

Precision Compact Linear Actuator LAH Series (DC servo motor drive) Operating Manual

- LAH-46-1002-F
- LAH-46-3002-F

- Thank you for purchasing our LAH series Precision Linear Actuator.
- Incorrect handling or use of this product may result in unexpected accidents or a shorter product life. Read this document carefully and use the product correctly so that product can be used safely for many years.
- 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 product.
- The end user of the product should have a copy of this manual.



LAH series, HS series

SERVO SYSTEM SAFETY GUIDE



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



CAUTION: 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
- * Aircraft, aeronautic equipment
- * Nuclear equipment
- * Household apparatus
- * Vacuum equipment
- * Automobile, automotive parts
- * Amusement equipment, sport equipment, game machines
- * Machines or devices acting directly on the human body
- * Instruments or devices to transport or carry people
- * Apparatus or devices used in special environments

Please consult with us if the above list includes your intended application for the products.

* If this product is utilized in any facility in which human life is at stake or that may incur material losses, install **safety devices** so that accidents will not occur even when the output control is disabled due to damage.

ITEMS YOU SHOULD NOTE WHEN USING THE ACTUATOR

NOTICES ON DESIGN DURING DESIGN, ENSURE THAT YOU READ THE MANUAL

 WARNING	Do not put your hand or other objects in the operation range of the output rod (output shaft) of the linear actuator. - Large driving force is output from the output rod. Putting your hand or other objects in the operation range may result in injury. - LAH Series: Max. driving force 390 N (40 kgf)		
 CAUTION	Always use drivers under followings conditions: - The actuator is designed to be used indoors. Observe the following conditions: *Ambient temperature: 0 to 40°C *Ambient humidity: 20 to 80%RH (no condensation) *Vibration: 24.5 m/s² or less *No contamination by water, oil *No corrosive or explosive gas	 CAUTION	Install the actuator with specified precision. - When installing the actuator, follow the manual and ensure that the actuator shaft is aligned with the center of the paired unit. - Secure the output rod (output shaft) of the actuator to the paired unit correctly according to the manual. - Improper alignment may cause vibration or damage to the output rod.

OPERATIONAL PRECAUTIONS DURING OPERATION, ENSURE THAT YOU READ THE MANUAL

 CAUTION	Do not exceed the max. driving force when using the actuator. - Using the actuator with a driving force exceeding the max. value may lower the accuracy or cause failure. - LAH Series: Max. driving force 390N (40 kgf)	 CAUTION	Never connect cables directly to a power supply socket. - Actuators must be operated using the proper driver. - Do not directly apply a commercial power supply. Failure to observe this caution may lead to fire or damage to the actuator.
 CAUTION	Do not apply impacts and shocks. - Because it is directly connected to the encoder, do not strike the actuator. - Damage to the encoder may cause uncontrolled operation of the actuator.	 CAUTION	Avoid handling of actuators by cables. Rough handling of cables may damage connectors, leading to uncontrolled operation of the actuator.
 CAUTION	Do not use an output rod stopper. It may cause damage to the actuator driving system, resulting in failure or shorter service life.	 CAUTION	Do not operate the actuator with wet hands. Electric shock may result.
 CAUTION	Do not touch the main unit during operation. - The output rod generates high driving force. Faulty wiring may cause the operation to become uncontrollable. - The surface of the actuator may become very hot during operation.	 CAUTION	The output rod does not have a self-holding function. It cannot hold the load in case of an alarm stop or power shutdown. Provide an external function to avoid danger.
 CAUTION	Do not attempt to repair, disassemble, or alter the actuator. Electric shock, injury, or fire may result. Also, the initial performance may not be reproduced.		

ITEMS YOU SHOULD NOTE WHEN USING THE DRIVER

NOTICES ON DESIGN DURING DESIGN, ENSURE THAT YOU READ THE MANUAL

 CAUTION	Always use them under followings conditions: - The control unit is designed for indoor use. Be sure to observe the following conditions. *Mount in a vertical position keeping sufficient distance to other devices. *0 to 50°C, 95% RH or below (No condensation) *No vibration or physical shock *No contamination by water, oil *No dust, dirt, corrosive, or explosive gas	 CAUTION	Use sufficient noise suppressing means and safe grounding. - Any noise generated on a signal wire will cause vibration or improper motion. Be sure to observe the following conditions. *Keep signal and power leads separated. *Keep leads as short as possible. *Ground actuator and driver at one single point, minimum ground resistance class: D (less than 100 ohms) *Do not use a power line filter in the motor circuit.
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NOTICES ON DESIGN DURING DESIGN, ENSURE THAT YOU READ THE MANUAL

 WARNING	Never change wiring while power is active. Make sure of power non-active before servicing the products. Failure to observe this caution may result in electric shock or personal injury.	 WARNING	Do not touch terminals or inspect products at least 5 minutes after turning OFF power. - Even after the power supply is turned OFF, electric charge remains in the driver. In order to prevent electric shock, perform inspections 5 minutes or more after the power supply is turned OFF. - When installing, make sure that the inner electronic components are hard to reach.
 CAUTION	Do not make a voltage resistance test. - Failure to observe this caution may result in damage of the control unit. - Please consult our sales office, if you intent to use a voltage resistance test.	 CAUTION	Do not operate the driver by switching the power ON/OFF. - Frequent power ON/OFF operations may cause deterioration of circuit elements inside the driver. - Use command signals to start/stop the actuator.
 CAUTION	In case of power failure, turn OFF the power for the control unit and drivers. Failure to do so may cause injury or damage to equipment due to sudden restart.	 CAUTION	Do not touch the driver with wet hands. Electric shock may result.
 CAUTION	Do not attempt to repair, disassemble, or alter the driver. Electric shock, injury, or fire may result. Also, the initial performance may not be reproduced.		

DISPOSAL OF AN ACTUATOR, A DRIVER AND/OR THEIR PARTS

 CAUTION	The actuator and driver must be disposed of as industrial waste. When disposing of the actuator or driver, disassemble it as much as possible, separate parts according to the material description (if indicated), and dispose of them as industrial waste.
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I Technical Information

1. Features and configuration of linear actuator

1-1 Features

The LAH series linear actuator (DC servo motor drive type) delivers high resolution and high driving force by combining a precision ball screw, HarmonicDrive® and DC servo motor.

With a dedicated control unit, the actuator offers remarkable following accuracy and the smoothest motion from extremely low speeds to high speeds in response to input commands.

