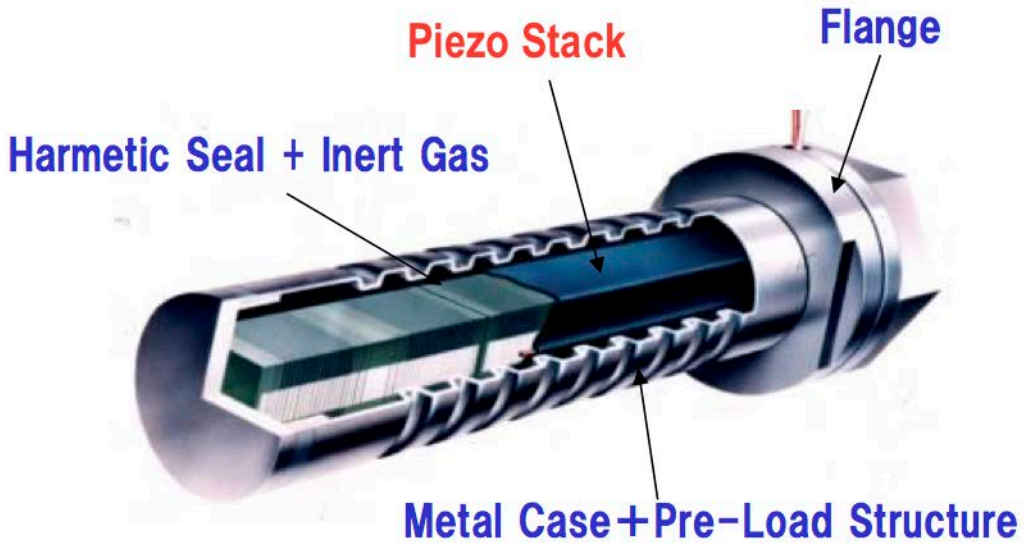


Metal sealed type multilayer piezoelectric actuators

For critical missions in harsh environments

Metal sealed type multilayer piezoelectric actuators

Hermetically sealed stacks for use in harsh environments

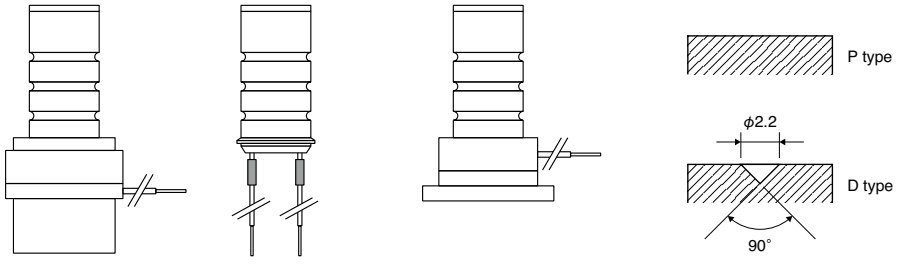
The metal sealed series actuators produced by NEC TOKIN are much less influenced by ambient humidity because of insulation from the atmosphere. As a result, long service life and high performance never experienced in the past have been attained to allow use in various applications such as semiconductor device production equipment and optical communication equipment which require high reliability.

Three hermeticaly sealed actuators series in metal package are available:

PHT: Hermetically sealed piezo stacks, T up to +150ºC
PHD: Hermetically sealed piezo stacks, T up to +85ºC, large displacement

Example: **PHT 510 801 NP**

Configuration of drive block	P=Plane, D=V groove
Configuration of mount	**N**=Female thread type **F**=Flange type（refer to page 12 for details） **W**=Without a flange
Generated force	Unit; Newton [N] The first two digits are effective numerals. The last digit is an exponent of 10. Example: 801=800 N=80 kgf
Nominal displacement	Displacement at the maximum voltage Unit: Micrometers（μm） The first two digits are effective numerals. he last digit is an exponent of 10. Example: 510=51μm
operating temperature range	D, maximum operating temperature: 85℃T T: maximum operating temperature: 150℃
Series name	PH=Encapsulated in metal case



