Medium Thrust Linear Actuator

LAH-80 Series

Technical Document

Operation Manual

■ Stepping motor models

● Thank you for implementing our precision linear actuator LAH-80 Series.

● Incorrect handling and use of this product can cause unexpected accidents and shorten the life of the product. Before using this document, read it carefully to ensure correct and safe use of the product over a long period of time.

● Product specifications are subject to change without prior 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 driver should have a copy of this manual.

ISO14001
（HOTAKA Plant）
ISO9001
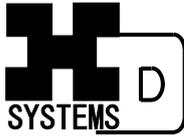
SAFETY GUIDE

For linear actuator series/servo driver system

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

⚠ **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
- ✳ Machine or devices acting directly on the human body
- ✳ Instruments or devices to transport or carry people
- ✳ Apparatus or devices used in special environments
- ✳ Instruments or devices to prevent explosion

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.

⚠ **WARNING**	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. ● LAH-80 series: Maximum thrust of 3000N (306kgf)		
⚠ **CAUTION**	Use the actuator and motors only in a specified environment. ● Use the actuator and motors with the following indoor conditions: - 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	⚠ **CAUTION**	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.

Notices for operation: Always read the relating technical documents for the purpose.

⚠ **CAUTION**	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. LAH-80 series: Maximum thrust of 3000N (306kgf)	⚠ **CAUTION**	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.
⚠ **CAUTION**	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.	⚠ **CAUTION**	Do not pull lead wires. ● Pulling lead wires will damage wire connections, causing uncontrolled rotation.
⚠ **CAUTION**	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.	⚠ **CAUTION**	Do not operate the actuator with wet hands. ● It may cause an electric shock.
⚠ **CAUTION**	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.	⚠ **CAUTION**	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.
⚠ **CAUTION**	Do not repair, disassemble, or modify it. ● It may cause an electric shock, injury, or fire. Also, the initial performance may not be reproduced.		

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

⚠ CAUTION	**Always use the driver unit in the specified environment.** ● The control unit is for indoor use only. Observe the following conditions: - 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.
⚠ CAUTION	**Make sufficient noise suppression and grounding.** ● Electric noise on a signal wire may cause result in unit malfunction or unexpected occurrence of troubles. Keep the following conditions: - 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.

Notices for operation: Always read the relating technical documents for the purpose.

⚠ WARNING	**Do not change wiring whenever power supply is active.** ● 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.
⚠ WARNING	**Do not touch a terminal after at least five minutes from power-OFF.** ● 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/
⚠ CAUTION	**Do not make a withstanding voltage test.** ● 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.
⚠ CAUTION	**Do not operate a control unit by means of power ON/OFF operation.** ● The frequent power ON/OFF operation may cause deterioration of the electric elements. ● Start/stop operation should be performed by means of input signals.
⚠ CAUTION	**In case of power failure, turn off the power of the control unit and driver.** ● Failure to do so may cause injury or damage to the device due to sudden restart.
⚠ CAUTION	**Do not touch the actuator with wet hands.** ● It may cause an electric shock.
⚠ CAUTION	**Do not repair, disassemble, or modify it.** ● It may cause an electric shock, injury, or fire. Also, the initial performance may not be reproduced.	

Abandonment of an actuator and servo driver:

⚠ CAUTION	**Abandon an actuator and motor as industrial waste.** ● Upon disposal, disassemble it as much as possible, separate parts with indicated materials according to the markings, and dispose of them as industrial waste.

Contents

I. Technical Document

II　Operation Manual

Warranty Period and Terms

The LAH-80 series are 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 LAH-80 series 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 LAH-80 series 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 the other than the LAH-80 series.

(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.

I. Technical Document

1. Outline of LAH-80 Series

The linear actuator LAH-80 Series is a high-precision, medium-thrust type linear actuator that can perform high-speed feed comprised of precision ball screws, Harmonic Drive, and stepping motor.

Features

◆ Straight line positioning accuracy in sub-micron-meter order

◆ High positioning accuracy and repeatability

◆ Small size, medium thrust

◆ High-speed feed (Stepping motor model)

◆ End limit sensor is mounted

◆ High durability

2. Model and Symbols

L A H – 8 0 – 5 0   2 0 – F – P A

- LAH series
- Size
- Stroke (mm)
- Rated thrust (2000N)
- Flange mounting type

Stepping motor drive shaft
- PA: No shaft on the non-load side
- PB: Shaft provided on non-load side
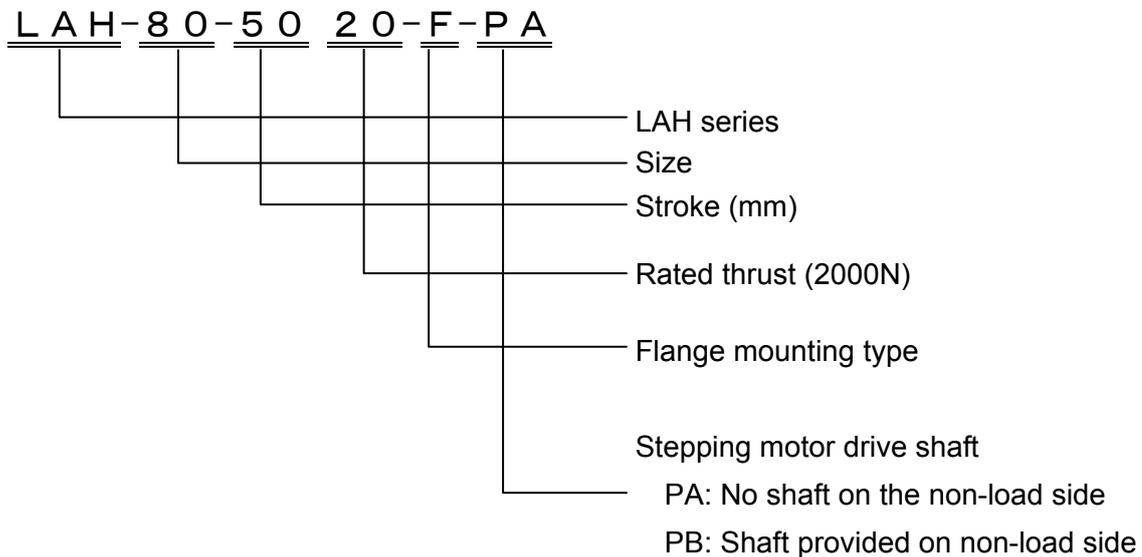
3. Specification

3-1 Linear actuator

Model / Item	LAH-80-5020-F-PA/PB
Stroke	50mm (±25mm)
Stroke upon a limit sensor trip	51mm (±25.5mm)
Resolution Note 1	2μm
Maximum feed speed	10mm/S
Rated thrust Note 4	2000N (204kgf)
Maximum thrust Note 5	3000N (306kgf)
One-way positioning accuracy Note 2	10μm/50m stroke
	4μm/2mm stroke
Repeatability Note 2	±1μm/1mm stroke
Reverse positioning accuracy Note 2	10μm/1mm stroke
Axial rigidity Note 3	40N/μm
Allowable max. static axial load Note 3	4000N
Allowable max. radial load Note 3	60N
Allowable max. rotational moment Note 3	1N.m
Load Direction	Push direction or pull direction
Structure	Totally-enclosed, self-cooling
Lubrication	Grease
Operating Temperature	10°C to 25°C
Ambient Humidity	20 to 80%RH (No condensation)
Environment	Stainless (excluding the following parts) Body machined parts: Aluminum (black alumite treatment)　Motor: Black paint Sensor cover: Aluminum (black alumite treatment) Motor flange: Aluminum (alumite treatment) Tightening screws of each part: Iron (black oxide finish or chromate treatment)
Storage temperature	-20°C to 50°C
Storage humidity	20 to 80%RH (No condensation)
Installation method	Directly connected to the flange
Installation orientation	No restriction (be careful of the holding force for vertical installation.)
Driving motor	Stepping motor: PK569A (B) W 　　　　　　　　Oriental Motor Snap angle　Full step: 0.72°/Step 　　　　　　Half step: 0.36°/Step
Protection function	End limit sensor (SMC: D-F79)
Shock resistance	294m/S^2 (30G)
Vibration resistance	24.5m/S^2 (2.5G)
Mass	5kg
Combined control unit	UDK5114NW2