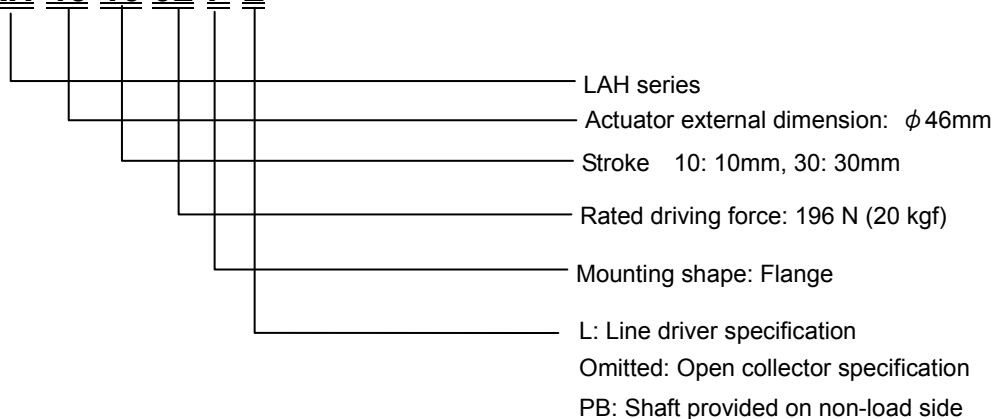
The LAH series linear actuator (DC servo motor drive type) offers the following features:

- ◆ Linear positioning in units of micron and sub-micron
- ◆ High positioning accuracy and repeatability
- ◆ Compact size with high driving force
- ◆ Semi-closed loop control method
- ◆ Load can be applied in both pushing and pulling directions
- ◆ Excellent durability
- ◆ Easy to use configuration in combination with a dedicated control unit

1-2 Configuration

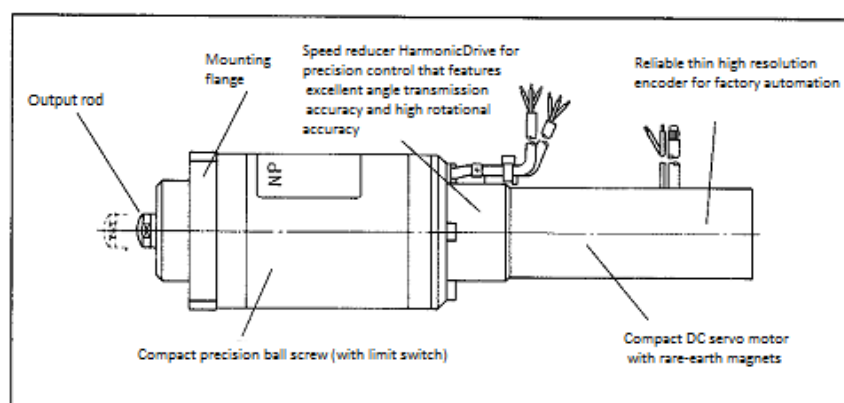
Models and symbols

LAH-46-10 02-F-L



The LAH series linear actuator delivers smooth and accurate linear motions with a high-performance DC servo motor, speed reducer HarmonicDrive® for precision control, and precision ball screw.

Fig.1



2. Specifications

2-1 Actuator specifications

Table 1

Item	Model	LAH-46-1002-F	LAH-46-3002-F
Resolution		0.069μm	
Stroke *1		10 mm	30 mm
Rated feed speed		2 mm/s	
Max. feed speed		3.7 mm/s	
Rated driving force *2		200 N 20 kg f	
Max. driving force *2		390 N 40 kgf	
Repetitive positioning accuracy *3		±0.5μm or less/1mm stroke	
Positioning accuracy *3		4μm or less/0.2mm stroke	
Full stroke *3 positioning accuracy		7μm or less	10μm or less
Lost motion *3		5μm or less/1mm stroke	
Load condition		Pressure of 50 N or more is applied on the shaft end to secure accuracy	
Drive motor		DC servo motor MDB02-IC22 Rated voltage 12V Rated current 0.5 A Encoder Output circuit Open collector or line driver Resolution 360 pulses/revolution Output signal Open collector: A, B, Z Line driver: A, $\overline{A}$, B, $\overline{B}$, Z, $\overline{Z}$ Power supply DC+5V ± 5%, 170 mA Max. * When combined with servo driver HS-360, the line collector type encoder is to be used.	
Combined driver		DC servo driver HS - 360-1A Power supply AC100V ± 10% 50/60Hz Control method incremental pulse command input Maximum input frequency 100 kp/s Only the line collector type encoders are supported. (Open collector type encoders cannot be connected.)	
End limit switch		Panasonic FU switch AV4024 incorporated	
Mounting direction		All directions (When mounting vertically, pay attention to the retaining force.)	
Mass		810 g	850 g
Using conditions		Current can be transmitted continuously	
Ambient temperature		10 to 25°C	
Lubrication		Grease	

*1: Detecting devices are incorporated in both stroke ends, but no mechanical stoppers are built in. Even with no-load, do not exceed the pushing and pulling limits.

Exceeding the limits may cause failure, performance deterioration, or shorter service life.

*2: Because the end of the actuator push rod has a spherical terminal, use it in the pushing direction.

To move a workpiece toward the pulling direction, utilize the air cylinder force or spring recovery force within the driving force range of 10 N to max.

*3: In compliance with JIS B6201. With the following conditions: Measurement temperature: 20°C ± 1°C, Load: driving force of 49 N to max.

*4: Using the actuator for continuous fine operations can cause local abrasion due to insufficient lubrication. Be sure to refer to the manual before use.

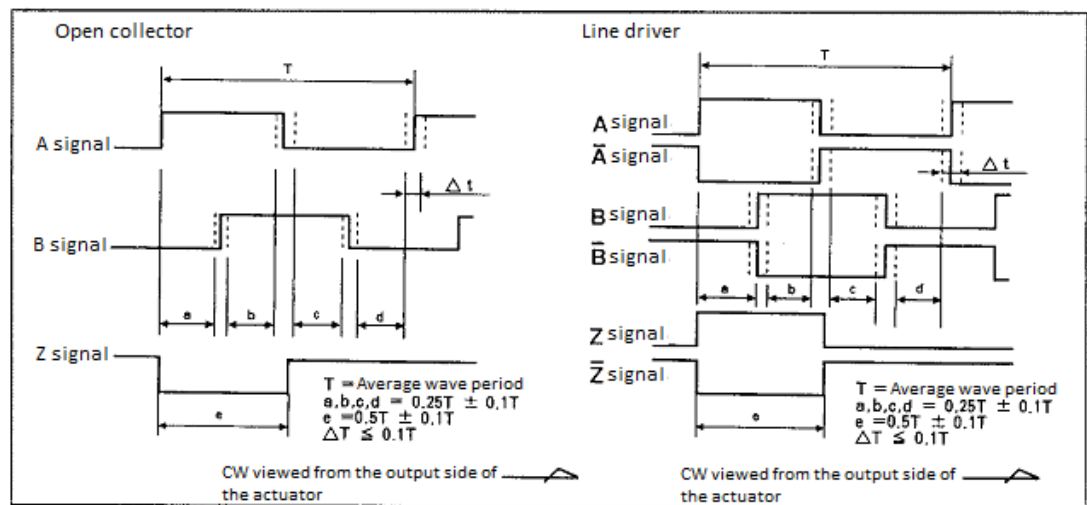
2-2 Encoder specifications

Table 2

Type	Incremental	
Output circuit	Open collector	Line driver
Resolution	360 pulses/revolution	
Output signals	3 channels (A,B,Z)	
Output waveform	Square wave	
Input voltage	DC5V $\pm$ 5%	
Current consumption	60 mA max.	170 mA max.
Output saturation voltage	$V_{OL} = 0.5V$ max.	
Output current	$I_{OL} = 20$ mA max.	
Output supply voltage	$V_{CC} = +5$ to $+15V$	—
Max. output current	DC35V max.	—
Signal rise time	1 μ s max. ($R_L = 1k\Omega$)	0.1 μ s max. ($R_L = 1k\Omega$)
Signal fall time	1 μ s max. ($R_L = 1k\Omega$)	0.1 μ s max. ($R_L = 1k\Omega$)
Max. response frequency	100 kHz	
Light source	LED	