Female thread type　No flange type　Flange type　Configuration of drive block

Standard Parts List

- PHD series

Order Code ※1	Displacement [μm] Maximum driving voltage [150VDC]	Generated force [N]	Resonance frequency [kHz] Female thread type Flange type	Resonance frequency [kHz] Without a flange	Capacitance [μF]	Insulation resistance [MΩ]
PHD550801■●	55.0±8	800	12	18	6.4	10
PHD700801■●	70.0±15	800	8	10	8.2	5
PHD800801■●	80.0±15	800	8	10	9.3	5
PHD101801■●	103.0±15	800	8	9	11	5
PHD550172■●	52.0±8	1,700		20	12	2
PHD550302■●	52.0±8	3,000		18	26	2
PHD700302■●	68.0±15	3,000		12	32	2
PHD101302■●	95.0±15	3,000		9	44	1
PHD101362■●	95.0±15	3,600		9	54	1
PHD151362■●	140.0±18	3,600		7	85	0.5
PHD201362■●	240.0±24	3,600		4	140	0.2

※1：■ in model number has “N” or “F”, “W”letter.
● in model number has “P” or “D” letter.

- PHT series

Order Code	Displacement [μm] Maximum driving voltage [150VDC]	Generated force [N]	Resonance frequency [kHz] Female thread type Flange type	Resonance frequency [kHz] Without a flange	Capacitance [μF]	Insulation resistance [MΩ]
PHT170C801■●	19.0±3	800	14	32	1.3	30
PHT340C801■●	39.0±6	800	12	18	2.6	15
PHT510C801■●	58.0±9	800	10	12	3.9	10
PHT680C801■●	77.0±12	800	8	9	5.1	5

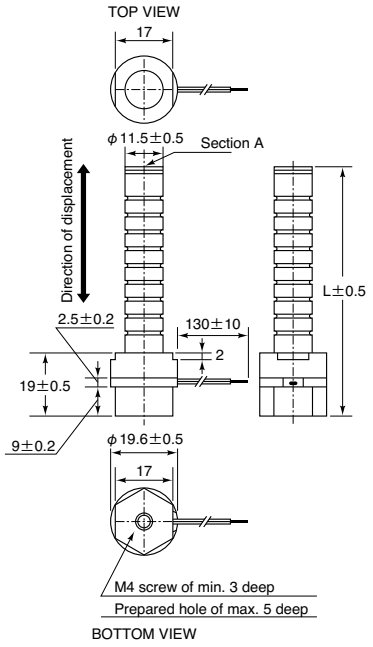
※1：■ in model number has “N” or “F”, “W”letter.
● in model number has “P” or “D” letter.

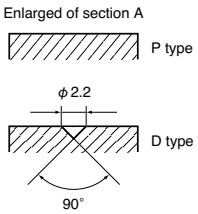
Performance

Item	Standard	Conditions
Operating temperature range	PHD −25 to +40℃ PHR −40 to +40℃	When applied with DC voltage: Ambient temperature When driven by pulse: Ambient temperature + Temperature rise due to generated heat
Recommended Storage condition	−5 to +40℃	
Maximum driving voltage	150VDC	
Displacement	See the standard parts list	At 150VDC
Generated force (compression resistance)	See the standard parts list	The force required for restricting the displacement to 0 when the maximum driving voltage is applied.
Capacitance	See the standard parts list	f = 1kHz,V=1Vrms (<10 μF) f = 120Hz,V=1Vrms (>10 μF)
Capacitance tolerance	+/−20%	
Dissipation factor	5% or less	
Insulation resistance	See the standard parts list	Value obtained in 1 minute at 150 VDC
Resonance frequency	See the standard parts list	With both ends of element in free state Typical value of the element under our test conditions
Airtightness	1×10^{-8} atm cc/sec or less	
Temperature cycle test	Displacement: Initial value ±30% Capacitance: Initial value ±30% tan δ : Less than initial rated value Insulation resistance: 1 MΩ or more Appearance: No noticeable defect	PH, PHD / PHT Room temperature (3 min) / Room temperature (3 min) −25℃ (30 min) / −40℃ (30 min) Room temperature (3 min) / Room temperature (3 min) +85℃ (30 min) / +150℃ (30 min) Repetition of 10 cycles of the above
High-temperature shelf test	Displacement: Initial value ±30% Capacitance: Initial value ±30% tan δ : Less than initial rated value Insulation resistance: 1 MΩ or more Appearance: No noticeable defect	Time 1,000 ± 48 h
Solvent resistance test	Displacement: Initial value ±30% Capacitance: Initial value ±30% tan δ : Less than initial rated value Insulation resistance: 1 MΩ or more Appearance: No noticeable defect Mark: Easily legible	Solvent: Isopropyl alcohol Temperature: 23 ± 5℃ Time: Immersion for 1 min
Heat resistance test	Displacement: Initial value ±30% Capacitance: Initial value ±30% tan δ : Less than initial rated value Insulation resistance: 1 MΩ or more Appearance: No noticeable defect Mark: Easily legible	Temperature: 150 ± 3℃ Time: 96 ± 4 h

