

Attracting Tomorrow



# Application Note for TDK's PiezoListen™ Actuators

**TDK Corporation**

Electronic Components Business Company  
Piezo & Protection Devices Business Group

Ver.2.20 Revised in September 2022

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- **PiezoListen™ Lineup**
- **Advantages of PiezoListen™**
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- **Desirable Piezo Product for Our Future**

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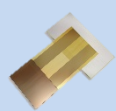
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# PiezoListen™ Series

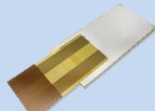
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For  
Tweeter

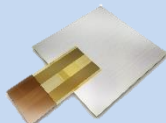


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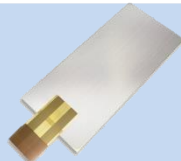


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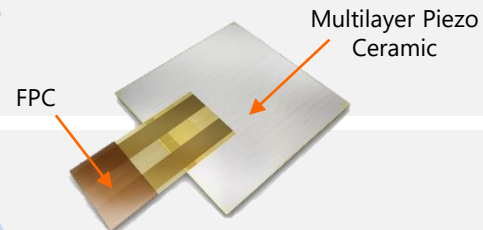
For  
Wide Range



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PHUA6630-076B-00-000

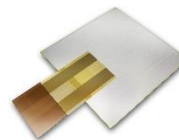
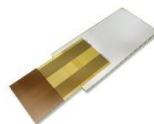
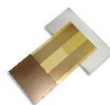


## Part Number Construction

PHU	A		3030		-	049		B		-	00-000	
Series name	Application		Element dimensions (L×W)		Thickness		Type		Internal code			
	A	General use	3030	30×30mm	49	0.49mm	B	FPC				
	B	Automotive application (UnderDevelopment)										

# PiezoListen™ Lineup

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TYPE	PHUA2010	PHUA3015	PHUA3030	PHUA6630
<b>Piezo Element Size</b> (Typical) [mm]	20 x 10	30 x 15	30 x 30	66 x 30
<b>Thickness (Max.)</b> [mm]	0.49	0.49	0.49	0.76
<b>Max. Input Voltage</b> [V <sub>p-p</sub> ]	24 (±12)	24 (±12)	24 (±12)	48 (±24)
<b>Capacitance</b> [μF] (1kHz, 1V <sub>rms</sub> )	1 ±30%	2.3 ±30%	4.8 ±30%	7.8 ±30%
<b>Consumption Power (Ref.)</b> [W <sub>rms</sub> ] (1kHz)	0.6	1.4	2.7	14.8

**Frequency Range**  
[Hz]

Frequency  
(Hz)



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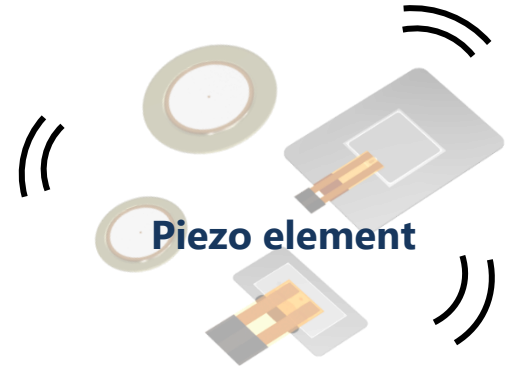
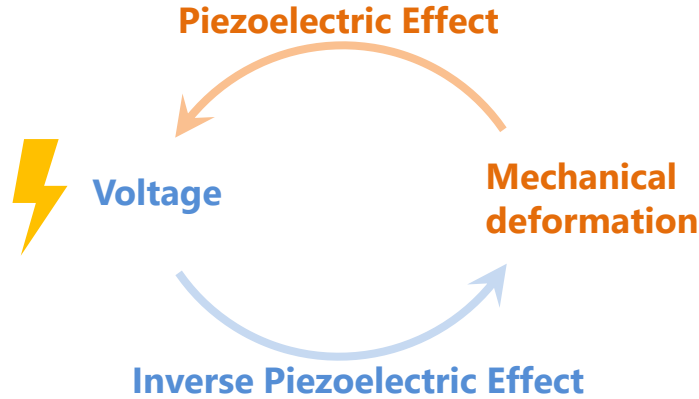
# What's Piezoelectricity?