◆ Encoder output waveform

Fig.2



◆ Encoder output

Fig.3

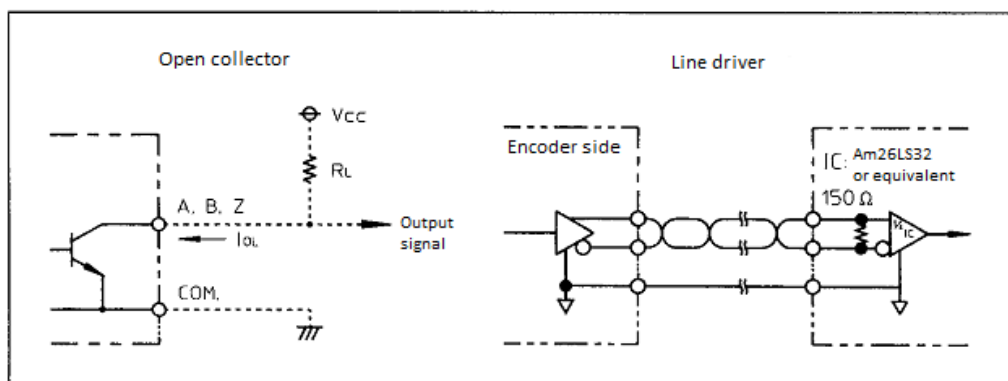
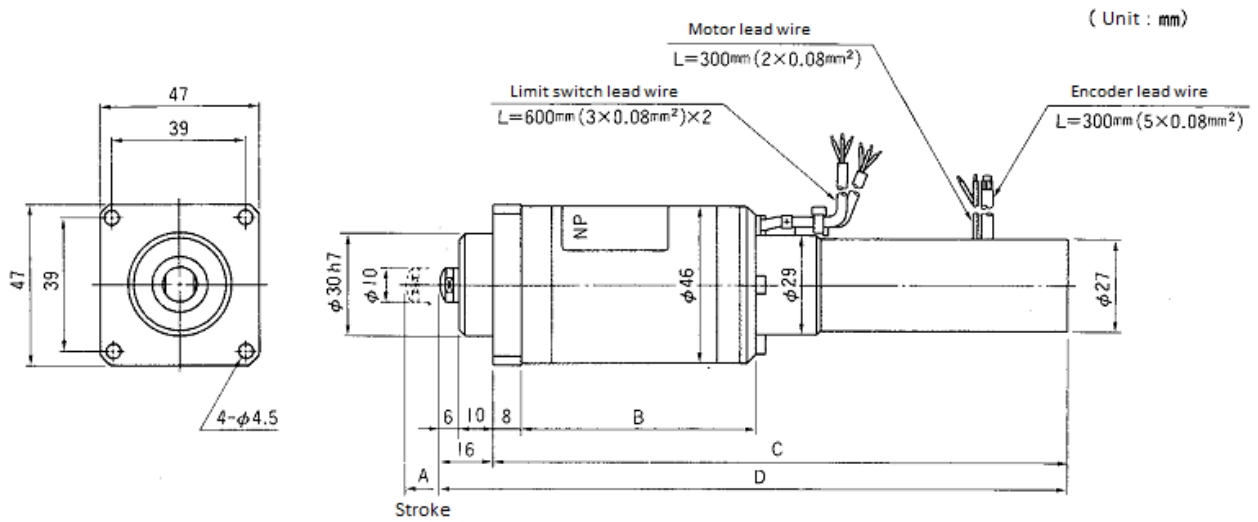


Table 3

Color	Open collector	Line driver
Brown	Signal A	Signal A
Blue	—	Signal $\bar{A}$
Red	Signal B	Signal B
Green	—	Signal $\bar{B}$
Yellow	Signal Z	Signal Z
Orange	—	Signal $\bar{Z}$
White	Power supply	Power supply
Black	Ground (COM)	Ground (COM)
Shielded	Floating	Floating

3. External drawing



Model No.	A	B	C	D	Mass
LAH-46-1002-F	10	69	169	185	0.81 kg
LAH-46-3002-F	30	88	188	204	0.85 kg

4. Accuracy

Table 4

Item		Accuracy	Load
Repetitive positioning accuracy		±0.5μm or less/1mm stroke	185
Fine stroke positioning accuracy		4μm or less/0.2mm stroke	49-196 N (5-20 kgf)
Full stroke positioning accuracy	LAH-46-1002-F	7μm or less/10mm stroke	
	LAH-46-3002-F	10μm or less/30mm stroke	
Lost motion		5μm or less/1mm stroke	

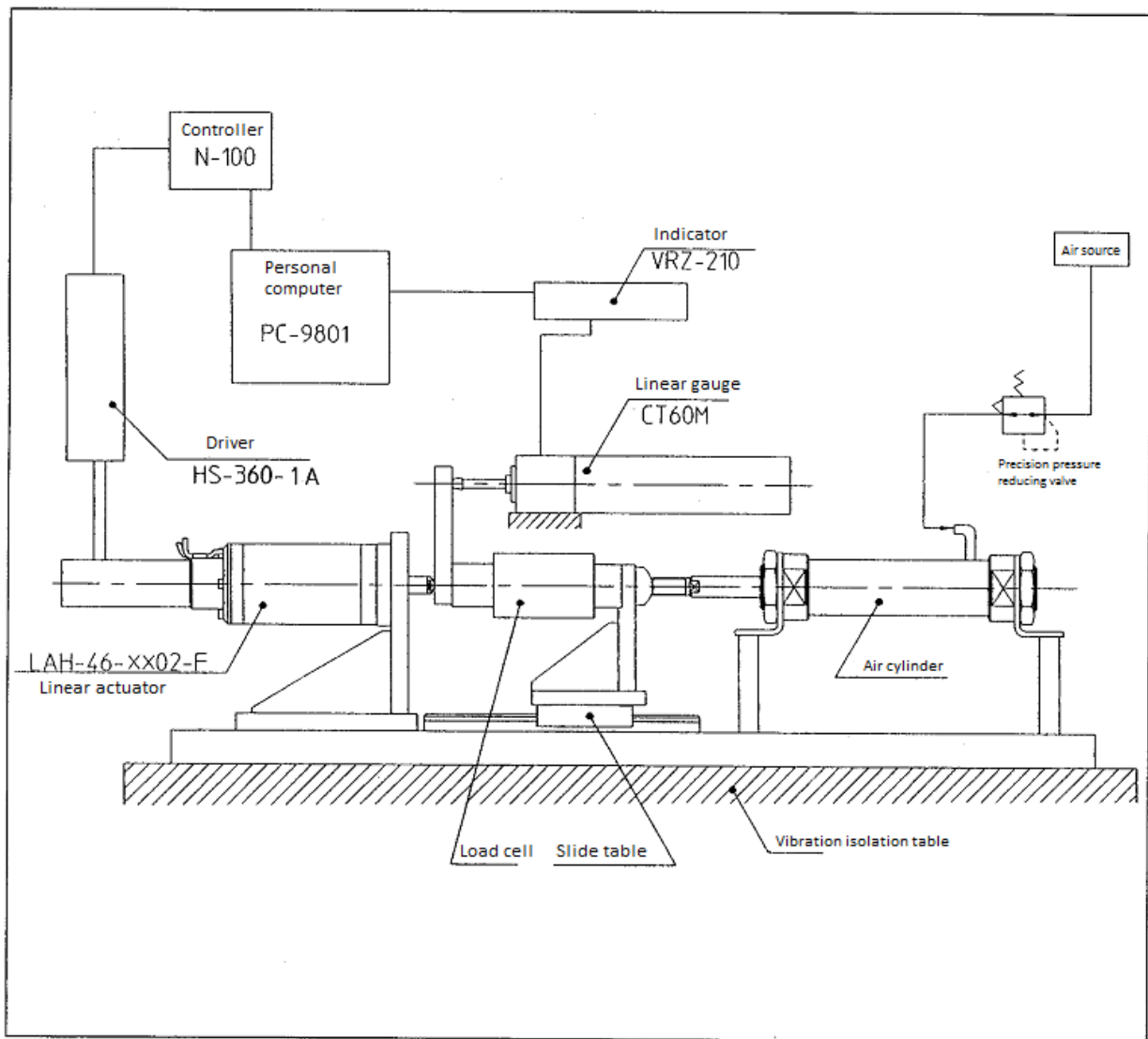
(Measurement temperature: 20 ± 1°C)

5. Performance evaluation system and evaluation method

Performance evaluations for LAH series linear actuators are conducted using an evaluation system we developed on our own in accordance with JISB6201. Through this system, optimized and necessary characteristic evaluations for high-precision positioning actuators are conducted.