Dimensions

● Female thread type





[mm]

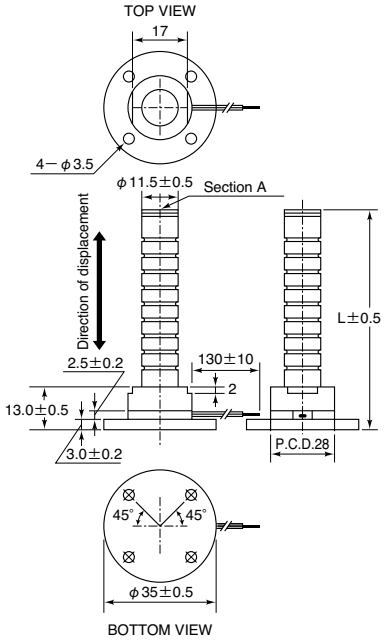
∗Lead wire: AWG26, UL1993
Red color: (+)
White color: (−)

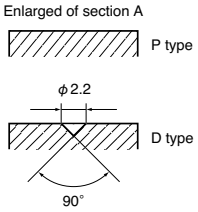
Model	L (mm)
PHT170C801NP	38.4
PHT340C801NP	58.4
PHT510C801NP	78.4
PHT680C801NP	98.4

Model	L (mm)
PHD550C801NP0LF	58.4
PHD700C801NP0LF	78.4
PHD800C801NP0LF	78.4

∗ Both P type and D type have the same overall lengths

● Flange type





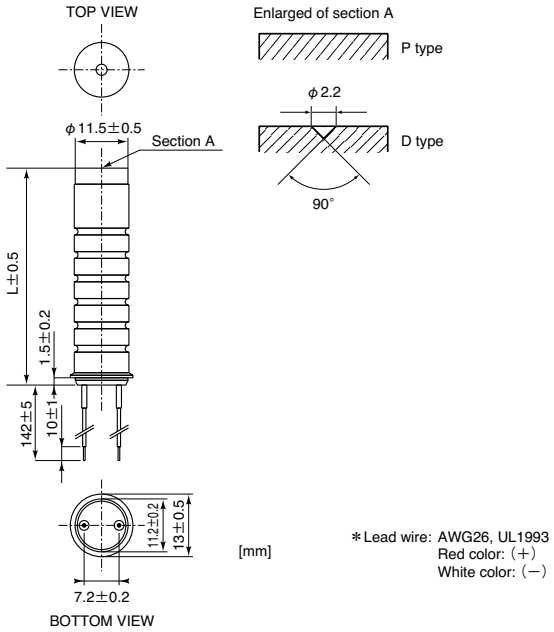
[mm]

∗Lead wire: AWG26, UL1993
Red color: (+)
White color:(−)