## 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



Simple Structure  
Slight movements and vibrations  
without any mechanical operations

**Durable**  
**Easily miniaturized**  
**Excellent for precision**

# 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.

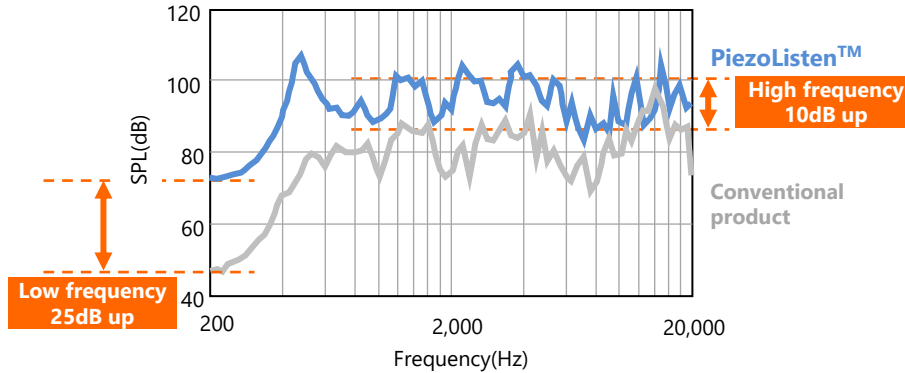
## Installation Example Into TV



Combination with dynamic speakers provides the viewer with a more immersive acoustic experience.

# Highlight: The World's Leading Piezo Wide Range Speaker

## Sound Pressure Level Comparison



## High Sound Pressure and Wide Frequency Range

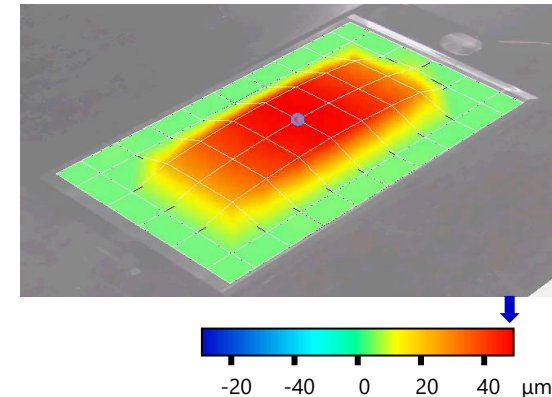
The wide range piezo speaker covers the frequency range from low to high frequency.

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

## Wide Directivity

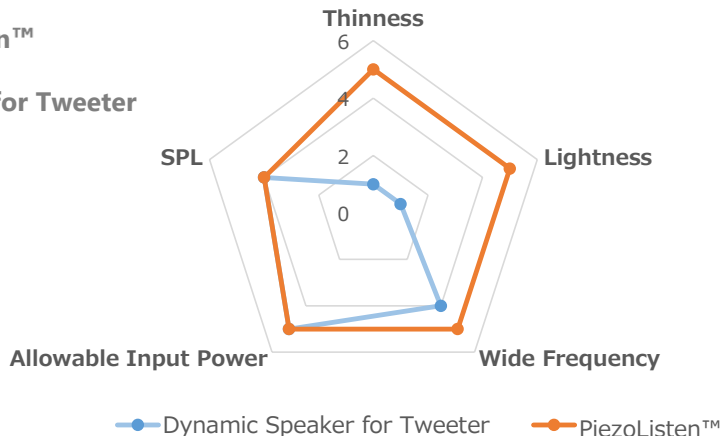
The entire element surface vibrates, the sound has wide directivity, so that uniform sound can be enjoyed at any point and it brings you a realistic sound experience.

## Vibration Simulation of PiezoListen™



# Advantages of PiezoListen™ over Dynamic Speaker for Tweeter

PiezoListen™  
vs  
Dynamic Speaker for Tweeter



## Key Advantages of PiezoListen™



### Lighter and thinner

Easy to integrate into existing designs.



### Make it seamless

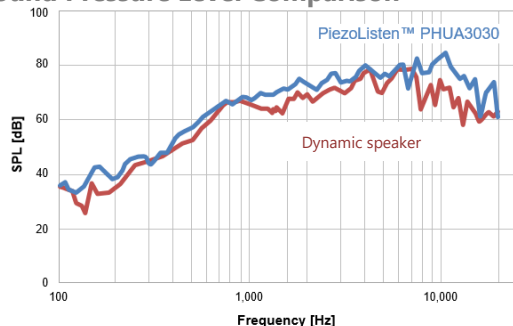
Contribute to achieving sophisticated seamless designs.