(Note 1)　Calculated value based on the screw lead, speed ratio of the reducer, and the number of splits of the encoder.
　　　　　Stepping motor type: Control unit half snap
(Note 2)　According to JISB6201 (For the evaluation method, refer to section 4.)
　　　　　The load orientation is one-way loading (refer to 4.3 of the Operation Manual).
　　　　　One-way positioning accuracy ellipticity guaranteed temperature range is 20±1°C.　Operating temperature for other cases (10 to 25°C).
(Note 3)　Refer to 5-1 to 5-4.
(Note 4)　Generated thrust with a torque at the motor rating or equivalent
(Note 5)　Thrust determined by the dynamic load rating of the ball screw used

3-2 Paired control unit

Model		UDK5114NW2 (Oriental Motor)
Applicable actuator		LAH-80-5020-F-PA/PB
Power supply		Single-phase 100 to 115V (-15%, +10%) 50/60Hz 5.5A
Excitation method		Full step, half step (selected with built-in switch)
Input signal	Input Type	Photo coupler input, input resistance 220 Ω, input current 20mAor less Signal voltage H: +4 to＋5V, L:0 to＋0.5V
	CW pulse signal (Pulse signal)	CW direction motion command pulse signal (For 1-pulse input type, motion command pulse signal) Pulse width 5ms or more, rise and fall time 2ms or less, activated by pulse fall (Negative logic pulse input)
	CCW pulse signal (Rotating direction signal)	CCW direction motion command pulse signal (For 1-pulse input type, rotational direction pulse signal H:CCW.L: CW) Pulse width 5ms or more, rise and fall time 2ms or less, activated by pulse fall (Negative logic pulse input)
	Output current off signal	At the "L" level, the output current to the motor becomes off, and the motor shaft can be rotated by an external force. At the "H" level, the operation current specified with the (RUN) switch is supplied to the motor.
Output signal	Output Type	Photo coupler open collector output (emitter common) external operation conditions DC 24V or less, 10mA or less
	Excitation timing signal	Signal is output when excitation sequence is at Step "0." (Photo coupler ON) When in full step: One output per 10 pulses. When in half step: One output per 20 pulses
	Overheat signal	Output when internal driver temperature (Photo coupler ON or OFF, automatic negative return) Motor turned OFF by auto hold off function.
Functions		Auto current down, auto current OFF, step angle selection, pulse input method selection
Display (LED)		Power input, excitation timing signal output and overheat signal output
Cooling Method		Natural air-cooled
Insulation resistance		100M ohm or more at the following locations when measured by a DC 500V megger at normal temperature and humidity: Power Input Terminal - Protective Ground Terminal, Signal Input/Output Terminals - Motor Output Terminal - P.G.T., Signal Input/Output Terminals – Power Supply Input Terminal
Insulation Strength		No anomalies detected when power is supplied to following locations for one minute at normal temperature and humidity Power Input Terminal - Protective Ground Terminal AC1.25KV 50Hz Motor Output Terminal - Protective Ground Terminal AC1.25KV 50Hz Signal Input/Output Terminals - P.I.T AC2.3KV 50Hz Signal Input and Output terminal - M.O.T. AC2.3 KV 50Hz
Operating condition		Operating temperature:0°C to + 50°C Storage temperature:-20°C to +70℃ Operating humidity: 95%RH or less Storage humidity: 95%RH or less (No condensation) (No condensation)
Installation method		Base mount (installed on the wall)
Mass		0.95kg

*   For details, refer to the operation manual of Oriental Motor's UDK5114NW2.

3-3 End limit sensor specification

Sensor model	D-F79 (SMC)
Wiring method	3-wire
Output method	NPN type
Output logic	Transistor ON upon limit detection
Reproducibility	±0.03mm
Applicable load	IC circuit, PLC, relay
Power supply voltage	DC5、12、24V(DC4.5 to 28V)
Current consumption	10mA or less
Load current	40mA or less
Indicator lamp	The red LED illuminates when the stroke limit is detected.
Cable	φ3.4 24AWG 3-conductor

Internal circuit
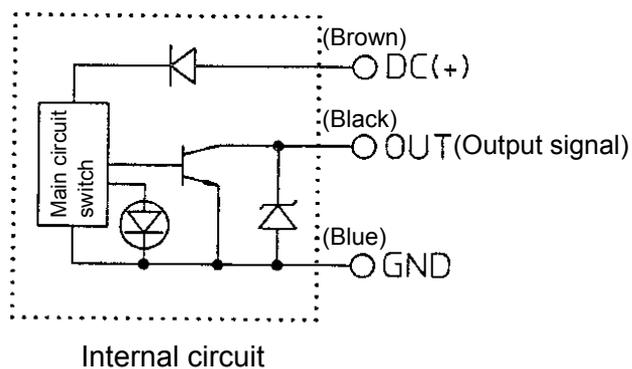
* For details, refer to the catalog of SMC.

4. Performance evaluation system and evaluation method

As performance evaluation of the linear actuator LAH-80 Series, characteristic evaluation that is optimal and necessary for a high-precision positioning system actuator is performed with our proprietary evaluation system based on JIS B6201.

4-1 Performance evaluation system
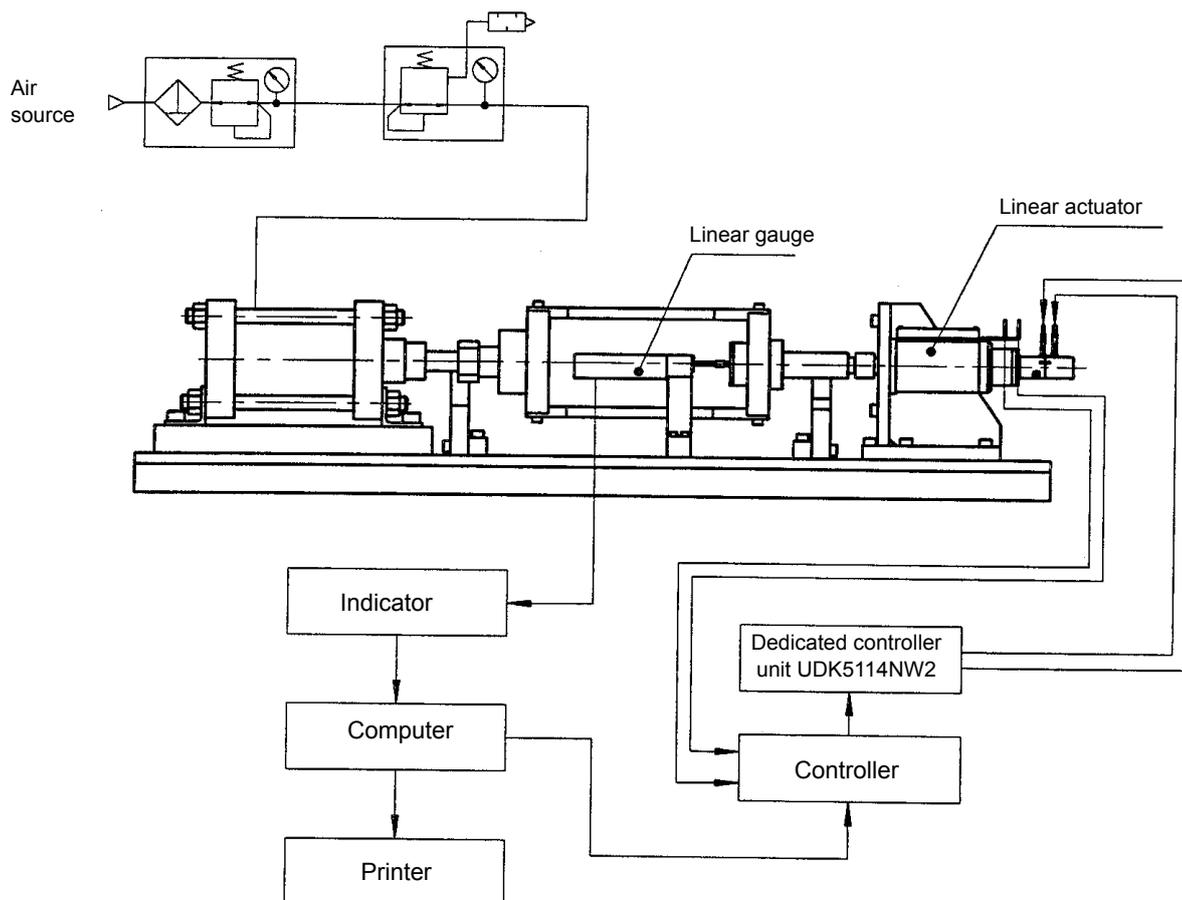
Figure 1