Model	L (mm)
PHT170801FP	32.4
PHT340801FP	52.4
PHT510801FP	72.4
PHT680801FP	92.4

Model	L (mm)
PHD550801FP	52.4
PHD700801FP	72.4
PHD800801FP	72.4

● Without flange type

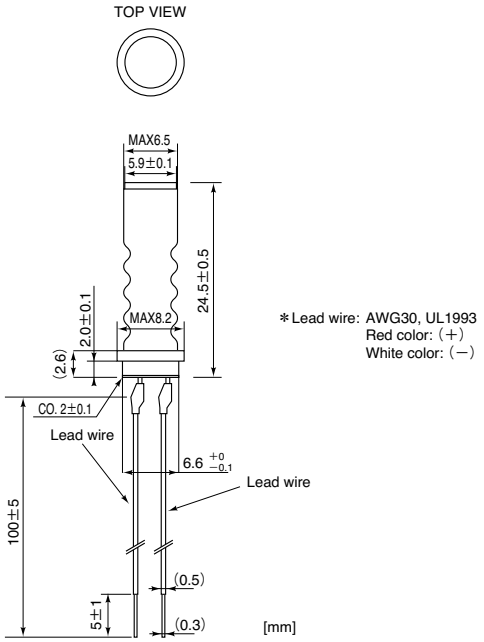


＊Lead wire: AWG26, UL1993
Red color: (+)
White color: (−)

Model	L (mm)
PHT170C801W	24.4
PHT340C801W	44.4
PHT510C801W	64.4
PHT680C801W	84.4

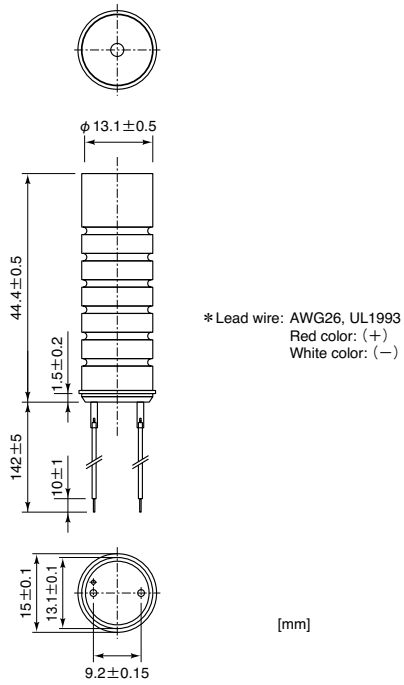
Model	L (mm)
PHD550C801W	44.4
PHD700C801W	64.4
PHD800C801W	64.4
PHD101C801W	84.4

● PH170C201WP1-A0LF



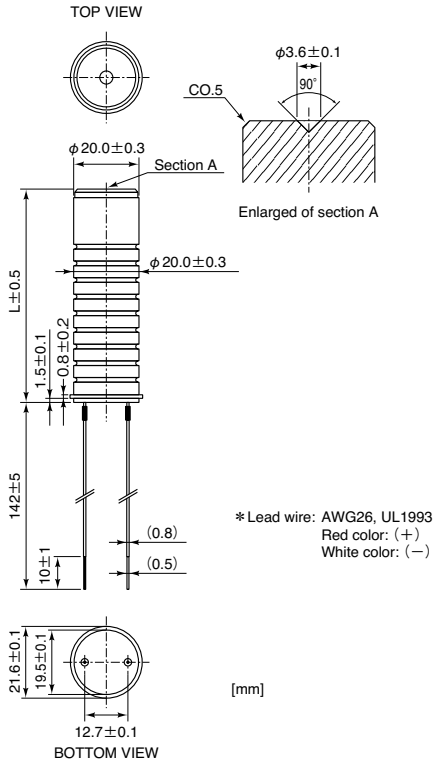
＊Lead wire: AWG30, UL1993
Red color: (+)
White color: (−)