### Facilitate dust- and waterproofing

Enable stylish and futuristic designs.

## Sound Pressure Level Comparison



SPL of PiezoListen™ exceeds dynamic full range speakers.

Measurement condition

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

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

PiezoListen™ is much lighter and thinner.



Dynamic speaker

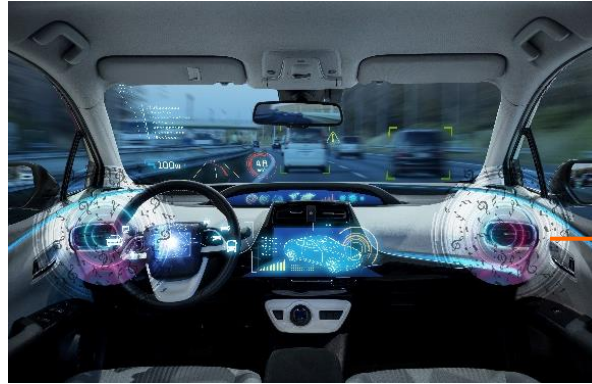


PiezoListen™

# Applications



**PC & Tablet**



## Automotive

PiezoListen™ for automotive is currently under development.

## TV Display



## Smart Home Appliance



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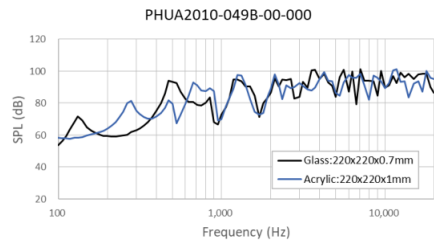
# Typical Performance Characteristics

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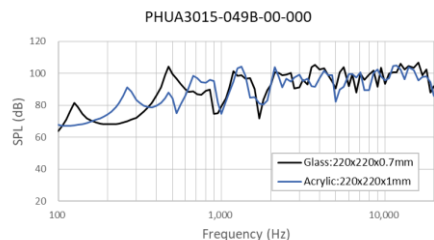
**PHUA2010**  
For Tweeter

