Application Note for TDK’s PiezoListen™ Actuators
Application Note for TDK’s PiezoListen™ Actuators Ver.2.0

Contents

• PiezoListen™ Series
• PiezoListen™ Lineup
• Advantages of PiezoListen™
  • What’s Piezoelectricity?
  • General Advantages of PiezoListen™ Solution
  • Highlight: The World’s Leading Piezo Wide Range Speaker
  • Advantages of PiezoListen™ over Dynamic Speaker for Tweeter
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    • Connection / Output
  • Inventvm’s IVM 6303 Piezo Speaker Driver IC
• Desirable Piezo Product for Our Future

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Piezo & Protection Devices BG / P2
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• **PiezoListen™ Series**

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### PiezoListen™ Series

#### For Tweeter
- **PHUA2010-049B-00-000**
- **PHUA3015-049B-00-000**

#### For Wide Range
- **PHU3030-049B-00-000**
- **PHUA6630-076B-00-000**

### Part Number Construction

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<tr>
<th>PHU</th>
<th>A</th>
<th>3030</th>
<th>-</th>
<th>049</th>
<th>B</th>
<th>-</th>
<th>00-000</th>
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</tr>
<tr>
<td>Series name</td>
<td>Application</td>
<td>Element dimensions (LxW)</td>
<td>Thickness</td>
<td>Type</td>
<td>Internal code</td>
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<tr>
<td>A</td>
<td>General use</td>
<td>3030 30x30mm</td>
<td>49 0.49mm</td>
<td>B</td>
<td>FPC</td>
<td></td>
<td></td>
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<tr>
<td>B</td>
<td>Automotive application (UnderDevelopment)</td>
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# PiezoListen™ Lineup

<table>
<thead>
<tr>
<th>TYPE</th>
<th>PHUA2010</th>
<th>PHUA3015</th>
<th>PHUA3030</th>
<th>PHUA6630</th>
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<tbody>
<tr>
<td><strong>Piezo Element Size</strong>&lt;br&gt;(Typical) [mm]</td>
<td>20 x 10</td>
<td>30 x 15</td>
<td>30 x 30</td>
<td>66 x 30</td>
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<tr>
<td><strong>Thickness</strong>&lt;br&gt;(Max.) [mm]</td>
<td>0.49</td>
<td>0.49</td>
<td>0.49</td>
<td>0.76</td>
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<tr>
<td><strong>Max. Input Voltage</strong>&lt;br&gt;([V_{p-p}])</td>
<td>24 (±12)</td>
<td>24 (±12)</td>
<td>24 (±12)</td>
<td>48 (±24)</td>
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<tr>
<td><strong>Capacitance</strong>&lt;br&gt;[(\mu F)]&lt;br&gt;(1kHz, 1V(_{rms}))</td>
<td>1 ±30%</td>
<td>2.3 ±30%</td>
<td>4.8 ±30%</td>
<td>7.8 ±30%</td>
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<tr>
<td><strong>Consumption Power (Ref.)</strong>&lt;br&gt;([W_{rms}])&lt;br&gt;(1kHz)</td>
<td>0.6</td>
<td>1.4</td>
<td>2.7</td>
<td>14.8</td>
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<tr>
<td><strong>Frequency Range</strong>&lt;br&gt;[Hz]</td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td><strong>Frequency</strong>&lt;br&gt;(Hz)</td>
<td>20</td>
<td>200</td>
<td>2k</td>
<td>20k</td>
</tr>
</tbody>
</table>

## PHUA2010, PHUA3015

## PHUA3030, PHUA6630
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What’s Piezoelectricity?

**Piezoelectric Effect**
An effect in which a voltage is generated in response to the stress caused by applying pressure to a crystal or a specific type of ceramic.

**Inverse Piezoelectric Effect**
When a voltage is applied to a crystal or ceramic that generates the piezoelectric effect, they are deformed.