5-1 Performance evaluation system

Fig.4



Main measuring instruments

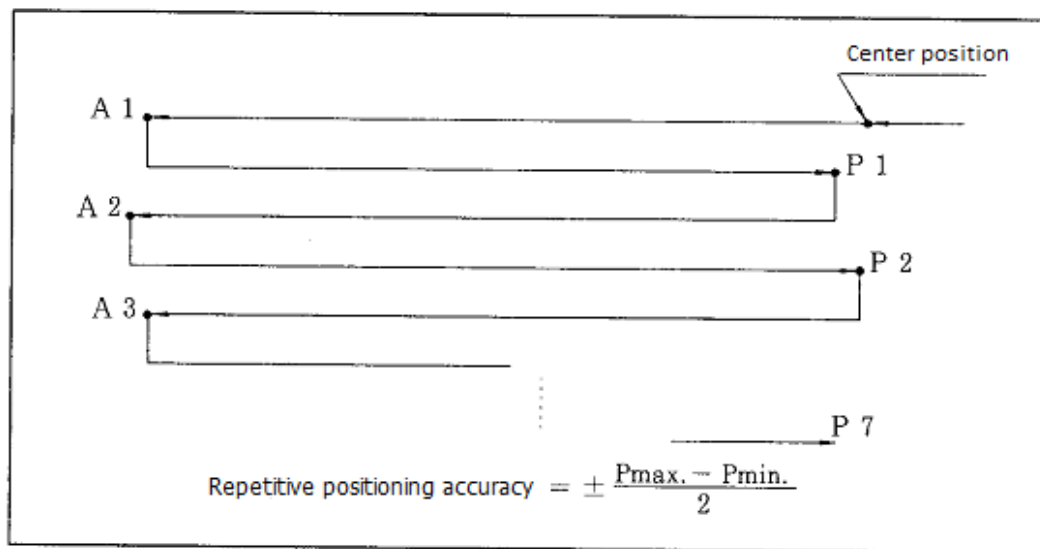
Linear gauge	CT-60M (HEIDENHAIN) Resolution: 0.05 μ m Accuracy $\pm 1\mu$ m
Indicator	VRZ-210 (HEIDENHAIN)
Control unit	HS-360-1A (HDS)
Controller	N-100 (Nippon Pulse Motor)
Computer	PC-9801 (NEC)

5-2 Tips for evaluating performance

(1) Repetitive positioning accuracy (See Fig. 5.)

- Move the output rod in the pushing direction to the stroke center position.
- From that position, feed 1mm in the pushing direction. Mark that point as A1.
- From point A1, feed 1mm in the pulling direction. Measure that point and mark it as P1.
- Again, from point P1, feed 1mm in the pushing direction and mark that point as A2. From A2, move 1mm back in the pulling direction, measure that point and mark it as P2.
- Repeat this operation 7 times. Take one-half the value of the max. difference of the values P1 through P7 and prepend ($\pm$) to the calculated value to obtain the repetitive positioning accuracy.

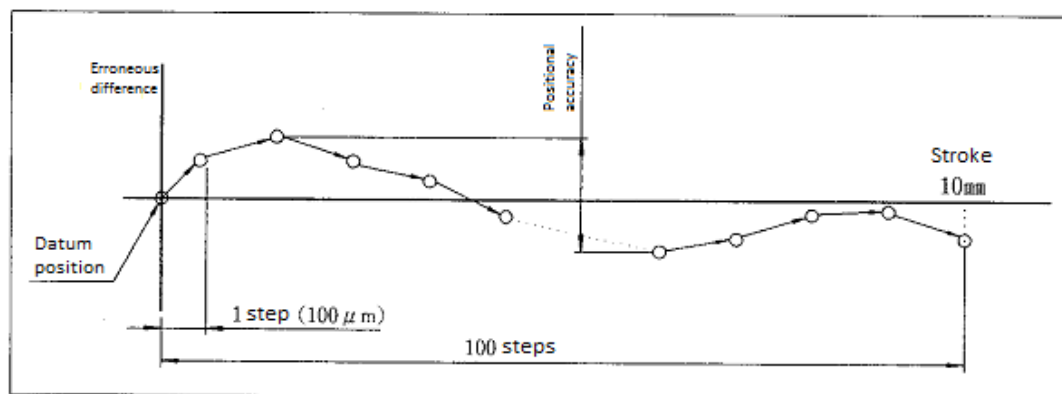
Fig.5



(2) Full stroke positioning accuracy (See Fig. 6.)

- Move the output rod to the limit position on the pulling side, and then move it by 1mm from there in the pushing direction. Mark that position as the datum position.
- From the datum position, perform sequential positioning for the full stroke by feeding 0.2mm per step in the pushing direction and measure each position.
- At each position, the difference between the actual distance moved from the datum position and the distance to be moved is considered as the erroneous difference. The greatest difference of the erroneous difference is the positioning accuracy.

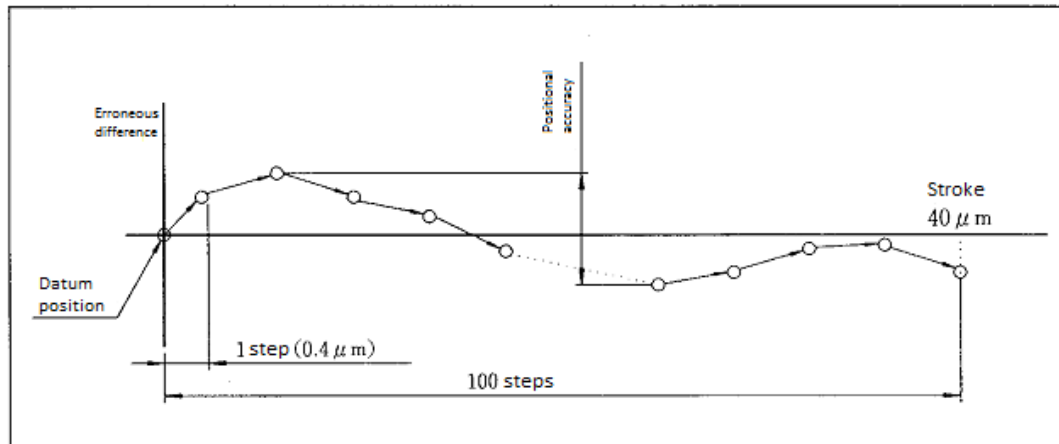
Fig.6



(3) Fine stroke positioning accuracy (See Fig. 7.)