SPL



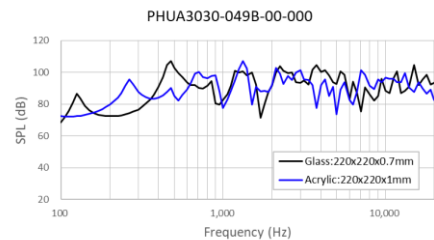
**PHUA3015**  
For Tweeter

SPL



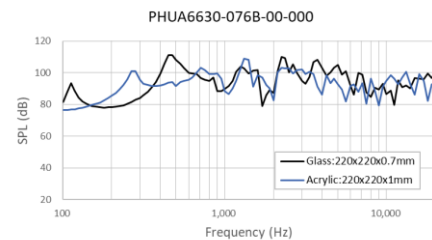
**PHUA3030**  
For Wide Range

SPL

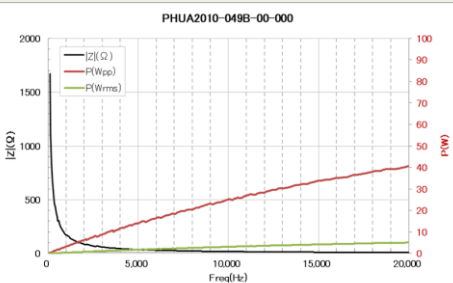


**PHUA6630**  
For Wide Range

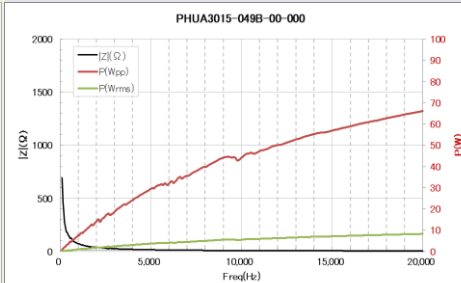
SPL



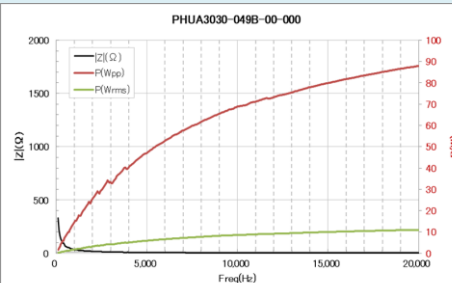
Impedance and Power Consumption



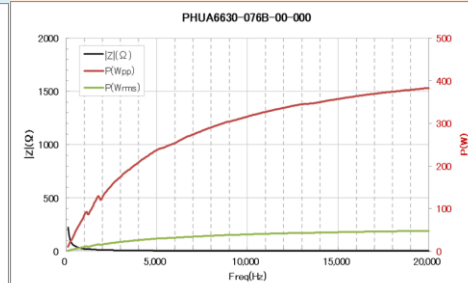
Impedance and Power Consumption



Impedance and Power Consumption



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

# Handling Guide - Reference Data

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

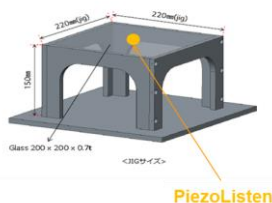
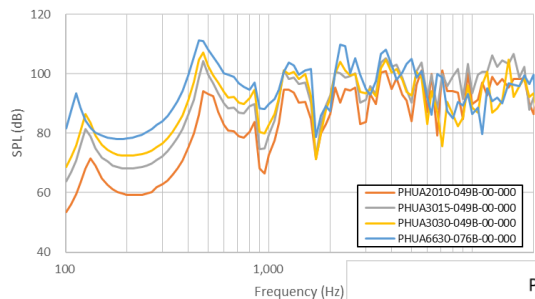
**03** Thickness of the object

# Handling Guide \_ Reference Data by Each Parameter

## 01 Element Size

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

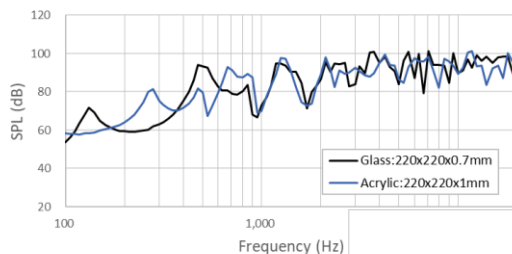
\*Measured with a glass plate (220x220x0.7mm)



### 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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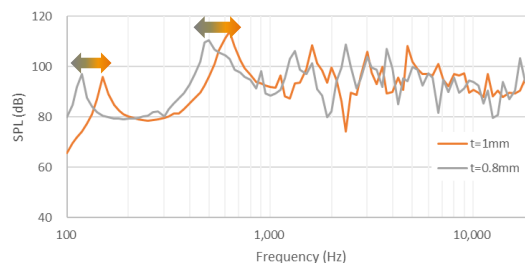


## 02 Material Type (Glass vs Acryl)

The frequency changes depending on the material to paste.

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

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## 03 Thickness

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

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

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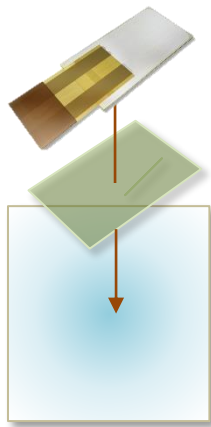
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# General Design Notes

## 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.



### PiezoListen™

Double-sided adhesive tape  
(e.g. Nitto Denko 5000 or 510)

Your device  
(Display module, housing etc.)

## ! Note

Please carefully avoid exposure to:

- ✓ Corrosive gases  
(Cl<sub>2</sub>, NH<sub>3</sub>, H<sub>2</sub>S, SO<sub>x</sub>, NO<sub>x</sub> etc.)
- ✓ Highly conductive substances  
(electrolytes, saltwater etc.)
- ✓ Acid, alkali or organic solvents

