■Overview

Piezoelectric diaphragms and piezoelectric buzzers / sounders are based on the flexural vibration of a diaphragm made by bonding a piezoelectric element and a metal plate, and have the following characteristics.

- Clear electronic sound.
- Low current consumption.
- High safety with no sparks due to the non-contacts inside structure.
- Compact and lightweight, mountable on a small space printed circuit board.

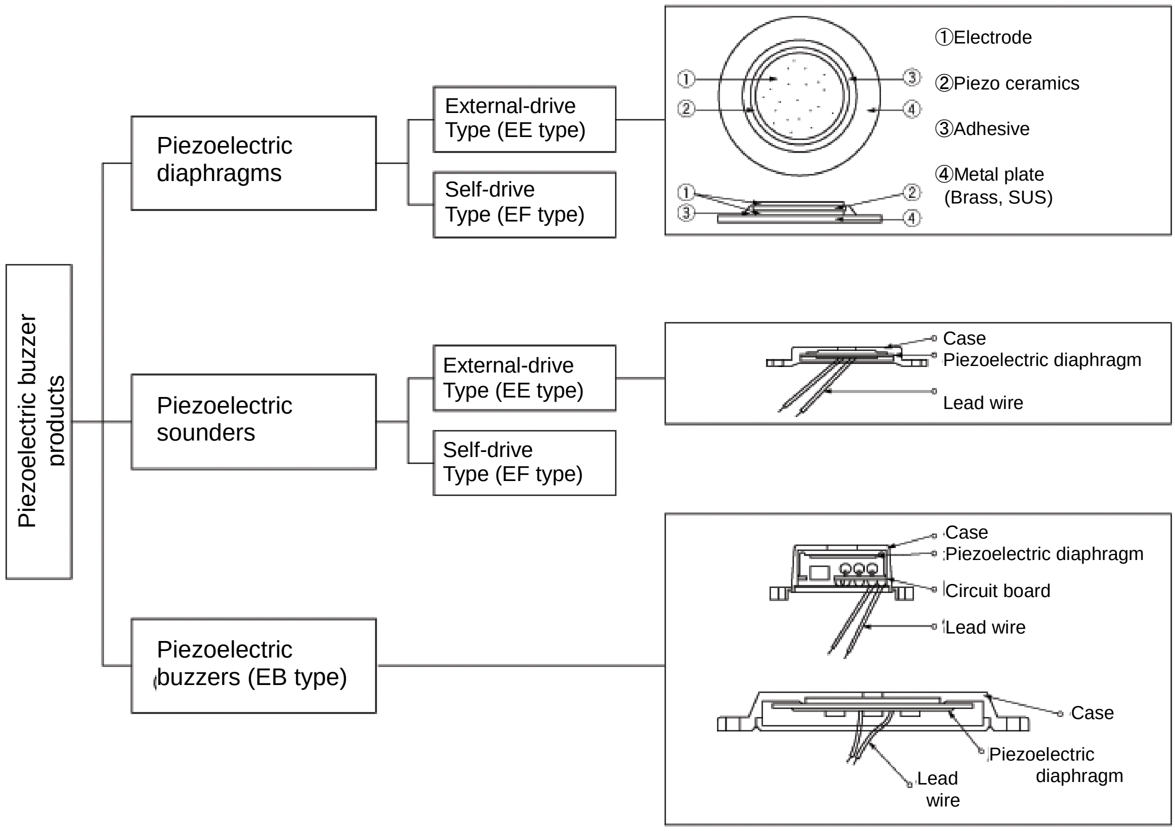
Our piezoelectric diaphragm and piezoelectric buzzer / sounder use piezoelectric elements using process technology such as our original piezoelectric ceramic material development technology / thin film technology, enabling integrated production from materials to finished products.

Our piezoelectric diaphragms, piezoelectric buzzers, and sounders can meet various needs such as high sound pressure and wide sound range, suitable for household appliances, and office automation equipment, plus, wide range of fields such as disaster prevention equipment, that require small size and light weight, high sound pressure and high reliability.

■Use cases

- Household appliances
  Refrigerator/ Microwave oven/ Washing machine/ Electric fan/ Air conditioner, etc.
- Clocks and toys
  Alarm clock/ Calculator/ Game console/ Greeting card, etc.
- Office automation equipment
  Copy machines/ Personal computers/ Facsimiles, etc.
- Automotive equipment
  Back buzzer, Light, il, battery, seat belt alarm/ Keyless entry, etc.
- Disaster prevention equipment
  Fire alarm/ Burglar alarm/ Gas leak alarm, etc.
- Other electronics equipment
  Vending machines/ Automatic control devices/ Measuring instrument/ Telephones Cameras, etc.

