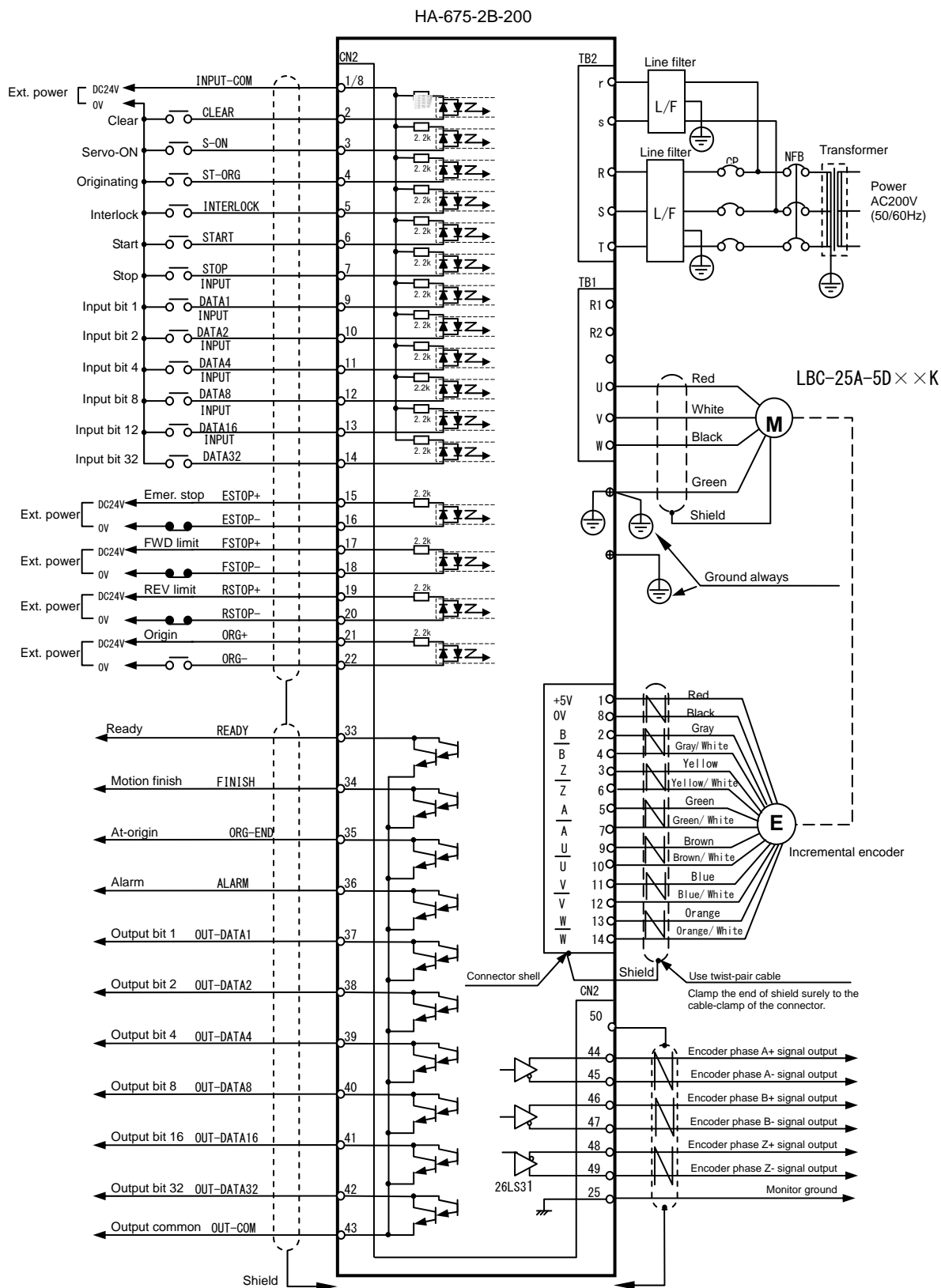
See the operation manual for HA-655 or HA-675 control unit for detail information.