Main instruments used

Linear gauge	Heidenhain	CT60M (Precision:± 0.1µm)
Indicator	Heidenhain	VRZ-210 (Resolution: 0.05µm)

4-2 Performance evaluation method

(1) One-way positioning accuracy (in compliance with JIS B6201)

    a) Move the output rod to the specified lead-in side limit, and then move it 1mm to the push-out direction. The position is the reference position.

    b) From the reference position to the push-out direction, perform positioning sequentially for 50mm (2mm) in steps of 0.5mm (0.02mm), and measure each of the positions.

    c) At each position, an error is the difference between the distance of actual movement from the reference position and the expected distance of movement. The positioning accuracy is the maximum difference of these errors.
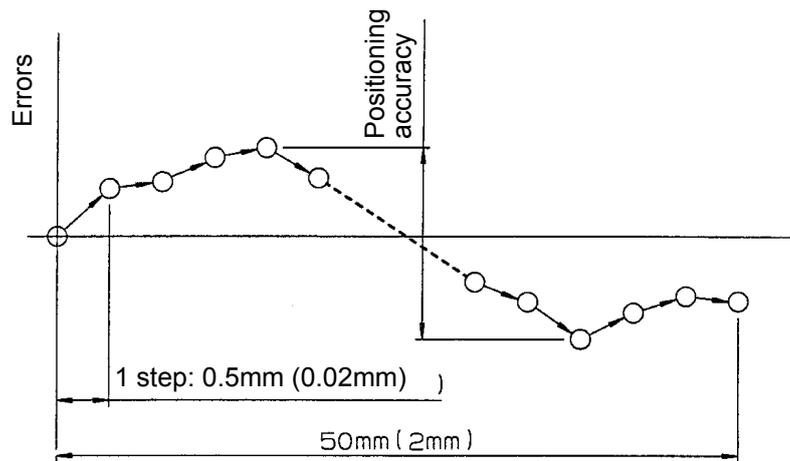
Note: Values in parentheses are for accuracy measurement with a travel of 2mm.

Figure 2

(2) Repeatability (in compliance with JIS B6201)

    a) Move the output rod to the push-out direction, and then move it to the center of displacement (±0mm).

    b) From that position, feed it 1mm to the push-out direction. The point is A_1.

    c) From Point A_1, feed it 1mm to the pull-in direction, and measure the point. The point is P_1.

    d) From P_1, feed it 1mm again to the push-out direction. The point is A_2. From A_2, return it 1mm to the pull-in direction, and measure the point. The point is P_2.

    e) Repeat this 7 times. The repeat positioning accuracy is 1/2 the maximum difference of P_1、 $P_2 \cdots \cdots$、 P_7 with ($\pm$).

$$\text{Repeatability} = \pm \frac{P_{max.} - P_{min.}}{2}$$
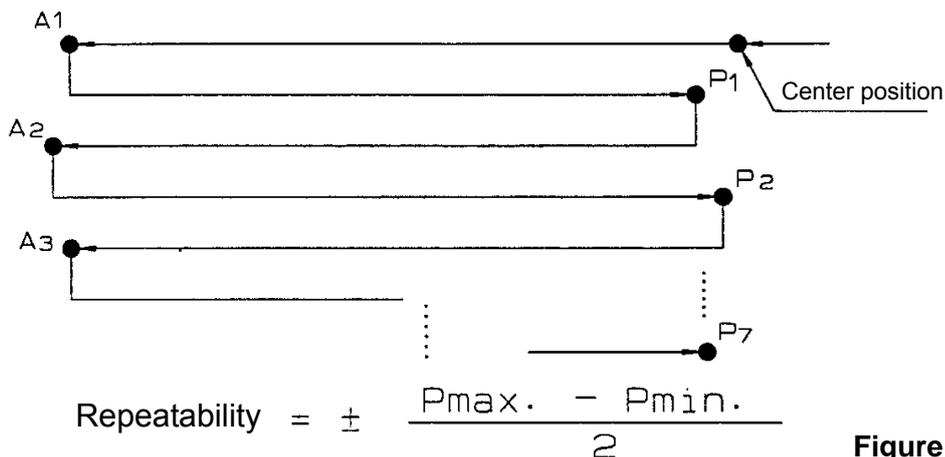
Figure 3

(3) Reverse positioning accuracy (Lost motion) (in compliance with JIS B6201)

    a) Move the output rod to the push-out direction, and then move it to the center of displacement (±0mm). The point is Ao.

    b) From Ao, feed it 1mm to the push-out direction. The point is A_1.

    c) From Point A_1, feed it 1mm to the pull-in direction, and measure the point. The point is P_1.

    d) From Point P_1, feed it 1mm further to the pull-in direction, and measure the point. The point is A_1'.

    e) From Point A_1', feed it 1mm to the pull-in direction, and measure the point. The point is P_1'.

    f) Repeat the steps b to e 7 times. The reversed positioning accuracy (lost motion) is the difference between the average value of P_1, P_2, $\cdots$ $\cdots P_7$ and the average value of P_1', P_2', $\cdots$ $\cdots$. P_7'.
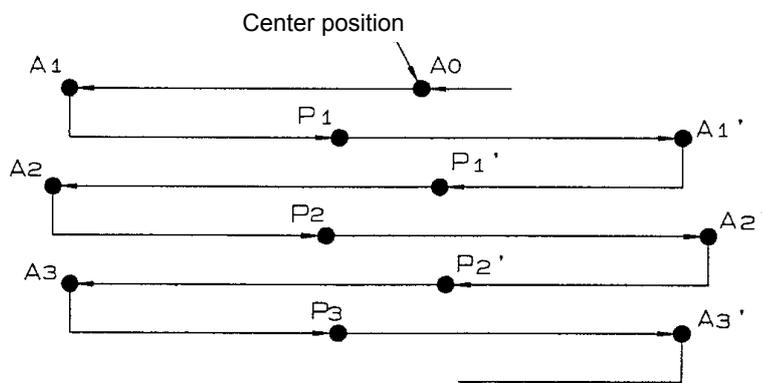
$$\text{Reverse positioning accuracy} = \left| \frac{(P_1 + P_2 + P_3 + \cdots + P_7) - (P_1' + P_2' + P_3' \cdots + P_7')}{7} \right|$$

Figure 4

5 Mechanical characteristics

5-1 Axial stiffness

Axial stiffness is the load value required for elastic deformation of 1μm to the axial direction of the output rod with respect to the fixed flange of the actuator when tensile load and compressive load are applied to the output rod as loads.