■ Types and structures of piezoelectric buzzer products



■ How to use a piezoelectric buzzer

A piezoelectric diaphragm has a simple structure of a piezoelectric ceramic thin plate (piezoelectric element) polarized in the direction to the thin metal plate and a thin metal (or resin) plate bonded together. Piezoelectric elements have the property of contracting when a voltage in the same direction as the polarization direction is applied, and expanding when a reverse voltage is applied (see Fig. 1). When the expansion / contraction change of the piezoelectric element is transmitted to the metal plate, the fixed metal plate causes a bending phenomenon and generates sound waves.

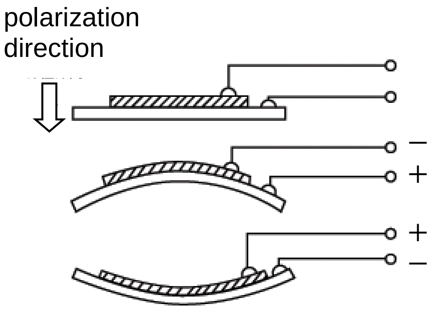


Fig.1 Bending phenomenon

● Driving method of piezoelectric diaphragm

There are the following two methods for driving the piezoelectric diaphragm.

Method	Oscillation frequency	Features
External-drive Fig.2 (a)	Arbitrary frequency can be selected	・Driving with a non-stable multi-vibrator circuit. ・Simple configuration and adjustable frequency.
Self-drive Fig.2 (b)	Sounds at the lowest impedance frequency	・A method of driving with a positive feedback circuit using feedback electrodes provided on the element. ・Although the frequency is fixed, a large volume can be obtained.

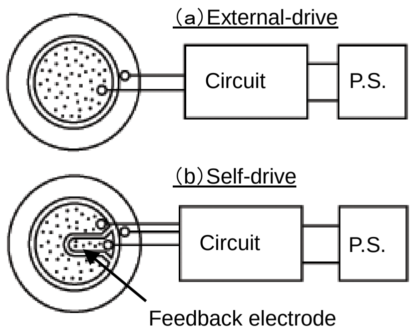


Fig.2 Driving method

●Method for supporting piezoelectric diaphragm

Since sufficient sound pressure cannot be obtained with the piezoelectric diaphragm alone, the piezoelectric diaphragm is supported and fixed in a case with a resonator.

There are two types of support methods: node support and peripheral support. A flexible material such as silicon is suitable for fixing the support.

Method	Features
Node support Fig.3 (a)	● Since it is in a state close to free vibration without controlling vibration, the impedance characteristics of the piezoelectric diaphragm can be faithfully reproduced. ● Strong and stable characteristics against mechanical stress. ● High efficiency and high sound pressure can be obtained.
Peripheral support FIg3 (b)	● Used to lower the resonance frequency of the piezoelectric diaphragm by controlling the vibration around the piezoelectric diaphragm. ● May become weak against mechanical stress on the support.

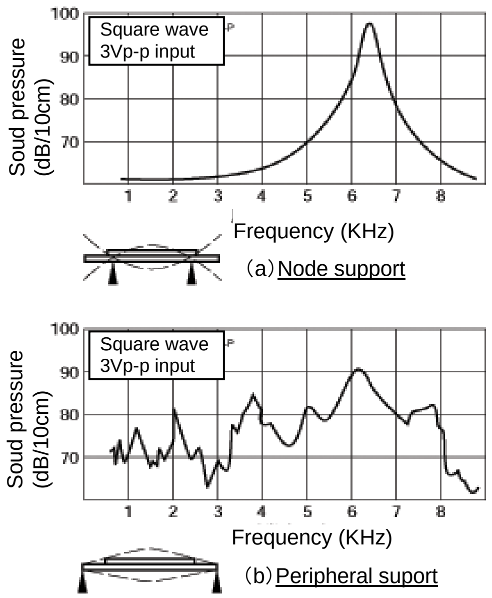


Fig.3 Support method

● Resonator design

In order to make the sound loud enough for practical use, it is necessary to match the impedance in the air with the piezoelectric diaphragm in addition to supporting the piezoelectric diaphragm with a node support (or peripheral support).

A resonator (cavity) plays the role of this matching, and is designed based on the following formula (see Fig. 4).