2-1 Example for HA-655 control unit



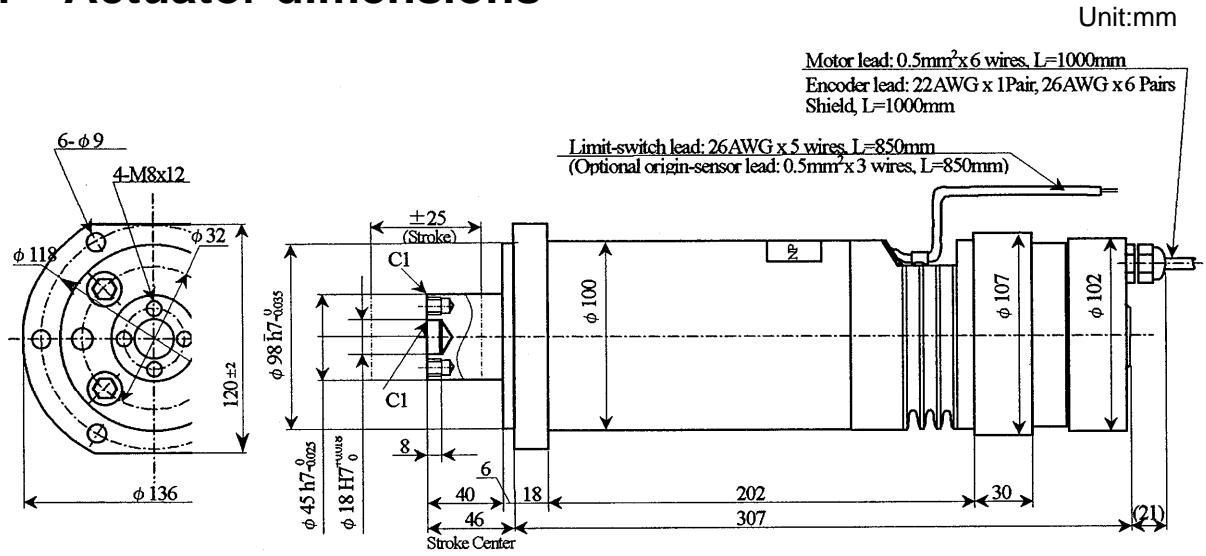
2-2 Example for HA-675 control unit

■ The figure below shows a connection example for the incremental system.