The axial stiffness of the LAH-80 Series is 40N/μm.

5-2 Maximum allowable static axial load (Foa)

The maximum allowable static axial load is the allowable axial load (tensile load and compressive load) regardless of the stroke of the output rod when the linear actuator is stopped (servo lock, etc).

The maximum allowable static axial load of the LAH-80 Series is 4000N.

5-3 Maximum allowable radial load (Fr）

The maximum allowable radial load is the allowable radial load at the tip of the output rod with the maximum displacement of the output rod (+25mm) when the actuator is stopped (servo lock, etc) or running.

The maximum allowable radial load of the LAH-80 Series is 60N.

5-4 Maximum allowable torque (Tm）

The maximum allowable torque (Tm) is the allowable maximum torque for the output rod when the actuator is stopped or running regardless of the stroke of the output rod.

The maximum allowable torque of the LAH-80 Series is 1N·m.
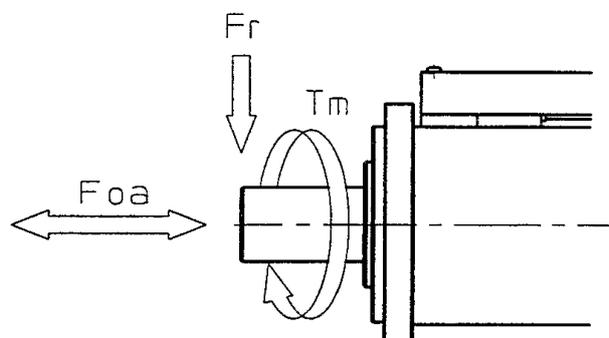
Figure 5

5-5 Output rod movement direction

The movement direction of the output rod of the linear actuator is the rod pull-in direction at a (+) direction input command.

Movement direction

Direction input (+)command

N.P
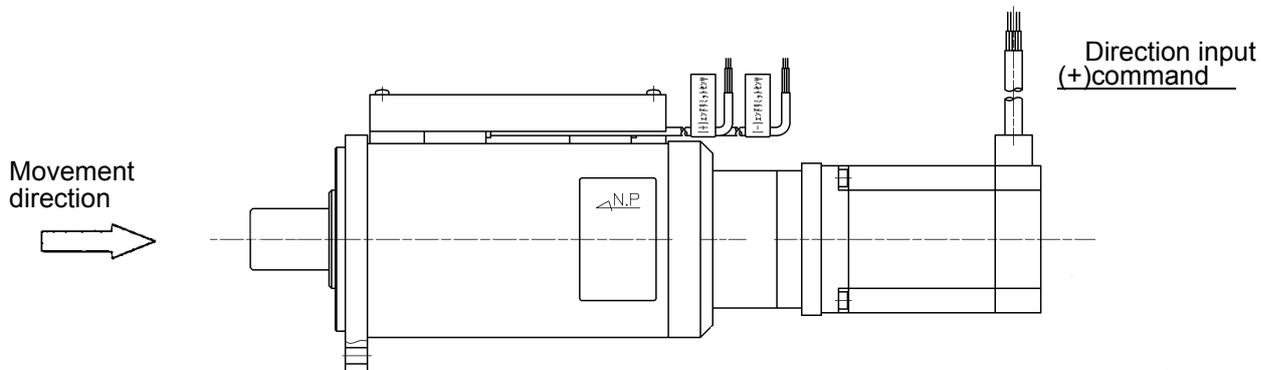
Figure 6

5-6 Shock resistance

The number of shocks is 3 or less with the impact acceleration of $294m/s^2$ (30G) when the linear actuator is installed horizontally and up/down, left/right, and forward/backward impacts are exerted.

⚠ **Never exert any direct impact on the output rod.**

CAUTION

Up
Left
Forward ← → Backward
Right
Down

N.P
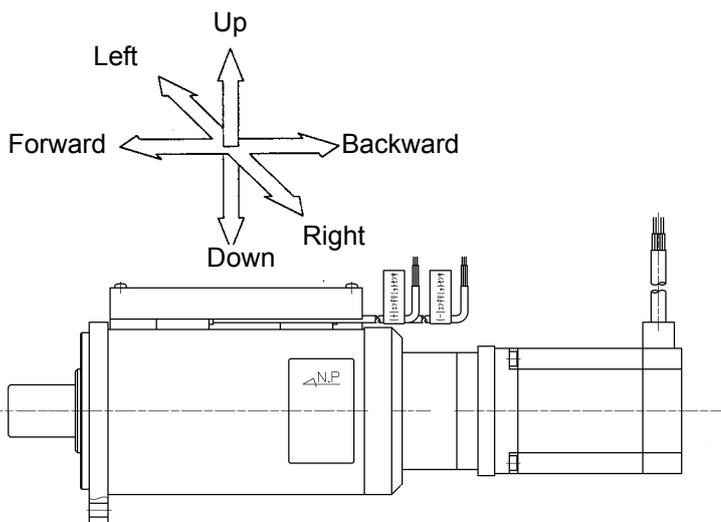
Figure 7

5-7 Vibration resistance

The vibration resistance of the linear actuator is vibration acceleration of 24.5m/s^2 (2.5G) (frequency 10~400Hz) in up/down, left/right, and forward/backward directions.　It can be used with this value or less.

⚠ CAUTION	**If positioning accuracy is required, use it with no vibration.**
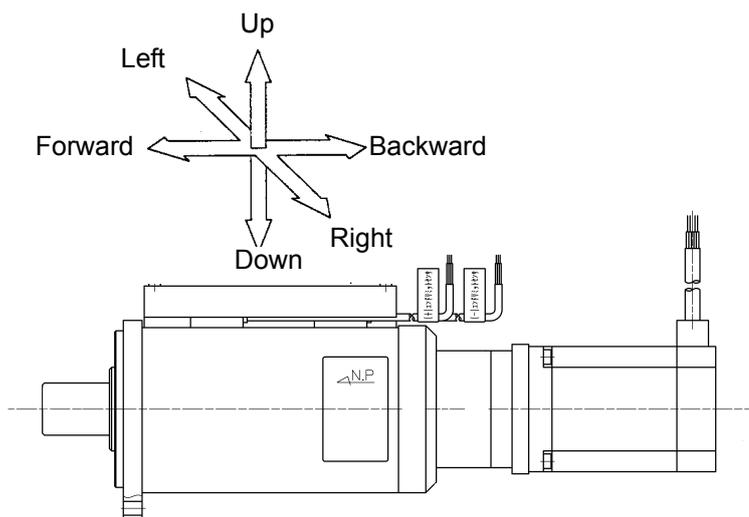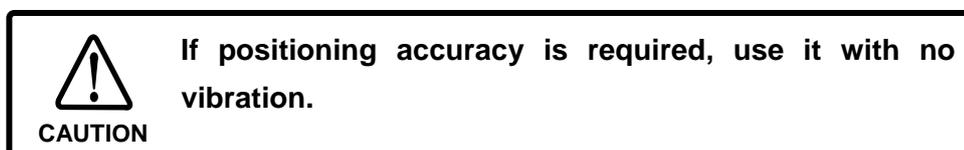
Figure 8

5-8 Life

The life of the linear actuator LAH-80 Series is the fatigue life of the precision ball screw used.　The life can be obtained from the following formula.

$$Ls = \frac{1}{(Fa \times fw)^3} \times 8.65 \times 10^{10} (km)$$

Ls: Total travel distance life (10% failure probability) (km)

Fa: Thrust (axial load)(N)

Fw: Load coefficient (coefficient depending on operation conditions)

Smooth operation with no impact	1.0 to 1.2
Normal operation	1.2 to 1.5
Operation with impact/vibration	1.5 to 3.0

Ls (total travel distance life):The travel distance in which 90% of linear actuators can be operated without stripping due to rolling fatigue (ball screw) when they are operated under the same condition.

