

PiezoHapt™ Actuator PHU Series

"PiezoHapt™ Actuator", a thin-type vibration unit that expands the VR utilization potential with vibration-utilized haptics (haptic technology) / haptic feedback

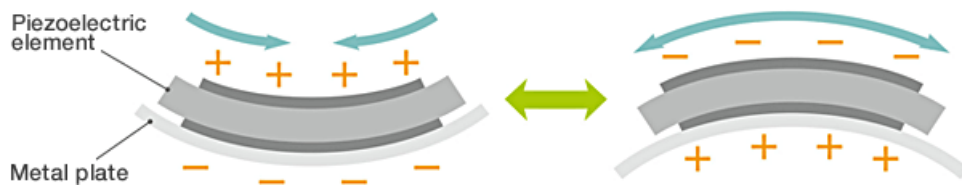
Haptics is a technology that transmits information through skin sensory feedback such as force and vibration.

Recently we often hear the word "Virtual Reality (VR)". In VR, haptic technology that transmits information through tactile sensing such as touching is required, in addition to visual and auditory senses that have been conventionally utilized.

TDK's PiezoHapt™ Actuator is a thin-type vibration unit composed of multilayer piezoelectric element and vibration plate, which can support various vibration patterns, while driving with low voltage. Compared with eccentric rotating masses and linear resonant actuators, both of which have been conventionally utilized for vibration of devices, this product has no installation restrictions and can be used for various applications that require feedback through skin sensation.

Principle and structure of PiezoHapt™ Actuator that realizes both low power consumption and high efficiency vibration

PiezoHapt™ Actuator is an actuator with unimorph structure in which ceramic piezoelectric elements having electrodes on both sides are bonded to one side of a metal plate. If an AC voltage is applied to the electrode, the piezoelectric element expands and contracts, which causes warpage on the bonded metal plate. This phenomenon is shown in the figure below. By changing the direction of applied voltage alternately, the metal plate repeats mountain warpage and valley warpage which makes vibration. **This unimorph structure enables the whole metal plate to vibrate with high efficiency.**



There are two types of piezoelectric elements; single-plate and multilayer. Since the PiezoHapt™ Actuator has multilayer type, it can generate a larger displacement than that of single-plate element of the same thickness. Therefore, while high voltage is required for the piezoelectric-type haptic technology in general, TDK's PiezoHapt™ Actuator can transmit a vibration sensation to the skin even at a low voltage of 24V.

Moreover, since solder joint with wire to the element became unnecessary, the load is not applied to the multilayer element, which improved the amplitude efficiency.

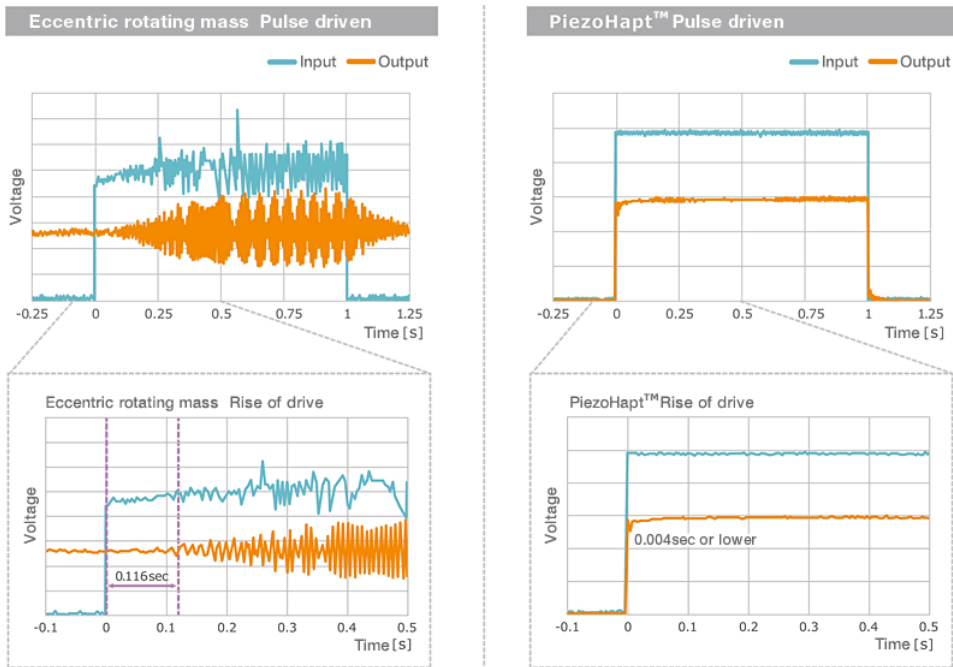
The rising speed is 1/25 of the eccentric rotating mass, and generates various vibration patterns that existing actuators cannot support

Realized the real-time, delicately controlled vibration with less power consumption than eccentric rotating masses