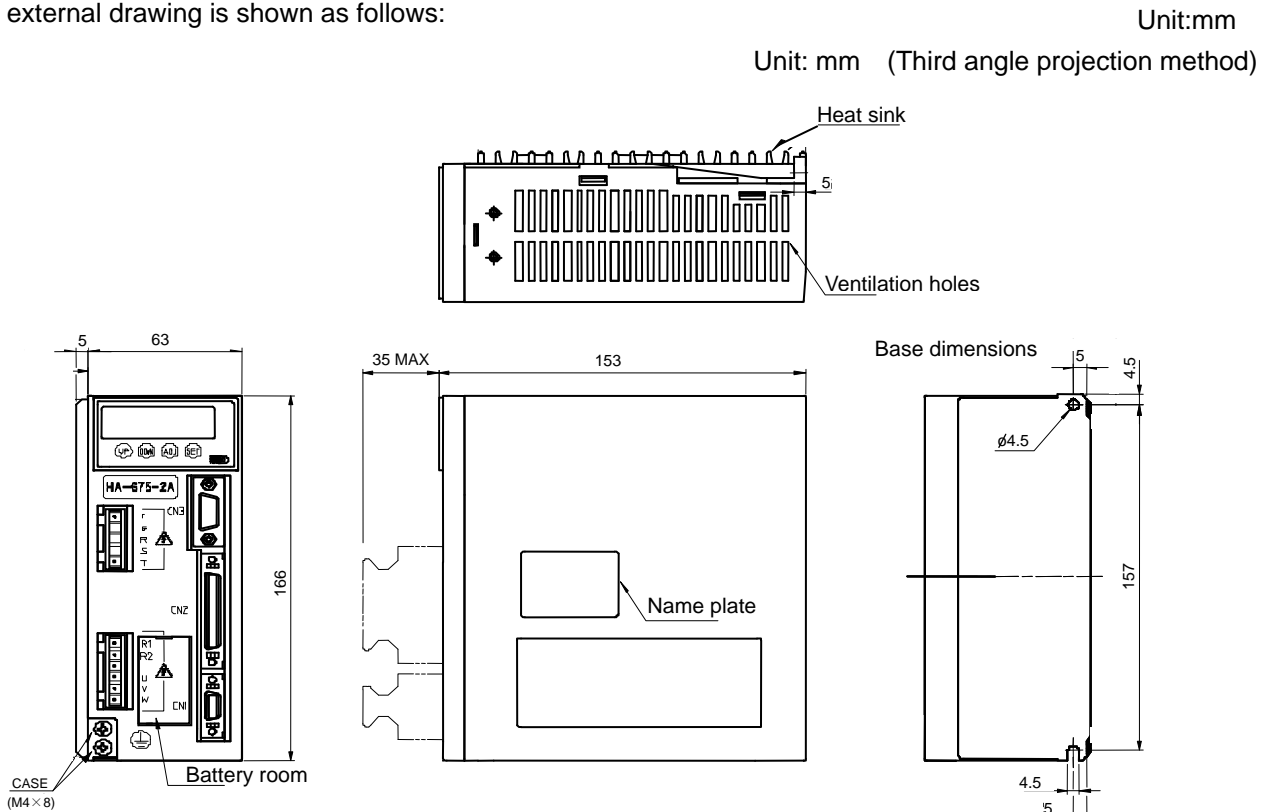
Chapter 3 External dimensions

3-1 Actuator dimensions



3-2 Control unit dimensions

The external drawing is shown as follows:



Chapter 4 Notices at system design and on usage

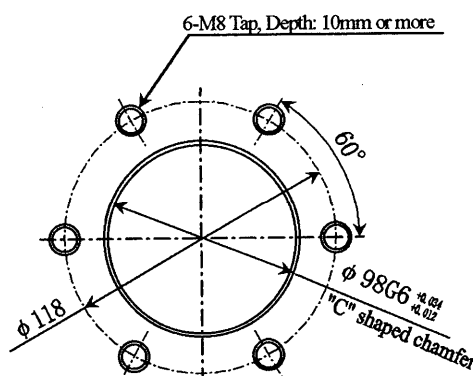
4-1 Environment

Install and use the actuators in the environment as follows:

- Indoor
- Ambient temperature: 0~+40°C
- Ambient humidity: 20~80%RH (Non-condensation)
- Vibration: Less than 24.5 m/s²)
- No water or oil drip (If the actuator is installed in the environment of oil or water drop, protect it with cover or other measures.)
- No corrosive gas, no explosive gas, no dust, no powder

4-2 Actuator installation

Install the linear actuator with its flange using six M8 hexagon socket head cap screws (intensity class: 10.9 or more). Engaging length of the bolt and the tap hole should be more than 10mm. Do not make eccentricity between actuator's $\phi 98h7$ fitting face and $\phi 98G7$ bore. The figure below shows the machining dimensions to install the actuator.



4-3 Rod fitting to load

Fix the object to the actuator rod using four M8 hexagon socket head cap screws (intensity class: 10.9 or more). Engaging length of the bolt and the tap hole should be more than 10mm. Do not make eccentricity between the actuator rod and object part using actuator's $\phi 45h7$ fitting face or $\phi 18H7$ bore hole, otherwise big eccentricity may cause poor characteristics, failure and short life of the actuator and the object machine.

Provide a linear guide and non-rotating mechanism on the object mechanism not to load exceeded radial force and torque to the actuator.

4-4 Stroke limits

The motion of the actuator rod should be the range shown in Figure A below. The actuator incorporates limit switches to detect over running outside the motion range shown in figure B.

Motion exceeding the limit-switch range, shown in Figure C, to one of the mechanical limits, may cause poor actuator characteristics, short life and failure. Therefore, make a control logic so that motor stops immediately when one of the limit switches works.

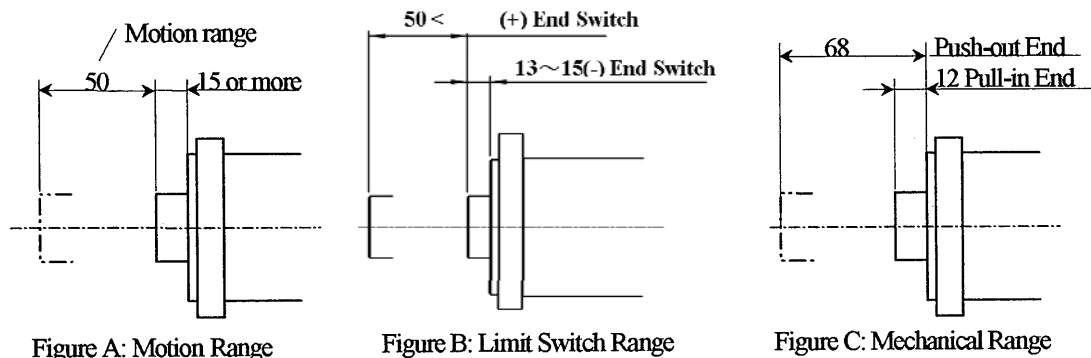


Figure A: Motion Range

Figure B: Limit Switch Range

Figure C: Mechanical Range

4-5 Manual rod movement

The figure below shows selectable working point of the optional origin sensor.