⚠ CAUTION	**The life becomes considerably shorter for movement with vibrations and impacts.**
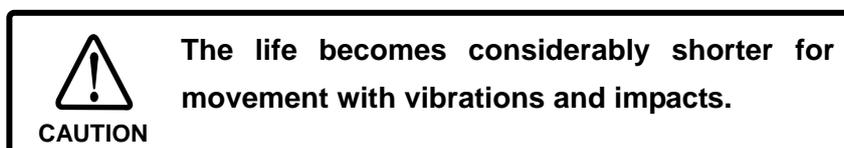
6. Connection

For the terminal block and connector pin layout and specific operation methods, refer to the operation manual of the stepping motor driver UDK5114NW2 (Oriental Motor).
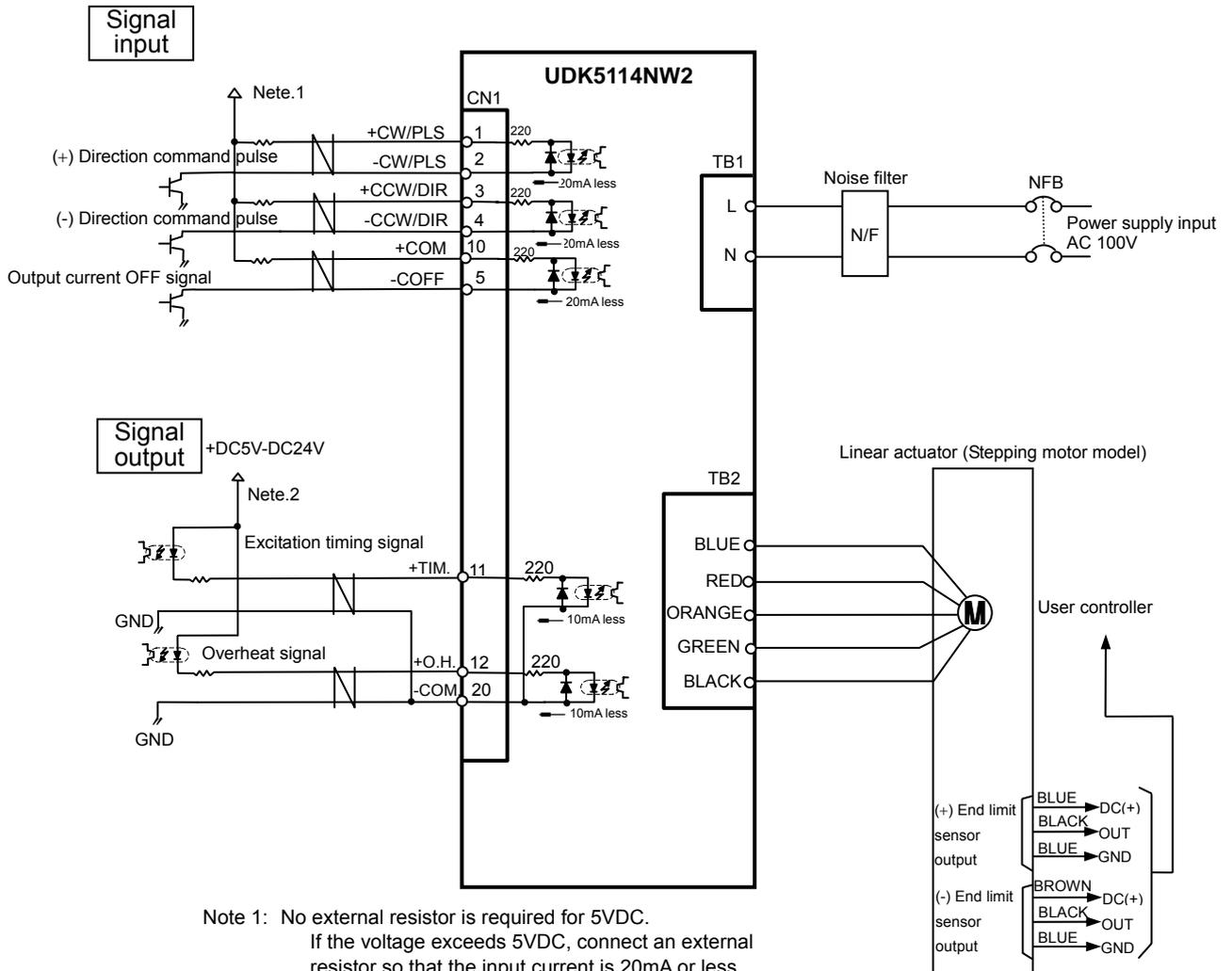
Note 1: No external resistor is required for 5VDC.
If the voltage exceeds 5VDC, connect an external resistor so that the input current is 20mA or less.
Note 2: The current value should be 10mA or less.

* For the electric specifications of the limit sensor, refer to 3-3, "End limit sensor specifications."

Figure 9

7. External drawing

(a) Linear actuator : LAH-80-5020-F-PA/PB

Unit:mm

(+) End limit sensor lead wire
24AWG 3心

(-) End limit sensor lead wire
24AWG 3心

Motor lead wire
22AWG 5心
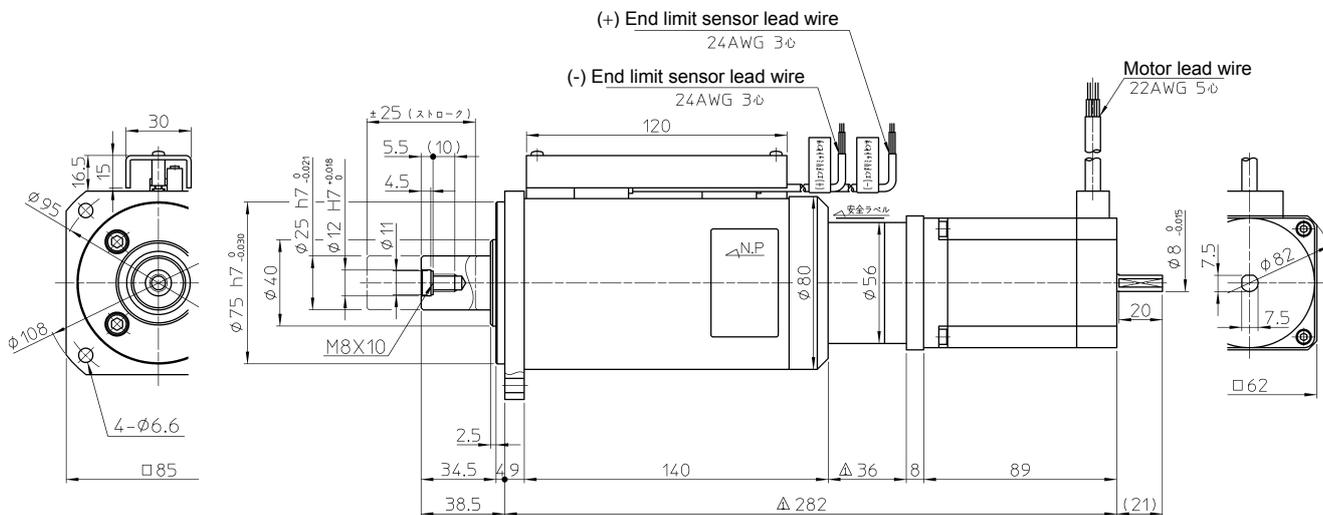
* Indicates a travel of ±0mm.