- Move the output rod in the pushing direction to the stroke center position. Mark that position as the datum position.
- From the datum position, perform sequential positioning for 100 points (stroke 0.2mm) by feeding $2\mu\text{m}$ per step in the pushing direction and measure each position.
- At each position, the difference between the actual distance moved from the datum position and the distance to be moved is considered as the erroneous difference. The greatest difference of the erroneous difference is the positioning accuracy.

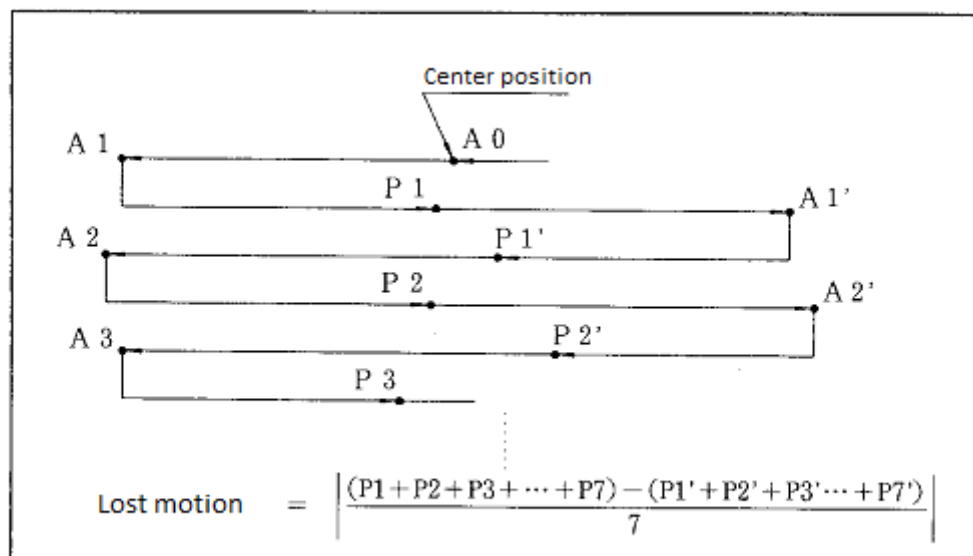
Fig.7



(4) Lost motion (See Fig. 8.)

- Move the output rod in the pushing direction to the stroke center position. Mark that position as A0.
- From A0, feed 1mm in the pushing direction. Mark that point as A1.
- From point A1, feed 1mm in the pulling direction. Measure that point and mark it as P1.
- From point P1, feed 1mm more in the pulling direction. Mark that point as A1'.
- From point A1', feed 1mm in the pushing direction. Measure that point and mark it as P1'.
- Repeat operations b) through e) 7 times. The difference between the average value of P1 through P7 and the average value of P1' through P7' is the lost motion value.

Fig.8



6. Mechanical characteristics

6-1 Permissible loads

Permissible loads for the output rod are as follows.

Fig.9

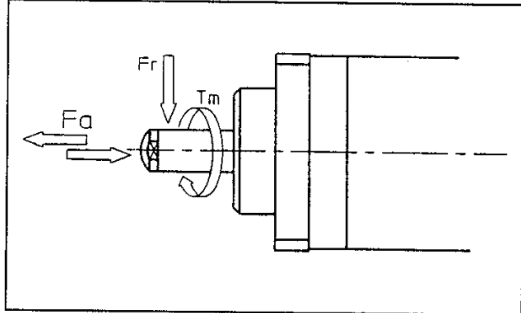


Table 5: Permissible loads

Load	Permissible value
Fa: Thrust load (driving force)	392 N or less (40 kgf or less)
Fr: Extending load	Not permitted
Tm: Rotational moment	0.49 N·m or less (5 kgf·cm or less)

6-2 Axial rigidity of output rod

The axial rigidity of the output rod is around 13.7 N/μm (1.4 Kg/μm).

6-3 Life

The life of LAH series linear actuator depends on the fatigue life of its ball screw. The equation of the life is as follows:

$$LS = \left(\frac{1}{Fa}\right)^3 \times 23.5 \times 10^7$$

LS: Accumulated travel distance life (10% probability of failure) (km)

Fa: Average axial load (N)

II Operation Manual

Please be sure to read this operation manual before using this product. If you have any concerns or comments about this product, please contact your dealer or our sales office.

1. Inspection during unpacking

When you receive the linear actuator, please check the following points.

- ◆ You received the product you had ordered.
- ◆ The product was not damaged during transport.
- ◆ No looseness in fasteners.
- ◆ Special order parts are included.

If you have any other concerns, please contact your dealer or our sales office.

2. Notices on handling

When handling a linear actuator, follow the general rules below.

 CAUTION	◆ Never disassemble the linear actuator. If you disassemble the actuator or loosen the screws, the performance is significantly decreased and the original performance is no longer guaranteed. ◆ Do not apply any impact on the linear actuator. Doing so may result in failure, lower accuracy, or abnormal sound.
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3. Design and operational precautions

This product is a high-precision positioning linear actuator. When this product is not used properly or used under undesirable operating conditions, performance cannot be sufficiently achieved. Also, the product life may be shortened or other problems may occur. Please observe the following precautions.

3-1 Operating environment

Use the linear actuator under the following environmental conditions.

- ◆ Indoors
- ◆ Ambient temperature: +10 to +25°C
- ◆ The temperature fluctuation of each operating temperature is recommended to be within $\pm 1^{\circ}\text{C}$ for more stable accuracy of the linear actuator.
- ◆ Ambient temperature: 35 to 80%RH (no condensation)
- ◆ Vibration: 19.6 m/s^2 or less (2G or less)
- ◆ No contamination by water or oil

(If there is a possibility of contamination by water or oil, cover the actuator.)

- ◆ No corrosive, explosive gas, or dust

3-2 Mounting direction of linear actuator

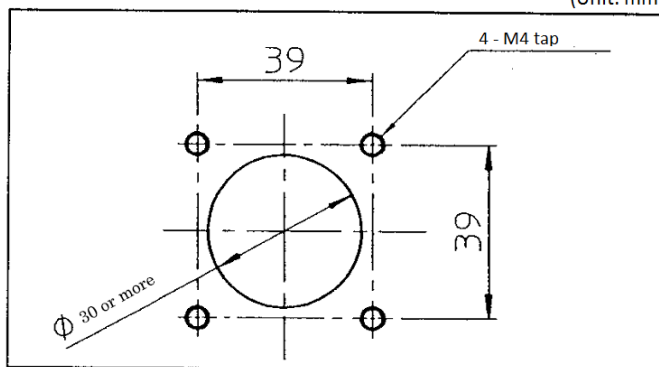
There are no restrictions on the mounting direction. However, please observe the following precautions.



When the actuator is operated in the vertical direction with the motor servo OFF, if a load of about 421 N (43 kgf) is applied, the output rod may move (reverse operation). When an actuator is used with a vertical load, place a stopper or brake system on the load side as a safety measure for power OFF.

3-3 Mounting method of linear actuator

Fig.10 Machining dimensions on the linear actuator mounting side
(Unit: mm)



Use four M4 screws to securely mount the linear actuator.