● PHD550C172WD1-A0LF



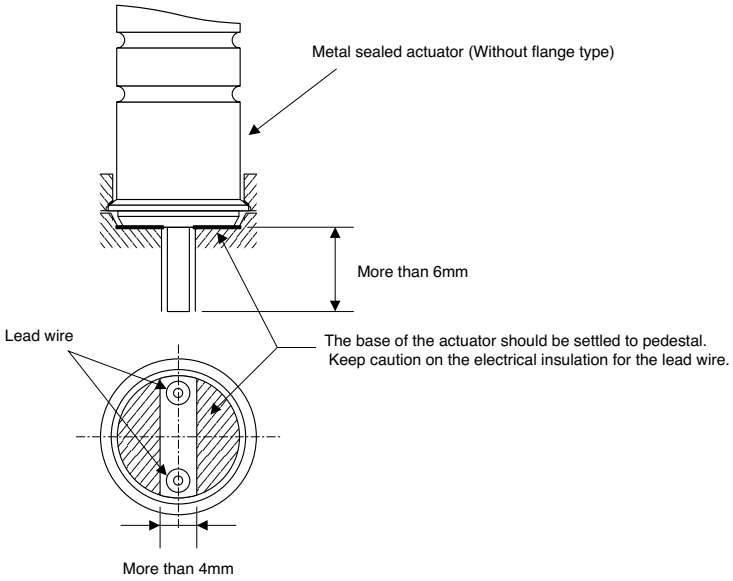
＊Lead wire: AWG26, UL1993
Red color: (+)
White color: (−)

● PH***C302W
PHD***C302W,PHD***C362W



Model	L (mm)
PHD550C302W	45.4
PHD700C302W	64.4
PHD01C302W	85.6
PHD101C362W	85.6
PHD151C362W	125.4
PHD201C362W	217.7

Example of fixing method for actuators without flange



Characteristic Data

- PHD (large displacement) series

Fig-18 Voltage vs. Displacement

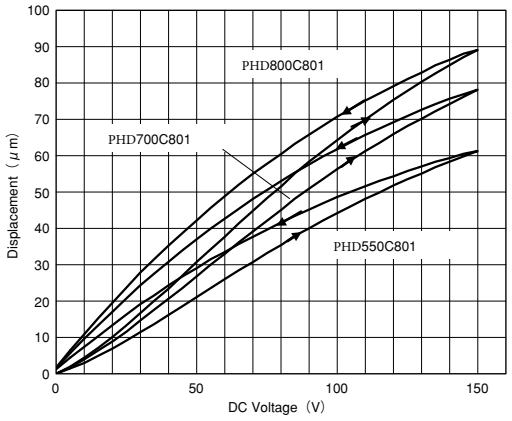


Fig-19 Compression load vs. Displacement

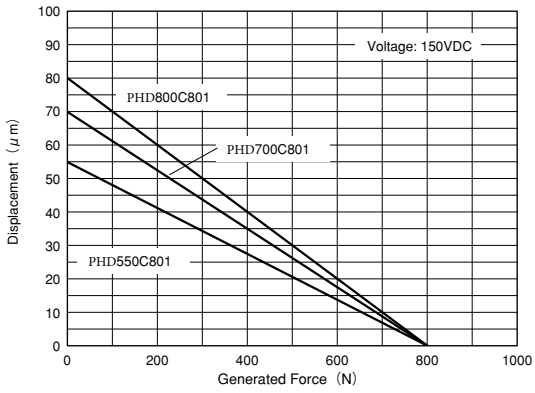
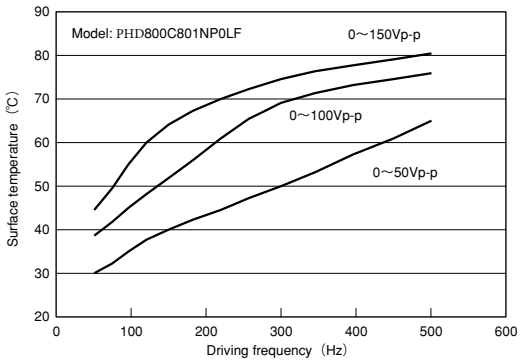


Fig-20 Heat generation vs. Drive frequency



Driving waveform: SIN wave 0~Vp-p
Temperature measurement： 10 minutes after the device is in operation

Reliability

Majority of failure mode of multilayer piezoelectric actuators is the short circuit due to degraded insulation. Though the cause of degradation of insulation has not been clarified perfectly, it has been found that the failure rate varies greatly between statistic uses (DC voltage application) and dynamic uses (pulse voltage application). Like other electrical components, piezo actuators can be influenced by humidity as well as applied voltage and ambient temperature. NEC TOKIN has added the metal sealed type piezo actuators featuring high reliability by eliminating influence of the ambient atmosphere.
This section describes reliability guidelines for static and dynamic usages of the resin-coated and metal sealed types actuators.
Reliability of our multilayer piezoelectric actuators is represented by MTTF (mean time to failure) in case of static usage. Though the number of repetitions is considered to be used to represent the reliability in the case of dynamic usage, the accurate relationship between the indicator and cause has not been determined because of various influential causes and the mutual action between them. For the present, therefore, only the obtained data and our concept are described.