(b) Driver: UDK5114NW2

Unit:mm

Slit
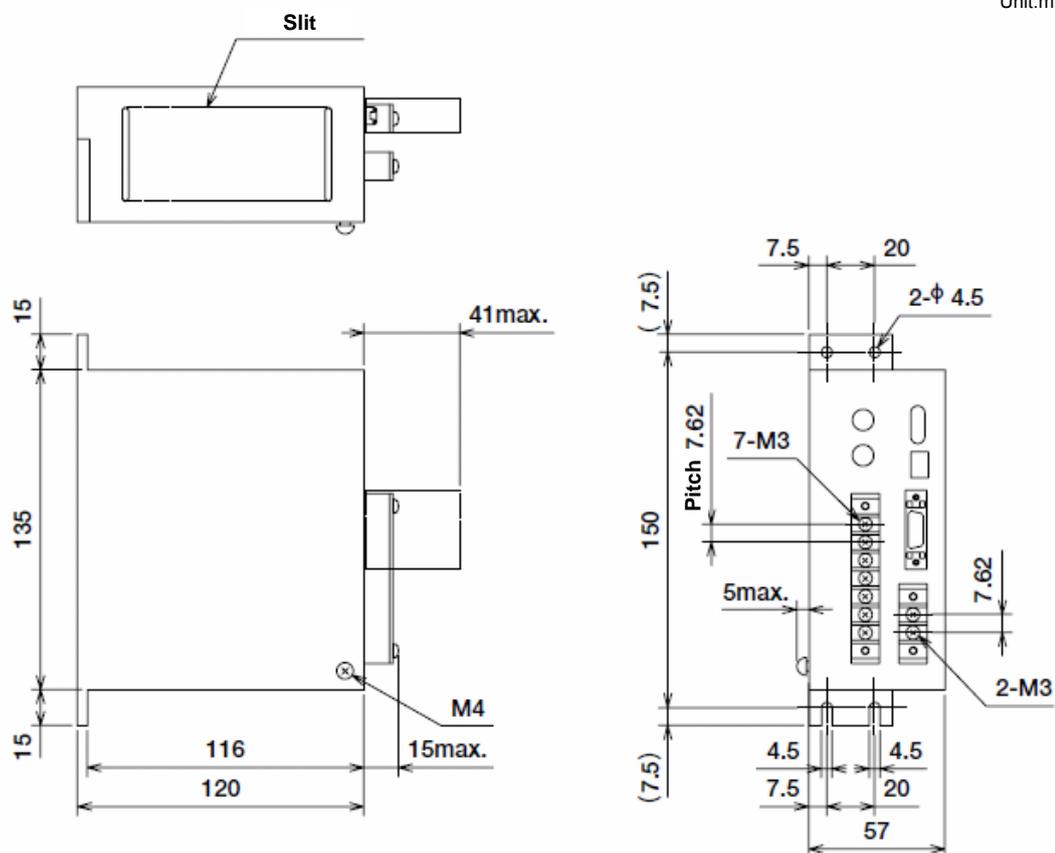
II Operation Manual

Thank you for purchasing the linear actuator LAH-80 Series.

This Operation Manual describes how to handle the LAH-80 Series and cautions.

Some information may overlap with the information described earlier in "For safe use." Before using this product, read it carefully for safe use.

After reading this manual, store it in a safe place so that it can be reached whenever necessary.

If you have any question or comment about this product, contact your distributor or one of our branch offices.

1. Inspection upon unpacking

When the linear actuator is delivered, check the following.

!
CAUTION

◆ **Check that the actual item is as you ordered.**

◆ **Use the motor, control unit, and driver as the specified combination.   Otherwise it may cause an electric shock, injury, or fire.**

◆ **Check for any damage during transportation.   It may cause injury or failure.**

◆ **Check for any looseness at tightening parts.   It may cause an electric shock, injury, or failure.**

◆ **Check that special order parts are attached.**

If you have any further question, contact your distributor or one of our branch offices.

2. Cautions on handling

When handling the linear actuator, be careful of the following.

!
CAUTION

◆ **Do not repair, disassemble, or modify the linear actuator.**

◆ **When transporting the linear actuator, hold the body firmly, and do not pull the lead wires.   It may cause poor electric contact and failure such as a break, and performance may not be guaranteed.   It may cause injury due to falling.**

◆ **Avoid physical shocks to the linear actuator.   It may cause failure, poor accuracy, or abnormal sound.**

Especially, avoid physical shocks to the encoder and output rod.

◆ **The maximum thrust of the output rod of the linear actuator is 3000N.   Use it under the maximum thrust.   For the stepping motor type, provide current limitation at the driver side to limit the maximum thrust.**

◆ **The insulation resistance of the encoder unit of the linear actuator has been checked upon product inspection.   The customer must not measure it.**

3. Structure and part names

LAH-80-5020-F-PA/PB
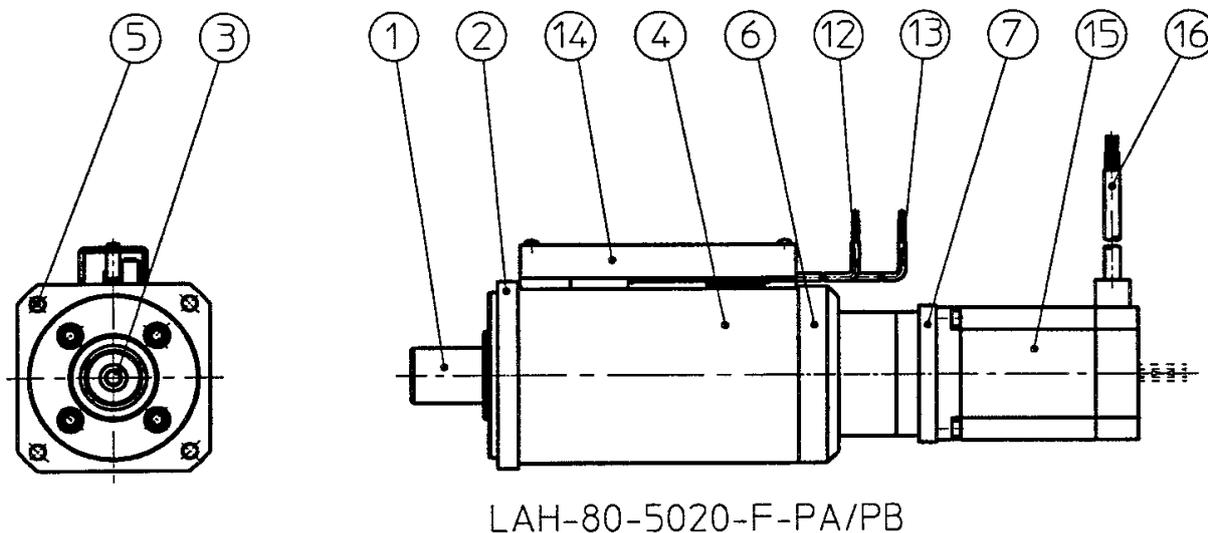
① Output rod

   (Material: Stainless)

② Installation flange

   (Material: Stainless)

③ Output rod fixing screw

   (M8 compatible)

④ Body pipe

   (Material : Aluminum,Surface treatment: Black alumite)

⑤ Linear actuator installation hole

   (M6 compatible)

⑥ House

   (Material : Stainless)

⑦ Motor flange

   (Material : Aluminum, Surface treatment : Alumite)

⑫ (＋)End limit sensor lead wire

⑬ (－)End limit sensor lead wire

⑭ Sensor cover

   (Material : Aluminum, Surface treatment : Black alumite)

⑮ Stepping motor

⑯ Stepping motor lead wire

4. Cautions on design and use

Poor operation methods or operating environments result in unsatisfactory performance, shorter product life, or unexpected troubles.　To avoid this, observe the following.