---

**Simple Structure of Piezo Element**

- **Upper electrode**
- **Piezo material**
- **Lower electrode**
- **Wire +**
- **Wire -**

---

**Piezoelectric Effect**
- Voltage
- Mechanical deformation

---

**Inverse Piezoelectric Effect**
- Simple Structure
- Slight movements and vibrations without any mechanical operations
- Durable
- Easily miniaturized
- Excellent for precision

---

Application Note for TDK’s PiezoListen™ Actuators Ver.2.20
General Advantages of PiezoListen™ Solution

01 Ultra-Thin  Min. thickness between 0.26 to 0.30 mm

02 Anything can be a speaker Just by pasting it to an object, it works as a speaker. Easy to integrate without changing the current design.

03 Wide directivity Rich music reproduction of bass, wide-range and treble.

How To Use

◆ As an Actuator (Single function)
  Triggered and driven by an external signal (e.g. from IC), PiezoListen™ vibrates as an actuator.

◆ As Actuator and Sensor (Multi-functions)
  When force is applied to PiezoListen™, voltage is generated which can be used as a trigger signal for the actuation.

Installation Example Into TV

Combination with dynamic speakers provides the viewer with a more immersive acoustic experience.
### Highlight: The World’s Leading Piezo Wide Range Speaker

#### High Sound Pressure and Wide Frequency Range

The wide range piezo speaker covers the frequency range from low to high frequency.

Its output surpasses conventional products by 25dB in the low frequency range and by 10dB in the high range.

#### Wide Directivity

The entire element surface vibrates, the sound has wide directivity, so that uniform sound can be enjoyed at any point and it brings you a realistic sound experience.

---

**Sound Pressure Level Comparison**

- **PiezoListen™**
  - High frequency: 10dB up

- **Conventional product**
  - Low frequency: 25dB up

**Vibration Simulation of PiezoListen™**
Advantages of PiezoListen™ over Dynamic Speaker for Tweeter

Key Advantages of PiezoListen™

- **Lighter and thinner**
  Easy to integrate into existing designs.

- **Make it seamless**
  Contribute to achieving sophisticated seamless designs.

- **Facilitate dust- and waterproofing**
  Enable stylish and futuristic designs.

A common dynamic speaker is composed of several components, while PiezoListen™ is just a thin plate element. PiezoListen™ is much lighter and thinner.

SPL of PiezoListen™ exceeds dynamic full range speakers.

**Sound Pressure Level Comparison**

Measurement condition:
- Anechoic chamber
- Sine wave 100Hz to 20kHz
- Mic distance 30cm

PiezoListen™ PHUA3030

Dynamic speaker
Applications

PC & Tablet

Automotive
PiezoListen™ for automotive is currently under development.

TV Display

Smart Home Appliance
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Typical Performance Characteristics

PHUA2010  
For Tweeter

PHUA3015  
For Tweeter

PHUA3030  
For Wide Range

PHUA6630  
For Wide Range

**SPL**

**Impedance and Power Consumption**

**Measurement Condition**
SPL – Anechoic chamber, Sin 100 to 20kHz, 12Vp-p, Mic distance:0.1m, Fixed by double sided tape
Impedance and power consumption – Attached to the acryl plate

Application Note for TDK's PiezoListen™ Actuators Ver.2.20
PiezoListen™ causes the object to which it is glued to vibrate and change it into a speaker so that the material and the shape of the pasted object affects the tone.

Sound quality is affected by changing:

01 Size of PiezoListen™

02 Material of the object

03 Thickness of the object
## Handling Guide _ Reference Data by Each Parameter

### 01 Element Size

The sound pressure simply varies by changing the size of PiezoListen™.

*Measured with a glass plate (220x220x0.7mm)

### 02 Material Type (Glass vs Acryl)

The frequency changes depending on the material to paste.

*Measured with a glass and an acrylic plate (220x220x0.7mm)

### 03 Thickness

As the thickness becomes thinner, the frequency shifts to the lower.