3-4 Load conditions and moving toward pulling direction



Use either one of the following load (driving force) directions:

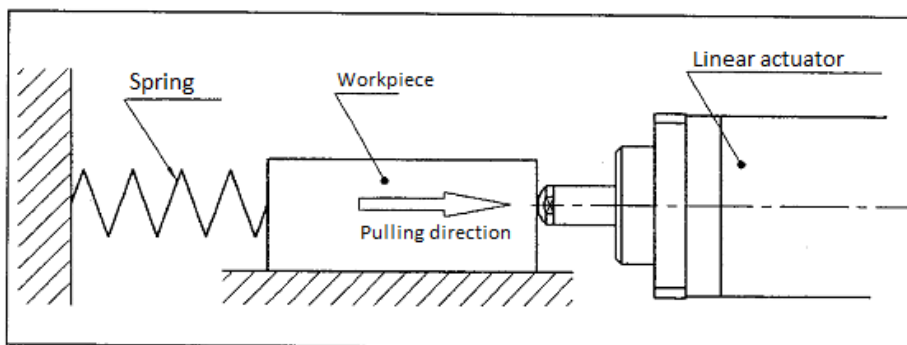
- Direction to push the output rod
- Direction to pull the output rod

- ◆ Apply 49 N (5 kg f) or more pre-load to secure the feeding accuracy of the linear actuator.
- ◆ When the actuator is used in the direction for pushing the output rod, set the hardness of the workpiece section that touches the linear actuator head to HRC55 to 65.

To move a workpiece toward the rod pulling direction, utilize the spring or air cylinder restoring force as shown in Fig.11.

At this time, keep the load fluctuations as little as possible.

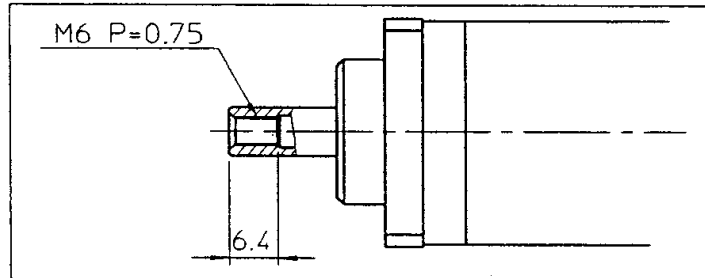
Fig.11



- ◆ When the actuator is used in the direction for pulling the output rod, remove the head on the end and use the internal thread on the output rod.

Internal thread size: M6 P = 0.75 (J1S fine thread)

When tightening a threaded fastener, apply tightening torque of $1.2 \text{ N} \cdot \text{m}$ ($12 \text{ kg f} \cdot \text{cm}$) or less. Also, do not let the threaded fastener go 10mm or more into the output rod.



3-5 Hardness of contact surface on workpiece

Set the hardness of the section where the workpiece touches the linear actuator output rod to HRC55 to 65.

3-6 Operational precautions



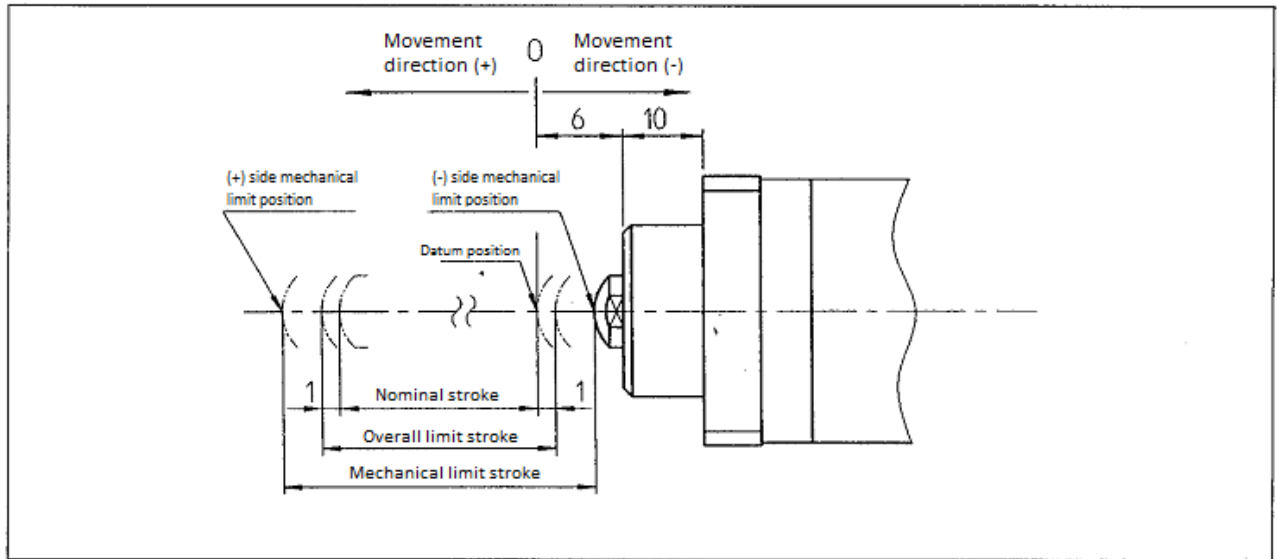
CAUTION

- ◆ Do not use an output rod stopper. Doing so may cause a decrease in performance such as positioning accuracy and a shorter life. Also, the ball screw may be damaged, resulting in improper motion.
- ◆ Never apply any load on the output rod other than a thrust load. Applying a load other than a thrust load may cause abnormal abrasion on the ball screw, resulting in a decrease in performance such as positioning accuracy and a shorter life.

3-7 Overall limit stroke

Overall limit stroke is shown in Fig. 12.

Fig. 12



(Unit: mm)

Model	Nominal stroke	Overall limit stroke	Mechanical limit stroke
LAH-46-1002-F	10: 0 to +10	12: -1 to +11	17.8: -3 to +14.8
LAH-46-3002-F	30: 0 to +30	32: -1 to +31	36.8: -3 to +33.8

(Unit: mm)

Model	(+) side mechanical limit position	(-) side mechanical limit position	(+) side LS operation position	(-) side LS operation position
LAH-46-1002-F	+14.8	-3	Operates between +11 to +14.8.	Operates between -1 to -3.
LAH-46-3002-F	+33.8	-3	Operates between +31 to +33.8.	Operates between -1 to -3.

LS: Limit switch

3-8 Limit switch



Linear actuators have incorporated limit switches for stroke end detection to prevent damage to the actuator and peripheral devices. When using the limit switch, connect the limit switch to the host device and program so that the actuator stops when the limit switch is operated.

Linear actuators have incorporated limit switches, but the output rod is not programmed to stop automatically when the limit switch is operated.

If the output rod hits the mechanical limit shown in Fig. 12, this may result in lower accuracy and shorter life and in some cases, it could damage the linear actuator. To prevent damage to the actuator and peripheral devices, connect the limit switch to the host device and program so that the enable signal on the driver connected to the linear actuator immediately turns OFF when the limit switch is operated.

Also, do not use an output rod stopper even within the operable range. Doing so may cause a decrease in performance of the linear actuator such as positioning accuracy and a shorter life. Also, the ball screw may be damaged, resulting in improper motion.

◆ Limit switch

Panasonic FU switch AV4024

Resistance load: 0.5 A 30 Voc

($\cos \phi \approx 1$)

◆ Limit switch lead wire

(+): Pushing side limit switch

(-): Pulling side limit switch

Black-COM, White-N0 (a contact point operation), Red-NC (b contact point operation)

3-9 Output rod continuous fine operation



Using the actuator for continuous fine operations (0.5 mm/stroke or less) can cause local abrasion of the HarmonicDrive® or ball screw due to insufficient lubrication, resulting in a shorter life of the linear actuator.