4-1　Operating environment

Use the linear actuator in the following environment.

- ◆ Indoor
- ◆ Ambient temperature:　10°C to 25°C
- ◆ Ambient humidity:　　20% to 80%RH or less (no condensation)
- ◆ Vibration:　　　　　24.5m/s^2 or less.　If positioning accuracy is required, use it in a non-vibrating condition.
- ◆ No fire or oil nearby
- ◆ No corrosive gas, explosive gas, or dust

4-2　Installation of the linear actuator

⚠ CAUTION	◆ **Securely fix the linear actuator.　Otherwise it may cause injury or damage of the device.** ◆ **Do not climb on or hang from the linear actuator.　It may cause injury.**

To fix the linear actuator, use the installation flange and M6 hexagon socket head bolts (strength category of 10.9 or higher).　Use a bolt length and tap hole such that the thread engagement of the bolt and tap hole becomes 8mm or more.　Also, use φ75h7 spigot to eliminate displacement of the core with the target machine.　Figure 13 shows the installation machining dimensions of the linear actuator.

4-M6 tap depth of 8mm or more

φ95

φ75H7$^{+0.030}_{0}$

Provide C chamfering

Figure 10
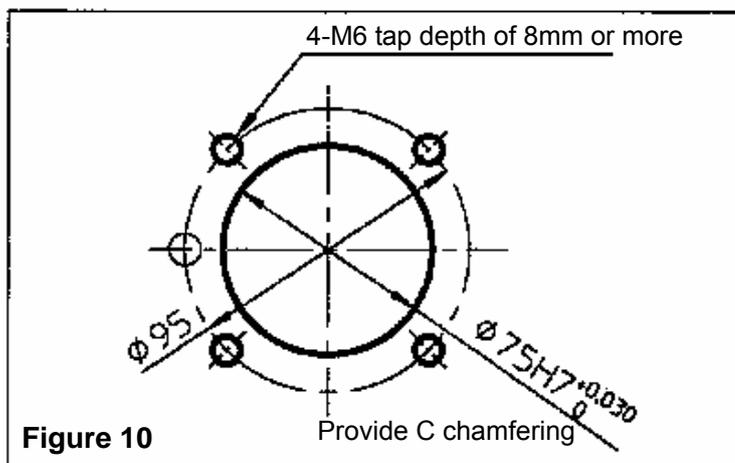
4-3 Load direction

The load (thrust) direction can be the push-out and pull-in directions of the output rod.

If the load direction changes between the push-out and pull-in directions of the output rod, especially the reverse positional accuracy becomes poor because the elastic deformation of each component of the linear actuator is involved.   If positioning accuracy is required, use only one of the directions.

4-4 Connection of the output rod to the paired unit

To connect the output rod to the paired unit, use M8 hexagon socket head bolts (strength category of 10.9 or higher), and select a bolt length such that the thread engagement of the bolt and output rod tap hole becomes 8mm or more.

Also, use φ12h7 spigot or the output shaft rod outer diameter φ25h7 to eliminate displacement of the core with the paired unit. A commercial rod end can be used for connection.   Secure it so that there is no shaft center displacement.

> ⚠️ **CAUTION**
>
> ◆ **Provide a detent mechanism or linear guide mechanism to the target machine so that no torque or radial load is exerted to the output rod. Failure to do so may cause failure, poor accuracy, or shorter life.**
>
> ◆ **Grease is applied lightly on the output rod for smooth sliding.**

4-5 Push-out and pull-in limits of the output rod

a)   The push-out and pull-in limits must be within the range as shown in Figure 15.

The linear actuator has the (+) end limit switch for the push-out limit and (-) end limit sensor for the pull-in limit.   Figure 15 shows the factory-shipped operating points of each.

b) Hitting the mechanical limits as shown in Figure 16 may cause poor performance and shorter life, resulting in internal damage in some cases.   Therefore, control must be provided so that the motor stops immediately when any of the limit sensor trips.

c)   During check operation such as a test run and control sequence, perform operation check with low speed (feed speed of 0.5mm/s or less) and no load.   It will mitigate damage of errors in the operation program or runaway due to wrong wiring.

Available range

63.5

13.5

Figure 11

64~64.5 (+) end limit operating point

12.5~13 (-) end limit operating point
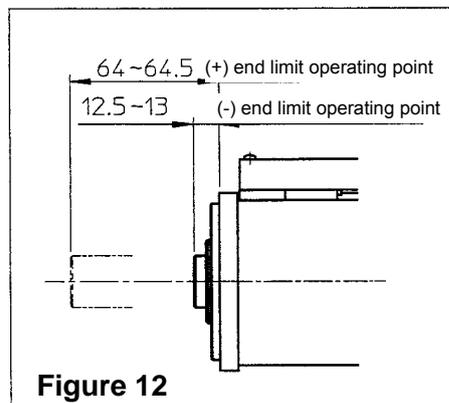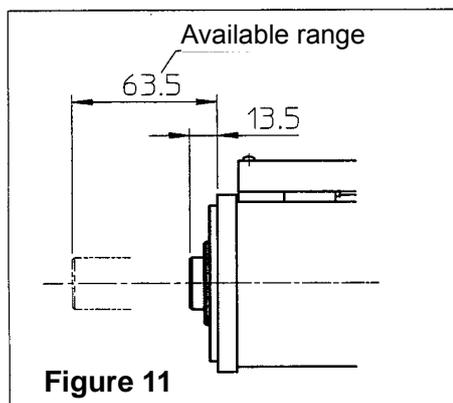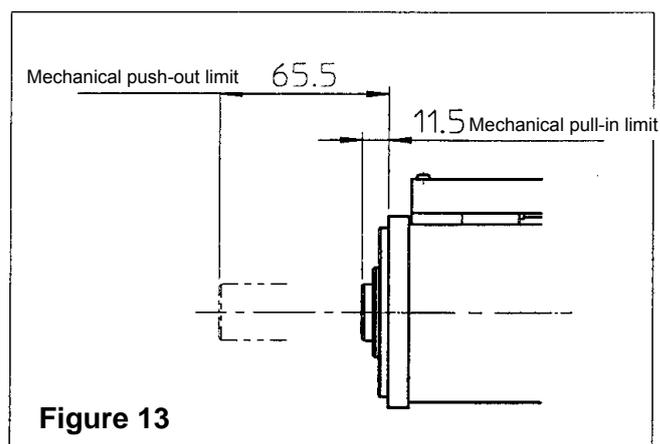
Figure 12

Figure 13

> ⚠️ **CAUTION**
>
> ◆ **Do not use the product with the travel exceeding the available range as shown in Figure 14 and Figure 15. It may cause failure, poor accuracy, or injury.**
>
> ◆ **Control must be provided so that the motor stops immediately if any of the sensors trips by connecting each of the end limit sensors to a user controller. Otherwise it may cause failure, poor accuracy, or injury.**

4-6 Adjustment of the end limit sensor

The operation range of the end limit sensor can be set to any value within the range of Figure 14 and Figure 15.

    a) Remove the round head screw securing the sensor cover.

    b) Slightly loosen the round head screw securing the sensor.

    c) Move the sensor to the desired position along the rail, and fix it with the screw.

    d) Secure the sensor cover with the screw.

    e) Run the linear actuator at a low speed with no load to check the operation of each of the sensors.