## Driver Circuit

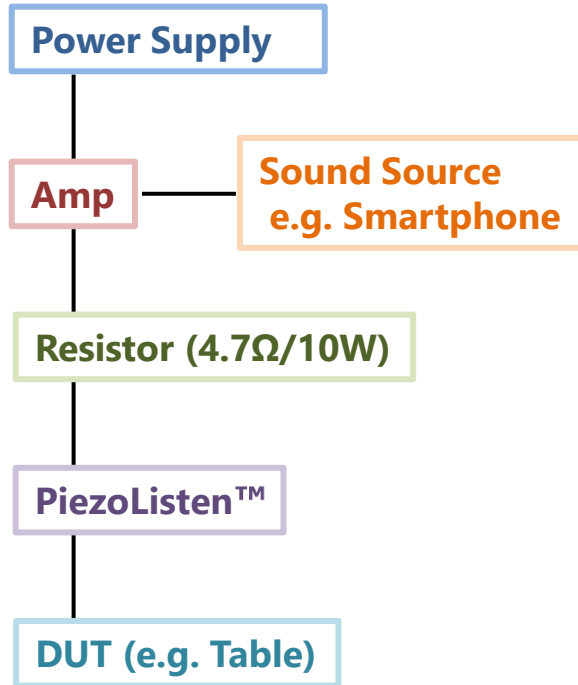
PiezoListen™ can be driven by audio driver IC or a discrete circuit.

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

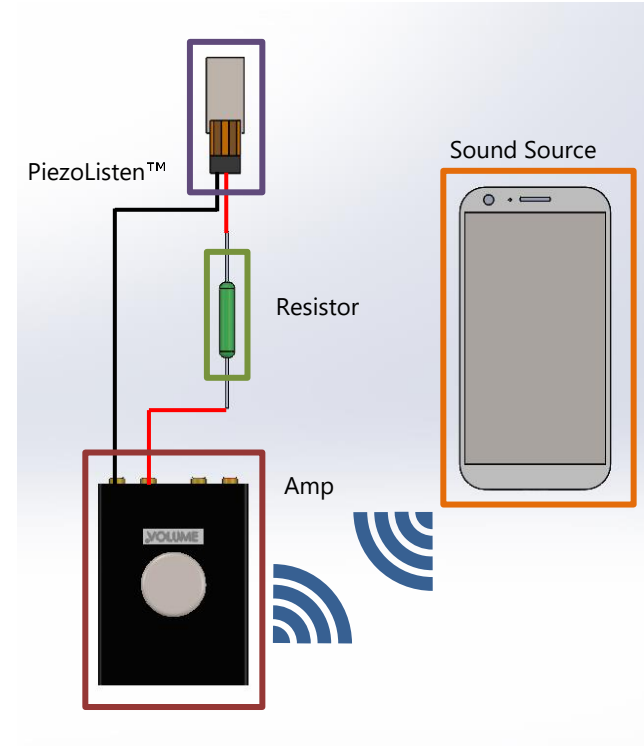


# Demo Structure Example Using Audio Amp

## Block Diagram

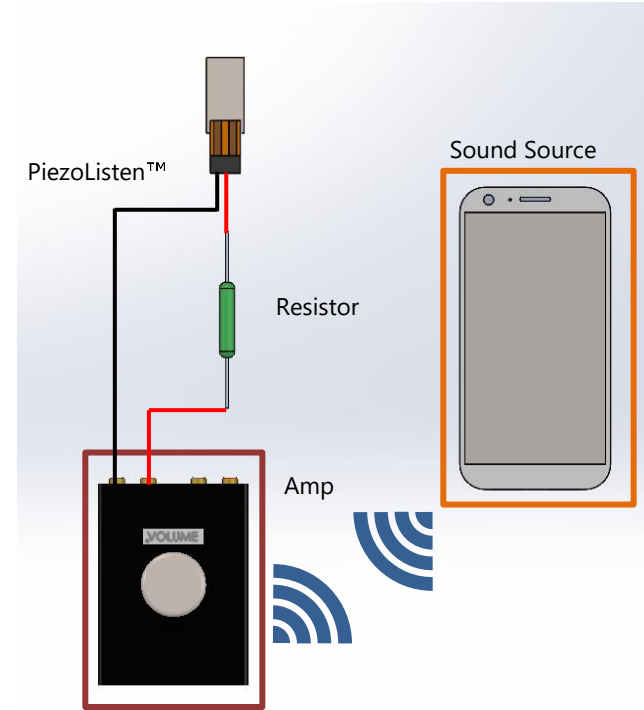
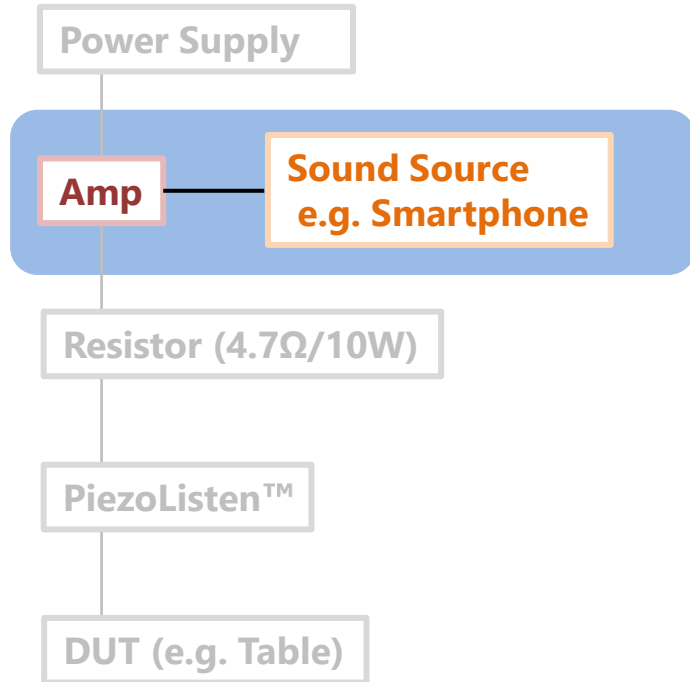