As a countermeasure, perform stroke operations of 2mm or more 2 to 3 times in 1000 strokes to promote the flow of internal lubricant.

4. Cables

4-1 Motor cables and output rod movement directions

When (+) is connected to the white motor cable and (-) to the black cable, the output rod moves in the pushing direction.

4-2 Encoder cable colors

Table 5

Color	Open collector	Line driver
Brown	Signal A	Signal A
Blue	—	Signal $\bar{A}$
Red	Signal B	Signal B
Green	—	Signal $\bar{B}$
Yellow	Signal Z	Signal Z
Orange	—	Signal $\bar{Z}$
White	Power supply DC+5V	Power supply DC+5V
Black	Ground (COM)	Ground (COM)
Shielded	Floating	Floating

☆ The insulation resistance at the encoder section is checked sufficiently during the pre-shipment product inspection. Please do not measure yourself.

4-3 Handling lead lines

Do not apply tension of 5 N (0.5 kgf) or more to the motor and encoder cables.

Install the lead line with slack and do not apply more tension than specified.

When the lead line curvature is required for use, set the curvature radius to 40mm or more.

4-4 Extension cable for motor

Use extension cables with the conductor cross-sectional area of 0.1 mm^2 or more for the motor. To avoid noise induction to surrounding signal circuits, we recommend that you use shielded cables

4-5 Extension cable for encoder

- ◆ Twisted shielded cable is recommended for encoder extension cable. Shielded cable can also be used when the transmission distance is shorter than about 2 m with little noise.
- ◆ Keep the encoder extension cable length under 10 m.
Check the following when using extension cables.
 - a) Check the supplied voltage at the encoder cable end if it goes out of the specified range due to the voltage drop caused by resistance.
 - b) Check that a delay in signal pulse rise is not caused by the stray capacitance of the cable.
Please contact us when cable length exceeds 10 m.
- ◆ Do not use a single cable for wiring encoder signal lines and motor power lines.
Also, when the same cable is used for the signal lines for other equipment, take measures so that the encoder is not affected by noise from those signal lines.
- ◆ Design the interface of the encoder signal properly so that the signal is not affected by noise.

5. Applicable driver

The LAH series driver has a driver that supports line driver outputs for its encoder output circuit.

When a driver that supports open collector outputs is required, please provide your own driver.

For driver details, refer to the separate driver manual.

5-1 Driver specifications

Table 6

Item	Model	HS-360-1A
Rated output current (rms)		1.0 A
Max. output current (rms)		1.0 A
Power supply		Single phase AC100V $\pm$ 10% 50/60Hz
Control method		PWM control method (control element: IPM), Switching frequency: 12.5kHz
Connected position sensor		Incremental encoder (A, B, Z phase output), line collector type
Structure/installation method		Totally enclosed, self-cooled type/base mount (wall installation)
Control functions		Positioning control by pulse train input
Max. input pulse frequency		400 kpps (line collector type) 200 kpps (open collector type)
Pulse input mode		single-pulse train, two-pulse train, 2-phase pulse train
Control input signal		Enable, alarm reset, deviation counter reset, forward limit, Reverse limit
Control output signal		Ready, alarm, in position
Encoder monitor output		Z-phase opt-isolator output, A, B, Z-phase voltage output (+5V)
Serial interface		RS-232C (dedicated cable connection)
Monitor		Operating status, alarm history, I/O, parameters, etc. can be monitored. Operation waveforms can be monitored with dedicated software.
Protective functions		Memory failure, overload, encoder failure, regenerative failure, heating system failure, overcurrent, excessive deviation, IPM error, overspeed
Embedded circuit		Dynamic brake circuit, regeneration unit connection terminal
Embedded functions		Manual operations (JOG operation, alarm history clear, etc.)
Mass		800 g
Environmental conditions		Operating temperature: 0 to +50°C/Storage temperature: -20 to +85°C Operating humidity: 90%RH or less/Storage humidity: 90%RH or less (no condensation) (no condensation) Ambience: No metal powder, dust, oil mist, corrosive gas.

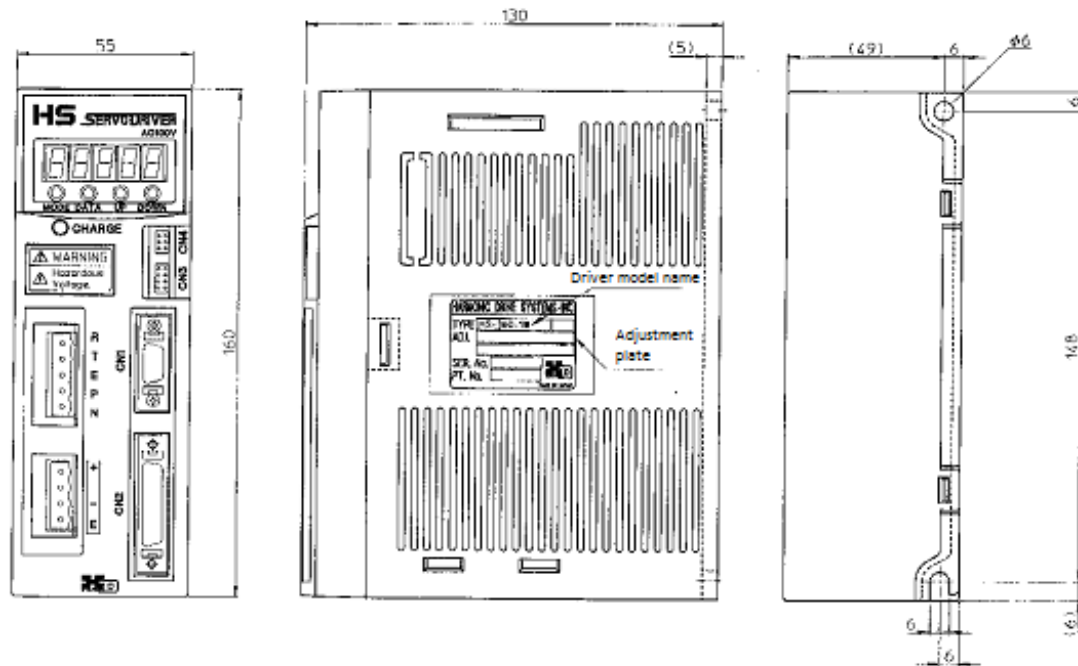
Note 1: The rated output current indicates the continuous output current of the driver.

Note 2: The max. output current indicates the instantaneous max. current of the driver.