> ⚠️ **CAUTION**
>
> ◆ **Do not perform adjustment of the end limit sensor during excitation.**
> **Perform adjustment after turning off the power. Otherwise it may cause an electric shock or burning.**
>
> ◆ **Securely fix the end limit sensor.**
> **Any looseness may result in failure or injury due to malfunction. Too much tightening may result in dropping of the nut securing the sensor. Be careful not to lose it. If it is lost, a JIS-standard M3 nut may be used as a replacement.**
>
> ◆ **Do not forcefully bend, pull, or pinch the lead wire for the end limit sensor. It may cause a break, resulting in defective operation of the sensor, failure, or injury.**
>
> ◆ **Do not loosen or remove any screw that is not to be loosened or removed. It may cause failure, poor accuracy, or injury.**

4-7 Wiring

The control unit is a control device that processes signals of several mV or less. Observe the following to perform wiring.

(1) Use a twisted pair shielded cable with the required number of conductors as the I/O signal line. If two or more control units are used, use a separate cable for each of the control units. The wiring length (cable extension) should be as short as possible.
A guideline of the wiring length is as follows.

  1. Command I/O signal line: 3m or shorter

(2) The ground line should be line diameter of $0.75mm^2$ or more with one-point grounding. Grounding of Class 3 (grounding resistance of 100Ω or less) or greater is recommended.

(3) The wiring length should be as short as possible.

(4) To prevent malfunction due to noise, take the following measures.

  ◇ Place the noise filter and control unit as close as possible.

  ◇ Insert a surge absorber circuit to a coil such as a relay, magnetic contactor, and solenoid.

  ◇ Separate the power line (strong electric circuits such as AC lines and motor lines) and the signal line 30mm or more. Do not pass them through the same duct or bind them together.

  ◇ If there is any source of high-frequency noises such as electric welders and electrical discharge machines, even if not connected to the same power supply, place a noise filter in the power supply and input circuit.

  ◇ A switching amplifier is used in the control unit, which may generate noises on the signal line. When wiring especially the analog input, make sure that the termination is not open.

(5) Measure against radio interference
The control unit is industrial equipment, so it has no measure against radio interference. Therefore, if it is used near private residence or radio interference becomes an issue, provide a line filter to the input of the power supply line.

(6) The conductor of the cable used as a signal line is thin. Be careful not to bend or pull it forcefully.

⚠ **CAUTION**

◆ **Perform wiring carefully based on the connection diagram. Any wrong wiring or poor connection may cause runaway or malfunction of the actuator, burning, or injury.**

◆ **Connect the input of the control unit, signal lines, and sensor driving voltage based on the specifications and connection diagram. Applying a voltage exceeding the operating range or making wrong wiring may cause malfunction, failure, burning, or injury.**

◆ **The wiring length should be as short as possible.**

◆ **Provide measures against noise. Failure to do so may cause malfunction.**

◆ **Check the wiring before power supply is active. Wrong wiring may cause runaway or malfunction of the actuator.**

◆ **Do not bend or pull the line forcefully. It may cause malfunction.**

---

5. Operation

5-1 Cautions on operation

⚠ **CAUTION**

Do not insert your hand in the output rod (movement shaft) of the linear actuator.

Do not touch the terminal for 3 minutes after power off.

⚠ **CAUTION**

◆ **Operation cannot be done by power on/off. It deteriorates the internal circuit elements.**
◆ **Perform operation/stop of the actuator by using command signals.**
◆ **Do not use control method by hit and stop of the output rod. It may cause failure or poor performance.**
◆ **Do not touch the moving parts including the output rod during operation.**
  It may cause injury due to getting caught or pinched.
◆ **Do not perform connection operation during excitation. Turn off the power before starting operation. It may cause an electric shock or burning.**
◆ **Operate it not to exceed the maximum feed speed. It may cause failure or poor performance.**
◆ **If any error occurs, immediately perform emergency stop. It may cause an electric shock or injury.**
◆ **If the linear actuator runs away with the load applied and the mechanical limit travel is exceeded, it may cause failure or injury. Electric recovery may become difficult.**
◆ **Load cannot be held upon alarm stop due to runaway or driver power off. The output rod may move in the reversed direction due to the load.**

5-2 Repeated operation in small travel

⚠ **CAUTION**

◆ **Perform operation of 4mm or more sometimes to improve the lubrication of the ball screw. Otherwise it may cause deterioration of positioning accuracy or shorter life.**

The grease of the ball screw may become low only with back-and-forth movement of 2mm or less.

Low grease may cause abnormal wear or galling, causing deterioration of positioning accuracy or shorter life.

Perform operation of 4mm or more a few times every 1000 operations to spread grease on the ball screw.

For details, consult with your distributor or one of our sales offices.

5-3 Test run

For a test run, check the following and perform it at low speed without any load.

◇ Check items before test run

◆ The linear actuator is installed securely.

◆ The motor and end limit sensor lead wire are wired correctly.

◆ No obstacle that interferes with the movement range of the output rod exists.

◇ Check items during test run

◆ There is no abnormal vibration.

◆ The temperature of the motor part is not abnormally high.

◆ Movement of the output rod is smooth.

◆ Each of the end limit sensors operates, and operation stops.

① The travel and feed speed of the output rod is as shown in the following formula depending on the model.

(1) LAH-80-5020-F-PA/PB (stepping motor type)

<Driver full step>

① Travel of the output rod (mm) $= \dfrac{\text{Operating pulse count (pulse)}}{250}$

② Feed speed of the output rod(mm/s) $= \dfrac{\text{Operating pulse count (pulse/S)}}{250}$

(Note)

For driver half step, change the denominator of the formula to 500.

The rod feed speed must not exceed the maximum feed speed of 10mm/s.

6. Storage overview

To store the linear actuator temporarily or stop using it for a long time, take measures based on the next page.

After storing it for a long time, perform a trial run (refer to Trial run in section 5) to check the operation state.

6-1 Storage location

◆ No dust, dirt, or moisture

◆ No toxic gas or liquid

◆ Storage temperature: -20°C to 50°C

◆ Storage humidity: 20 to 80%RH (no condensation)

◆ Vibration: 24.5m/s^2 (2.5G) or less

6-2 Rust proof measure

◆ Before storing, provide rust-proof treatment lightly on the side of the output rod (refer to 3. Structure and part names) with a waste with rust-proof oil or grease.

◆ To prevent rust in the bearing or feed screws, perform back-and-forth movement of the linear actuator in the range of ±25mm several times every 3 months.

◆ As a measure against moisture, seal the linear actuator with vinyl sheet with absorbent such as silica gel.

6-3 Storage orientation

◆ The storage orientation is horizontal.   Be careful not to crush lead wires.

This manual described how to handle the linear actuator.

If any accident occurs, check the model and number on the nameplate, and contact your distributor or one of our sales offices.   In case of failure, report the details as much as possible.

Remark: The specifications may change without any notice due to improvements of the product.

Warranty Period and Terms

The LAH-80 series are 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 LAH-80 series 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 LAH-80 series 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 the other than the LAH-80 series.

(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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