## Overview



# Demo Structure Example Using Audio Amp

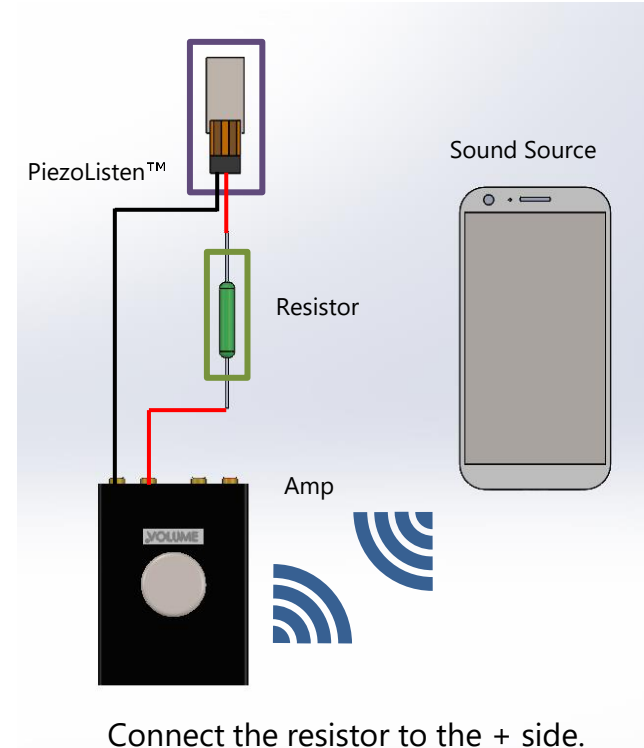
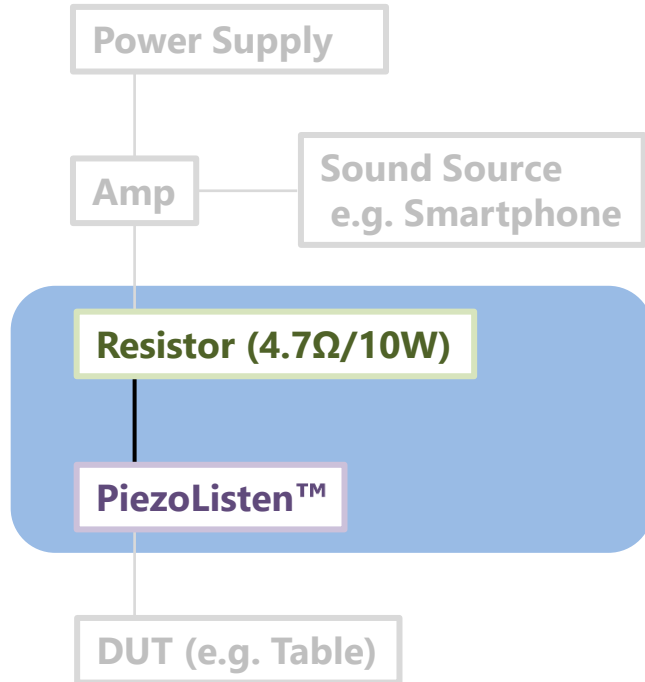
## Connection / Amp – Sound Source



Connect the amp with the sound source via cable or Bluetooth etc.