DC voltage application

MTTFr of the metal sealed type under the actual operating conditions is calculated/estimated from the reference MTTFs and the acceleration factor as in the case of the resin-coated type. However since the internal element is sealed from the atmosphere, it is not influenced by the atmospheric humidity. Therefore, equation (2) below is used.

$$MTTF_r = MTTF_s \times A_v \times A_t \quad \cdots (2)$$

$MTTF_r$: Estimated value
$MTTF_s$: Reference value (=36,000h)

A_v : Acceleration factor for drive voltage $= \left(\frac{100}{V_r}\right)^2$ V_r : Actual operating voltage (V)

A_t : Acceleration factor for ambient temperature $= 1.5^{\frac{85-T_r}{10}}$ T_r : Actual operating temperature (℃)

[Example] The following calculation is made for use at 25(c and 150 V:

$$MTTF_r = 36{,}000 \times \left(\frac{100}{150}\right)^2 \times 1.5^{\frac{85-25}{10}}$$

$$= 36{,}000 \times 0.44 \times 11.3$$
$$\approx 179{,}000\text{h (20.4years)}$$

Pulse voltage application

Like the resin-coated type, it is extremely difficult to estimate reliability by using an equation in the metal sealed type because of the influence of the pulse waveform, frequency, etc. in addition to the voltage and ambient temperature.
In NEC TOKIN's testing on the ASB170C801NP0, there was no failure confirmed up to 1000 hours (equivalent to 100 million pulses were applied) under the conditions below.

[Conditions for evaluation]
Temperature: 85 ± 2℃
Humidity: 90 to 95% RH
Load: 200 N to 500 N (20 kgf to 50 kgf)
Drive voltage waveform: Rectangular wave, 30 Hz, 0 V to 100 V, duty ratio at 30%

Guide to Use

Fixing Method:

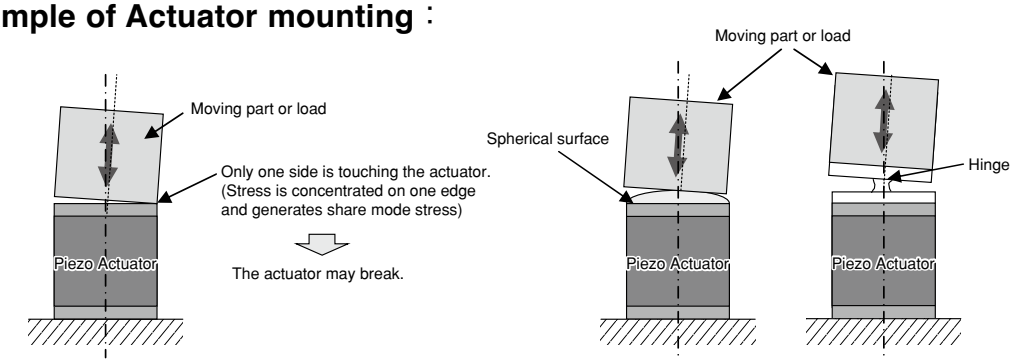
- Carefully prevent the piezo actuators from being bent, being twisted, or being applied tensile force.
  Reference: Guide for tolerance of twisting and tension

	Reference value	Remarks
Twisting force	3×10^{-1}N・m or less	For an actuator which generates a force of 800 N (compression resistance)
Tension	50 N or less	

- Install the actuator so that the center axis of generated displacement is aligned with the center axis of the load.