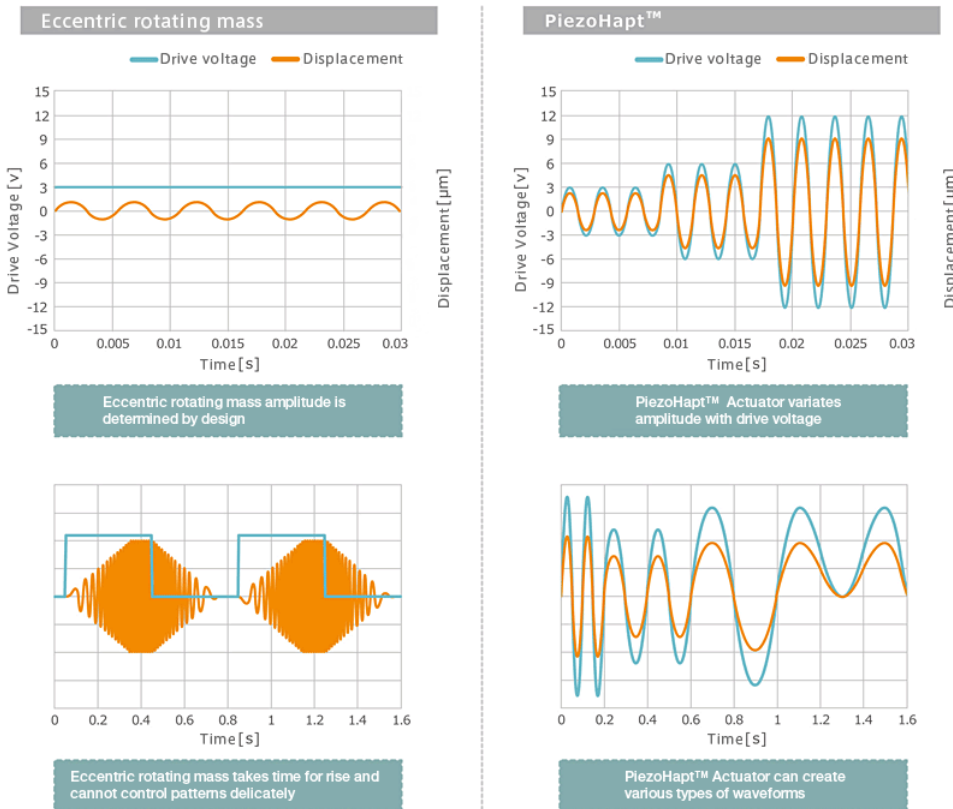
Actuators commonly used for vibrators are eccentric rotating masses and linear resonant actuators. However, these actuators have common disadvantages of the low response speed. For example, in order to create a device that feels uneven when you stroke the display surface with your finger, the response speed must be faster than that of the existing actuators. Therefore, there is an issue in the realization in the advancement of haptic technology.

TDK's PiezoHapt™ Actuator can respond instantaneously based on the piezoelectricity. The graph below compares the driving patterns of the eccentric rotating mass and the PiezoHapt™. While the eccentric rotating mass takes 0.1 seconds or more to rise, the PiezoHapt™ Actuator rises only 1/25 of its time.

Moreover, since it can be operated in shorter energization time compared with that of eccentric rotating masses, the lower power consumption is also one of the advantages of PiezoHapt™ Actuator. As the input frequency or voltage increases, the power consumption increases accordingly, however, power saving can be realized by optimizing the vibrations to be formed.



As shown in the graph below, with the PiezoHapt™ Actuator which can change the amplitude with drive voltage, it is possible to express various, delicately controlled vibration patterns. This is impossible for eccentric rotating masses of which amplitude is determined by design.



With this quick response and free amplitude control, the PiezoHapt™ Actuator can form the feedback base of vibration to the fingertip in various patterns and displacements, which expands the possibility of haptic feedback utilization.

PiezoHapt™ Actuator can transmit uniform vibration to the remote place

While it was difficult for an eccentric rotating mass to transmit vibrations far from its mounted position, PiezoHapt™ Actuator can transmit uniform vibrations to the whole. This feature allows it to transmit strong vibrations to the entire surface of the display and touch pad. The animations below indicate the distribution of vibrations showing the PiezoHapt™ Actuator is transmitting the vibration not only to around the mounted position but to the wider area. In addition to forming uniform vibration, it is also possible to detect the position of the touched fingertip and change the vibration according to its position.



Comparison of eccentric rotating mass and TDK PiezoHapt™ Actuator

The table below is a summarization of the comparison. TDK's PiezoHapt™ Actuator that overcame the issue of high drive voltage for the piezoelectric-types with multilayer piezoelectric elements, enables what could not be realized with an eccentric rotating mass, and further expands the possibility of utilization of haptic feedback using vibration.

	Eccentric rotating mass	TDK PiezoHapt™ Actuator
Rise*	0.116seconds	0.004seconds or lower
Response	Slow	Fast
Vibration Uniformity	Transmits vibration partially	Vibrates the desired area uniformly
Displacement	Medium	Large
Vibration Patterns	Monotonous	Vibration is formed by pulse control
Power Consumption	15mWs	5mWs

*Measurement by TDK

Main applications

This product can be used for various devices that require haptic feedback regardless of the fields, such as wearable devices, touch pad, display monitors, and controllers.