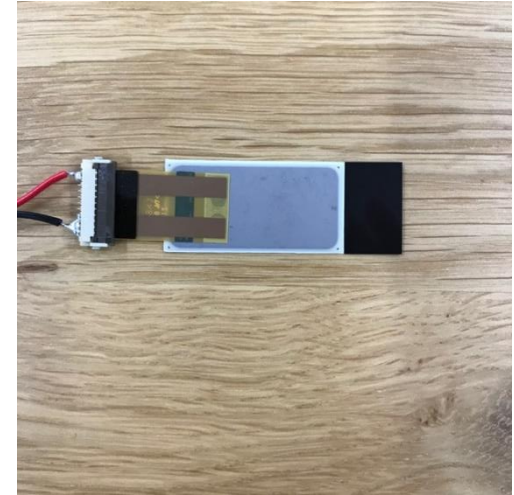
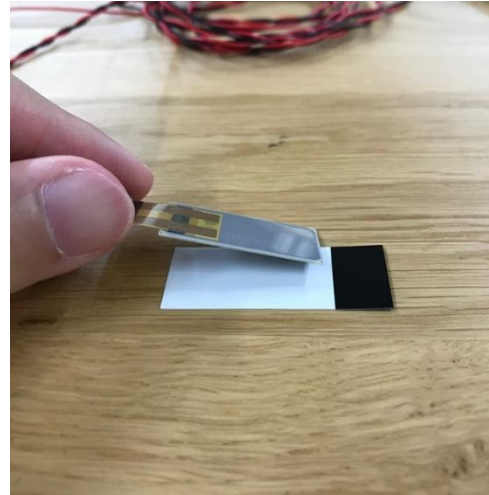
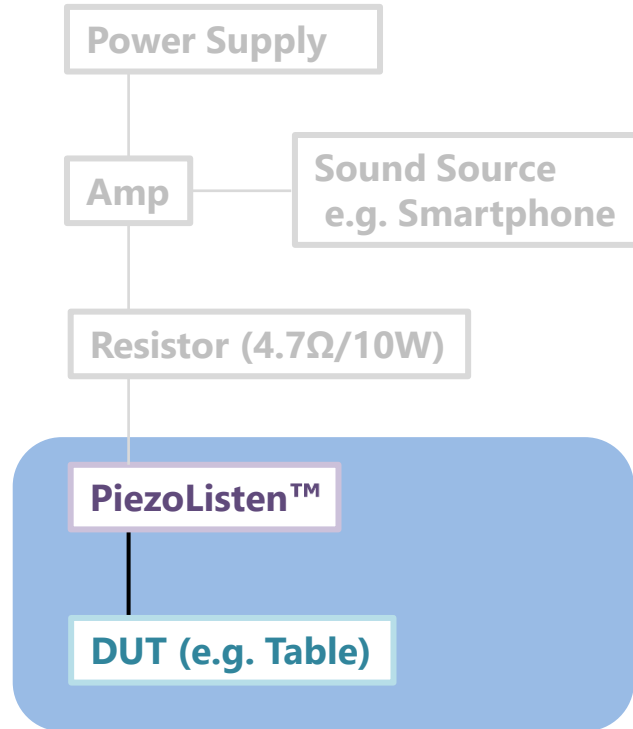
# Demo Structure Example Using Audio Amp