  ・ Select the mounting bracket (female thread type or fl ange type) according to the mounting method, and install the element utilizing the bracket.
  ・Fix the element securely so that the generated force and displacement cannot be deteriorated.
  ・Connect the driven item at the displacement generating end after securing the mounting portion so that it avoids unnecessary stress applied at the time of installation.
  ・Though this product is designed to apply a compressive force to the internal element by the metal case, avoid any usages that cause bending, twisting, or tension force when the device is in use

Example of Actuator mounting：



a) Example of wrong mounting
Imperfect alignment between actuator and load
<Actuator will be broken>

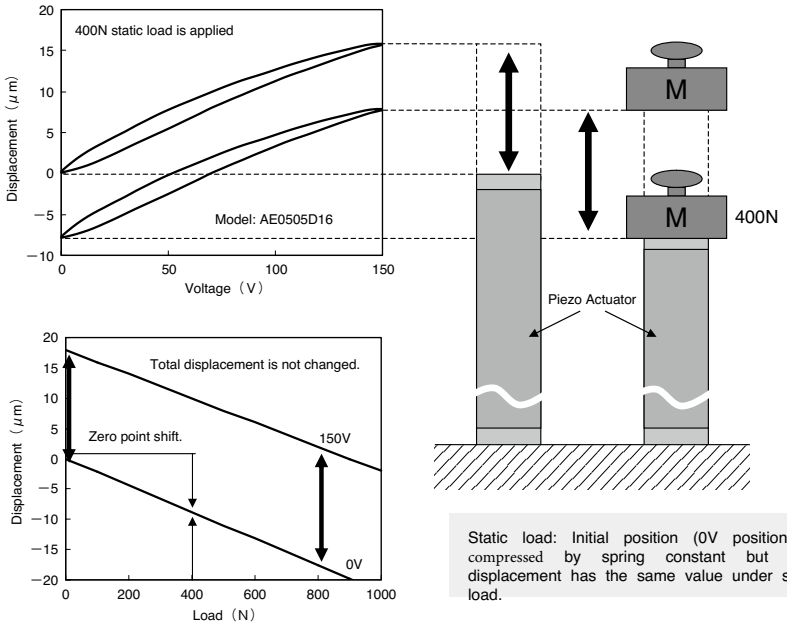
b) Example of correct mounting
Mount the device so that the load is uniformly
applied by the spherical surface or the hinge

Driving Method:

- Connect the red lead wire to the positive (+) terminal of the power supply. Also prevent reverse voltage application.
- Basically the voltage controls the aimed displacement and generated force. In driving, however, it is also necessary to take ringing due to the resonance or hysteresis of the element itself into consideration. In pulse driving, it is further necessary to pay sufficient attention to heat generation due to dielectric loss, charge/discharge current due to the capacitive component and the power output impedance as well.

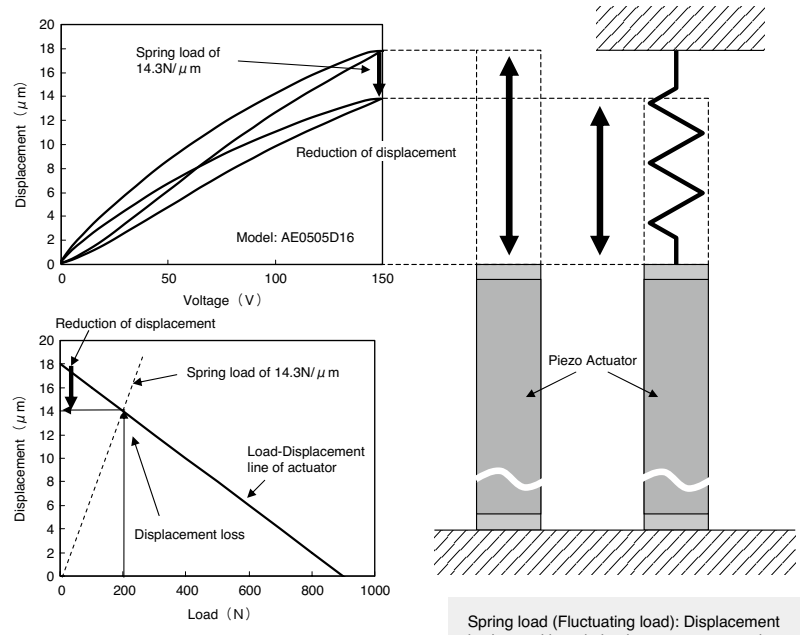
Generated force and load relation:

Static load: No load value change when actuator moves.