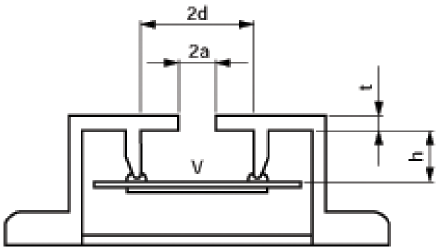


Fig.4 Cavity

$$f_{cav} = \frac{c}{2\pi}\sqrt{\frac{\pi a^2}{(16a/3\pi + t)d^2 \pi h}} \quad (\mathrm{Hz})$$

f cav : Cavity resonance frequency (Hz)
c : Speed of sound (331＋0.6T) × 10^3 (mm/sec)
T : Temperature
a : Radius of sound emission hole (mm)
d : Radius of supporting circuit (mm)
h : Cavity height (mm)
t : Thickness of sound emission hole (mm)

■Piezoelectric buzzer sounder measurement method

●Standard conditions　Temperature 25℃±2℃、Humidity 15～85%

●Characteristics

Electrical Characteristics	Resonant frequency Resonant resistance	Measured with impedance analyzer
	Capacitance	Measure between electrodes with LCR meter. Measurement frequency 1kHz.
Acoustic characteristics	Oscillation frequency	Measured with frequency counter.
	Current consumption	Measured with an ammeter.
	Sound pressure	Measured with a sound level meter equipped with a microphone.

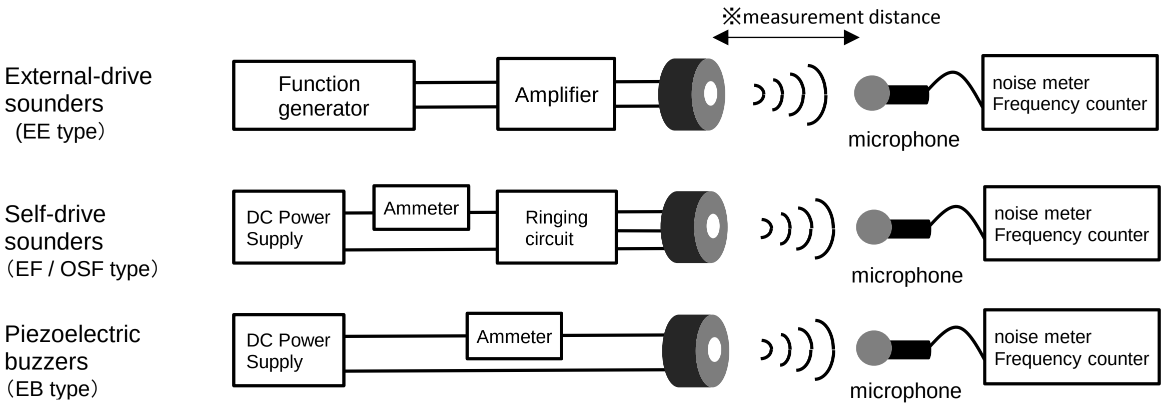
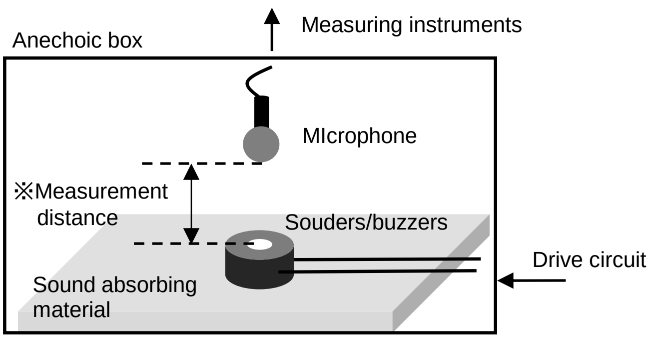


Fig.1 : Evaluation system for acoustic characteristics

Fig.2 : Sounders, buzzers, and Microphone setting



※Measurement distance Piezoelectric sounder 10cm, Piezoelectric buzzer 5cm, or 10cm

●Conversion method of sound pressure by distance

For a piezoelectric sounder, the measurement distance is 10 cm. For a piezoelectric buzzer, the measurement distance is 5 cm or 10 cm. After that, the sound pressure is converted according to the rated distance of each model according to the following relational expression.

In addition, when comparing the sound pressure of models with different measurement distances, conversion can be performed using the following relational expression.

$$B = A + 20 \log (La / Lb)$$

A : Sound pressure value at measurement distance La

B : Sound pressure value at measurement distance Lb