## Connection / Resistor – PiezoListen™



# Demo Structure Example Using Audio Amp

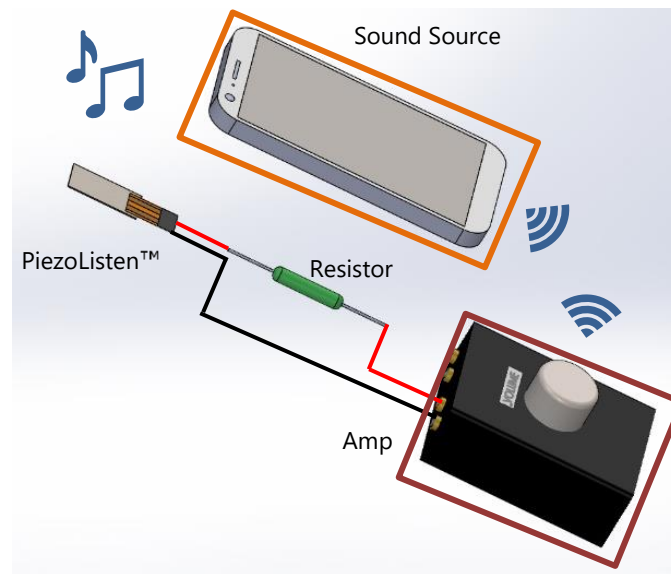
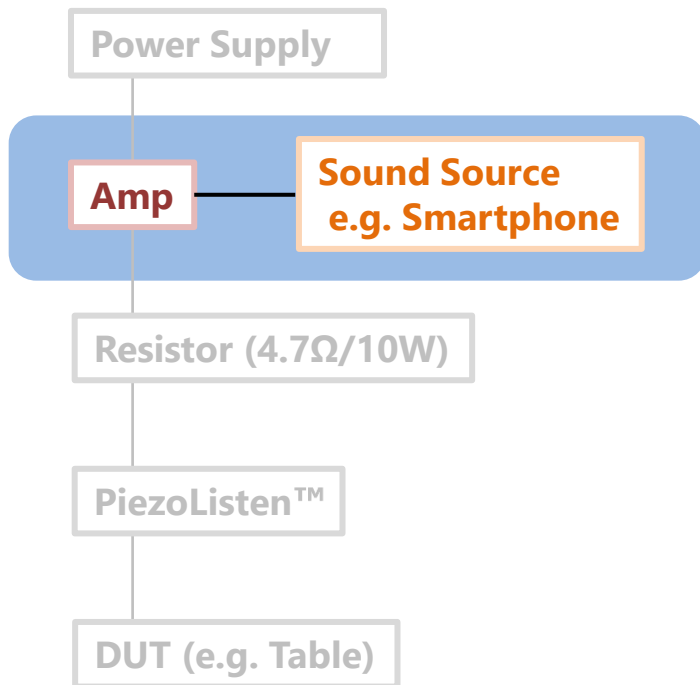
## Connection / PiezoListen™ – DUT



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

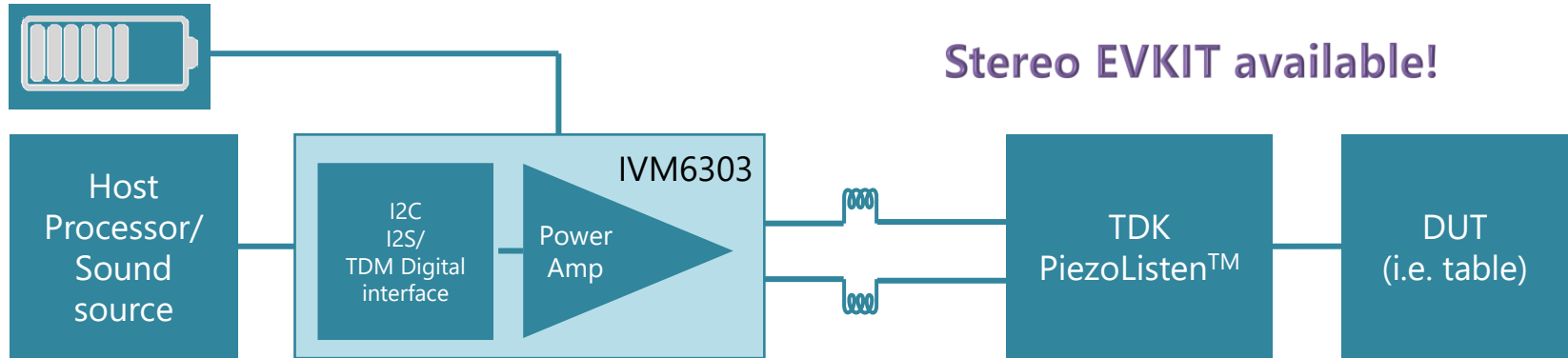
## Connection / Output



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

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

## 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  $< 11\mu\text{Vrms}$  +  $\text{THD+N} < -80\text{dB}$  @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

# 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