Static load: Initial position (0V position) is compressed by spring constant but total displacement has the same value under static load.

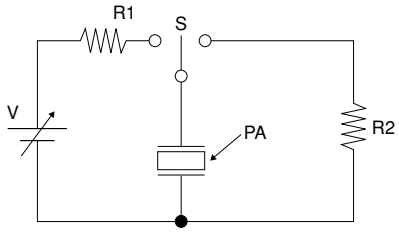
Fluctuating load: Load value changes by spring reaction when actuator moves.



Spring load (Fluctuating load): Displacement is changed by relation between generated force and spring constant of actuator.

Precautions

- Connect the red lead wire to the positive (+) terminal of the power supply.
- Carefully avoid electric shock since a high voltage is in use.
- Never apply excessive tension to a lead wire. Do not handle the product by picking up or moving the lead wire.
- Do not disassemble the case of the metal sealed type.
- Machining of the actuator element and replacement of the lead wire are prohibited.
- Do not handle the resin-coated type (AE series) with bare hands. Otherwise, the reliability of the element would be degraded.
- Do not wash resin-coated type (AE series) by organic solvant.
- Avoid excessive physical shock resulting from, for example, dropping. Otherwise, the internal piezoelectric ceramic element may be damaged.
- If the actuator is exposed to high temperature above 100℃ or if it is used after long storage period (more than three months), it should be polarized by using the circuit configuration and conditions shown below.



Protective resistor R1=1kΩ
Protective resistor R2=1kΩ
Polarizing conditions: DC voltage application
0V→150±0.2V (to be retained for 10 seconds) →0

- Do not apply voltage exceeding maximum rating voltage, or do not do rapid charging and discharging. These might lead to degradation of the reliability or mechanical fracture.
- Do not use the actuator in high concentration of highly inflammable gas. Otherwise, ignition may occur.
- Use the actuator so as not to cause bending, twisting or tension. Furthermore, align the center axis of displacement of the actuator with the center axis of the mechanical load.
- Drive the actuator so that the rising speed is more than three times as much as the resonance period in order to prevent the device from damaging by ringing.
- Store the resin-coated type (AE series) preferably in a dry atmosphere (desirably below 40% RH) at ordinary temperatures (− 5 to + 40˚C). Avoid condensation on the product surface.
- Store actuators where there is no vibration.
- These products must be handled properly as industrial waste. When disposing, please contact your local waste disposal service.
- Piezo actuator is industrial wastes, make sure disposal method under the laws.

Reference table Order Code vs. NEC/TOKIN Model

Order Code	NEC/TOKIN Model
PH170201■●	ASB170C201■●▲LF
PH170801■●	ASB170C801■●▲LF
PH340801■●	ASB340C801■●▲LF
PH510801■●	ASB510C801■●▲LF
PH680801■●	ASB680C801■●▲LF
PH400302■●	ASB400C302■●▲LF
PH800302■●	ASB800C302■●▲LF
PHT170C801■●	ASL170C801■●▲LF
PHT340C801■●	ASL340C801■●▲LF
PHT510C801■●	ASL510C801■●▲LF
PHT680C801■●	ASL680C801■●▲LF
PHD550801■●	AHB550C801■●▲LF
PHD700801■●	AHB700C801■●▲LF
PHD800801■●	AHB800C801■●▲LF
PHD101801■●	AHB101C801■●▲LF
PHD550172■●	AHB550C172■●▲LF
PHD550302■●	AHB550C302■●▲LF
PHD700302■●	AHB700C302■●▲LF
PHD101302■●	AHB101C302■●▲LF
PHD101362■●	AHB101C362■●▲LF
PHD151362■●	AHB151C362■●▲LF
PHD201362■●	AHB201C362■●▲LF