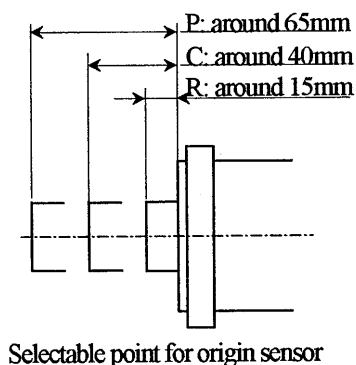
Three points are selectable:

P: around 65mm point from the actuator face (+25mm from the center)

C: around 40mm point from the actuator face (the center point)

R: around 15mm point from the actuator face (-25mm from the center)

As the sensor has a hysteresis motion deviation, one way motion is essential for originating. Otherwise, the origin position may differ depending on motion direction at the origination.



Selectable point for origin sensor

Chapter 5 Trial operation

Make trial operation, without load if possible, following to confirmations below:

■ Before trial operation

- (1) Check the actuator installation tightly.
- (2) Check the wiring for the motor, the encoder and limit switches correctly.
- (3) No obstacles interfering with the rod motion.

■ During trial operation

- (1) Check any abnormal vibrations.
- (2) Check any abnormal noises.
- (3) Is motor temperature rise normal?
- (4) Is rod movement smooth?

5-1 Relation between input signal and actuator motion

■ The relation between displacement and input signal pulses is given by the following equations:

$$\text{LBC-25A-5D12K} \quad \text{Rod Displacement (mm)} = \frac{\text{Input Signal Pulse (pulse)}}{6250}$$

$$\text{LBC-25A-5D6K} \quad \text{Rod Displacement (mm)} = \frac{\text{Input Signal Pulse (pulse)}}{3125}$$

Do not move the rod beyond a motion limit.

■ Rod speed is given by the following equation:

$$\text{LBC-25A-5D12K} \quad \text{Rod Speed (mm/sec)} = \frac{\text{Input Signal Pulse Speed (pps)}}{6250}$$

Do not exceed the rod speed more than 10 mm/sec.

$$\text{LBC-25A-5D6K} \quad \text{Rod Speed (mm/sec)} = \frac{\text{Input Signal Pulse Speed (pps)}}{3125}$$

Do not exceed the rod speed more than 20 mm/sec.

Chapter 6 Storing

6-1 Storing place

- No dust, no powder, no water or oil drop
- No corrosive gas, no liquid
- Ambient temperature: -20°C to +50°C
- Ambient humidity: 10%RH to 80%RH (No water condensation)
- Vibration: Less than 19.6 m/s^2 (2G) at 5Hz to 55Hz

6-2 Anti-corrosion

- Move the output rod several times in the range of full-stroke supplying power in every three months, because of anti-corrosion for sliding portions and motor brushes.
- Seal up the actuator with a desiccant in a plastic bag.

6-3 Storing posture

Store the actuator with horizontal portion or vertical portion of the rod being upside.

Warranty Period and Terms

The equipment listed in this document is warranted as follows:

■ Warranty period

Under the condition that the actuator are handled, used and maintained properly followed each item of the documents and the manuals, all the applicable products are warranted against defects in workmanship and materials for the shorter period of either one year after delivery or 2,000 hours of operation time.

■ Warranty terms

All the applicable products are warranted against defects in workmanship and materials for the warranted period. This limited warranty does not apply to any product that has been subject to:

- (1) user's misapplication, improper installation, inadequate maintenance, or misuse.
- (2) disassembling, modification or repair by others than Harmonic Drive Systems, Inc.
- (3) imperfection caused by a non-applicable product.
- (4) disaster or others that does not belong to the responsibility of Harmonic Drive Systems, Inc.

Our liability shall be limited exclusively to repairing or replacing the product only found by Harmonic Drive Systems, Inc. to be defective. Harmonic Drive Systems, Inc. shall not be liable for consequential damages of other equipment caused by the defective products, and shall not be liable for the incidental and consequential expenses and the labor costs for detaching and installing to the driven equipment.



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 All specifications and dimensions in this manual subject to change without notice.
 This manual is correct as of February 2015.

<http://www.hds.co.jp/>

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