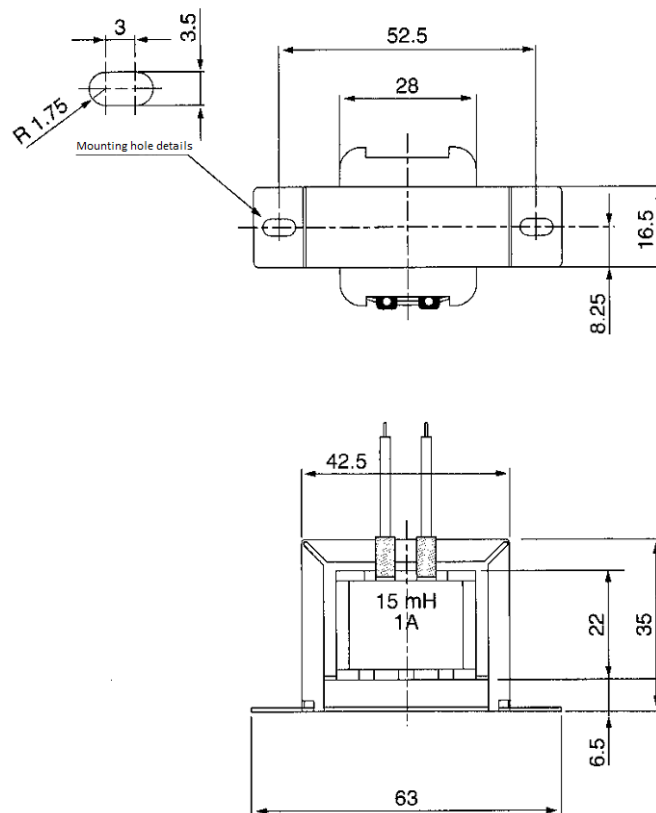
5-2 External drawing

◆ Driver: HS-360-1A

(unit: mm)



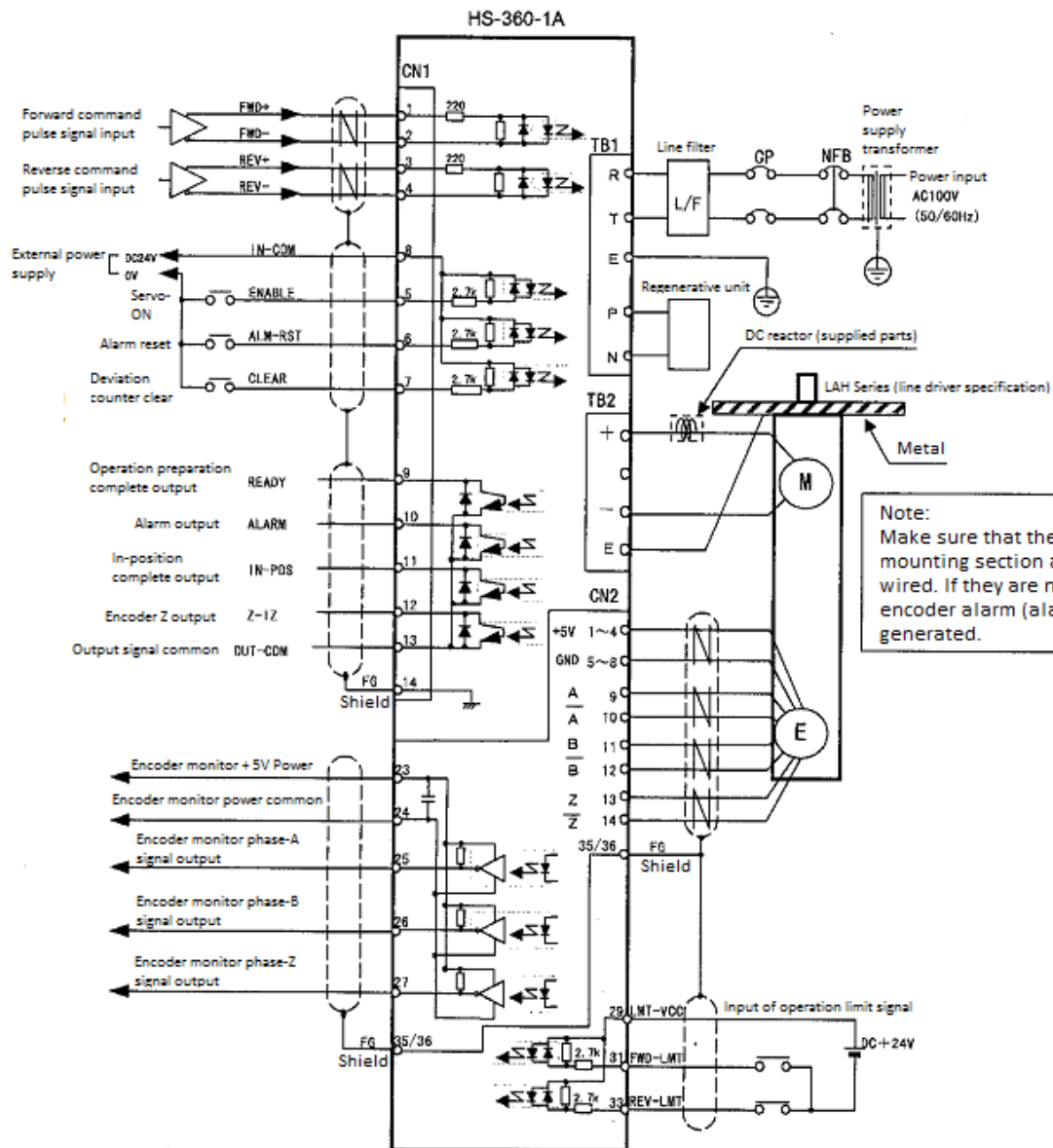
◆ DC reactor (attached to the driver)



5-3 Connection example

The following is a connection example where the pulse output mode is set to "line driver". The command mode is "two-pulse train".

For "open collector", refer to the manual of your driver.



6. Trial run

Perform a trial run with no-load. Check the following points beforehand.

- Check that the linear actuator is securely installed.
- Check that the motor and encoder cables are correctly wired.
- Check that there are no obstacles within the moving range of the output rod.

- ◆ The displacement of the output rod is found with the following equation.

$$\begin{aligned}\text{Output rod displacement (mm)} &= \frac{\text{Screw lead} \times \text{Input pulse (pulse)}}{\text{Harmonic Drive reduction ratio} \times \text{Encoder resolution} \times 4} \\ &= \frac{0.5 \times \text{Input pulse (pulse)}}{80 \times 360 \times 4} = \frac{\text{Input pulse (pulse)}}{230400}\end{aligned}$$

Note: Do not let the rod hit the mechanical limit.

- ◆ The travel speed of the output rod is found with the following equation.

$$\begin{aligned}\text{Output rod travel speed (mm/s)} &= \frac{\text{Screw lead} \times \text{Input pulse speed (pulse/s)}}{\text{Harmonic Drive reduction ratio} \times \text{Encoder resolution} \times 4} \\ &= \frac{0.5 \times \text{Input pulse speed (pulse/s)}}{80 \times 360 \times 4} = \frac{\text{Input pulse speed (pulse/s)}}{230400}\end{aligned}$$

Note: The rod travel speed should not exceed 0.9 mm/s.

Note: The formula above is used with the standard setting (quadruplicate) of the HS-360-1A driver. It can be changed with the command pulse input factor (driver parameter) settings. For details, refer to the manual of the HS-360-1A driver.

- ◆ Inspection of linear actuator status
 - Check for any abnormal vibrations.
 - Check for any abnormal noises.
 - Check if the temperature of the linear actuator is abnormally high.
 - Check if the output rod moves smoothly.

7 Storage instructions

When the linear actuator is stored temporarily or not used for a long period of time, pay attention to the following points.

7-1 Storage area

- ◆ Place with no dirt, dust, or moisture
- ◆ No toxic gas or fluid
- ◆ Ambient temperature: -20 to +50°C
- ◆ Ambient humidity: 10 to 80%RH (no condensation)
- ◆ Vibration: 19.6m/s² (2G) (5 to 55Hz) or less

7-2 Rust prevention

- ◆ Move the linear actuator back and forth several times in the range of full stroke every three months to prevent rust on the motor brush contact surface and bearing sections.
- ◆ To absorb moisture, we recommend that you seal the linear actuator with a vinyl sheet and place a silica gel packet or other desiccants.

7-3 Storage posture

- ◆ Store the actuator with the output rod placed horizontally or facing up.

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.
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