*Measured with A5052(Al-Alloy) plate (220x220mm)

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**Measurement conditions**

- Anechoic chamber
- Sin 100 to 20kHz, 1/12 oct
- 12Vp-p
- Mic distance:0.1m
- Fixed by double sided tape
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General Design Notes

Mounting

When mounting PiezoListen™ to the device, please use a strong double-sided adhesive tape so that vibration is fully transmitted to the attached surface.

Adhesive tape should cover the entire back surface of the actuator.

Driver Circuit

PiezoListen™ can be driven by audio driver IC or a discrete circuit.

TDK is cooperating with IC manufacturers on the verification of drive ICs.

Note

Please carefully avoid exposure to:

- Corrosive gases (Cl2, NH3, H2S, SOx, NOx etc.)
- Highly conductive substances (electrolytes, saltwater etc.)
- Acid, alkali or organic solvents
Demo Structure Example Using Audio Amp

Block Diagram

- Power Supply
- Amp
- Resistor (4.7Ω/10W)
- PiezoListen™
- DUT (e.g. Table)
- Sound Source (e.g. Smartphone)

Overview

- Sound Source
- Amp
- Resistor
- PiezoListen™
- DUT (e.g. Table)
Demo Structure Example Using Audio Amp

Connection / Amp – Sound Source

Power Supply

Amp

Resistor (4.7Ω/10W)

PiezoListen™

DUT (e.g. Table)

Sound Source e.g. Smartphone

Connect the amp with the sound source via cable or Bluetooth etc.
Demo Structure Example Using Audio Amp

Connection / Resistor – PiezoListen™

- Power Supply
- Amp
- Sound Source e.g. Smartphone
- Resistor (4.7Ω/10W)
- PiezoListen™
- DUT (e.g. Table)

Connect the resistor to the + side.
Fix PiezoListen™ to an object (e.g. table) by using double-sided tape. The vibration from PiezoListen™ is transmitted to the table, and the table itself works as a speaker.
Demo Structure Example Using Audio Amp

Connection / Output

- Power Supply
- Amp
- Sound Source e.g. Smartphone
- Resistor (4.7Ω/10W)
- Piezolisten™
- DUT (e.g. Table)

Note: The volume shall not be increased too much. The sound quality will be distorted because of overloading.

Increase the output of the sound source and the amp slowly.

Sound Source e.g. Smartphone

Amp

Resistor (4.7Ω/10W)

Piezolisten™

DUT (e.g. Table)
IC Reference: Inventvm’s IVM6303 Piezo speaker driver IC

- IVM6303 is the most efficient audio piezo driver IC in its class driving up to 8uF load, up to 46Vpp
  - 256 level boost converter with envelop tracking + class-D amplifier + No bulky resistor increase system efficiency
- Exceptional sound quality
  - Lowest noise floor at < 11uVrms + THD+N < -80dB @1KHz enables high quality voice and music playback
  - SW + HW DSP PiezoDrive™ algorithms further enhance SPL, low end frequency response
- Extreme system versatility: Force sensing, ultrasound and haptic pattern driving capable
- Supporting both 1S and 2S battery systems up to 10V
  - Power amp also supports an external supply up to 25V

Stereo EVKIT available!
Desirable Piezo Product for Our Future

A Comfortable Space Not Just a Transportation
Piezo speaker, Haptics
Contribute to immersive sound and seamless design

More Comfortable Smart Home
Smart meter, Haptics, Piezo speaker
More efficient energy management and IoT house

Drone with Multiple Applications
(AI smart drone, smart agriculture)
Piezo actuator
Drone’s higher image quality contributes to various situations

Smart Functions in Any Scenes
Haptics, Piezo switch
Various functions work in any environments even under the water

Realistic Feedback even at a Distance
Haptics, Piezo actuator
Various haptic feedbacks makes our experience more real and rich

Application Note for TDK’s PiezoListen™ Actuators Ver.2.20