Caution

1. When mounting and handling
(1) To prevent malfunctions, install the piezoelectric buzzer or sounder so that it does not come into contact with other components on its side or top surface.
(2) Do not block the sound release hole of the piezoelectric buzzer or sounder. Maintain a distance of at least 10mm between the sound release hole and any surrounding object. Also, do not cover the sound release hole with an adhesive tape or the like. If the sound hole is blocked or covered, the piezoelectric buzzer or sounder may exhibit abnormal oscillation or stop functioning.
(3) The sound pressure of the piezoelectric buzzer or sounder may be measured after, but not before, it is installed in the host equipment. When determining the installation position, make sure that adverse acoustic impedance does not exist in the installation area. If acoustic impedance exists, the piezoelectric buzzer or sounder may exhibit abnormal oscillation or stop functioning.
(4) When screw down the piezoelectric buzzer or sounder, tighten the screws within the specified torque range. Use pan-headed screws and washers not to deform the casing. A deformed casing may cause the piezoelectric buzzer or sounder to exhibit abnormal oscillation or stop functioning.
(5) When stripping a lead wire, do not cut the conductive line inside the coating, thereby ensuring the sound will be properly generated. Use a stripper suitable for the diameter of the lead wire.
(6) Do not apply strong force to the pins before they are soldered. If the pins are bent or cut due to excessive force, the piezoelectric buzzer or sounder may not generate sound.
(7) Do not connect the piezoelectric buzzer or sounder improperly, otherwise the internal circuit may break down when electricity is applied.
(8) The piezoelectric buzzer or sounder is recommended to be used at rated power supply voltage. Operating voltage range that can be used will vary depending on the use conditions (temperature, humidity, mounting method, ringing pattern, etc.). Please verify the actual operating voltage under your specific conditions.
(9) Do not apply DC voltage to the piezoelectric sounder. Otherwise, silver migration may occur, which will lower the insulation resistance and cause the sounder to stop functioning.
(10) Use a low-impedance (not more than 100Ω) power supply for the piezoelectric buzzer; otherwise, the piezoelectric buzzer may exhibit abnormal oscillation or stop functioning.
(11) Do not interpose a resistance in series between the piezoelectric buzzer and the power supply, otherwise the piezoelectric buzzer may exhibit abnormal oscillation or stop functioning. If the interposition of a resistance (3kΩ Max.) is necessary to adjust the sound volume, insert a capacitor of approximately 1 μF in parallel, not in series. (Fig.1)
(12) Do not use the piezoelectric buzzer or sounder where any corrosive gas, such as H2S, etc. Otherwise, a normal sound may not be generated due to corrosion of the components and diaphragm.
(13) Do not wash the piezoelectric buzzer or sounder with solvent or allow solvent vapor to enter them while washing. Any solvent trapped inside the casing may damage the piezoelectric buzzer or sounder.
(14) Do not drop the piezoelectric buzzer or sounder. With a mechanical shock, the piezoelectric sounder may accumulate a high voltage inside its piezoelectric elements, resulting in an electric shock to anyone who touches it. Also if such sounder is connected to a circuit, it may damage transistors and/or other electronic components. Sounders which have accidentally gotten a mechanical shock can be made safe by shorting them between the poles. Then check the sound pressure, tone and appearance before use.
15) Take special protective measures is required to prevent deterioration and malfunction, whenever the piezoelectric buzzers or sounders are stored in the following unfriendly areas.

① Dusty places
② Hot or frosty places
③ Areas exposed to sunlight
④ Places with leaking or infiltrating water
⑤ Humid places
⑥ Areas exposed to solvents or their vapor

(16) When operating the piezoelectric buzzer or sounder outdoors, protect it from moisture to ensure normal operation.

(17) Do not apply flow soldering and reflow soldering to piezoelectric diaphragms, buzzers and sounders. The piezoelectric diaphragms, buzzers and sounders have to be soldered manually after finishing flow soldering and reflow soldering process. When soldering (lead free) on piezoelectric diaphragms, use a solder containing 4% silver and complete each soldering job within a total of 3 seconds at a soldering temperature of 320±10°C. If the solder does not contain silver, diaphragm performance may be adversely affected. When soldering (lead free) on piezoelectric buzzers and sounders manually, complete each soldering job within a total of 3 seconds at a soldering temperature of 350±10°C for lead pins or within a total of 5 seconds at a soldering temperature of 350±10°C for lead wires.

(18) To protect an LSI from a counter voltage of the piezoelectric sounder, which may be caused by an external mechanical shock, connect a Zener diode or varister in parallel to the LSI. (Fig.2)

2. When storing
To prevent deterioration and/or malfunction, do not store piezoelectric buzzers and sounders in the following places.

① Dusty places
② Hot or frosty places
③ Areas exposed to sunlight
④ Places with leaking or infiltrating water
⑤ Humid places
⑥ Areas exposed to solvents or their vapor
⑦ Areas exposed to corrosive gases, such as H₂S, etc

3. Others
① To maintain the normal performance and safety do not disassemble, repair or modify the piezoelectric buzzer or sounder.
② Since these products contain the lead (lead is contained in "the main ingredients of piezoelectric ceramics", "the impurities in brass" and "the glass in a silver electrode"), which is excluded from the RoHS regulation. Please treat them as industrial waste in the case of disposal.
③ Please obtain a catalog and technological material for the details about the product, and check them carefully.

Because the electrical specification described in the catalog is subject to standard measurement conditions, it is not guaranteed under the operation voltage and temperature.

④ Treat piezoelectric diaphragms carefully as it is thin and damaged easily.

Please read carefully this document before using our piezoelectric buzzers.
Note that, in case any malfunction occurs due to incompliance with precautions described below, the product warranty will be void.
**Introduction**

FDK piezoelectric buzzers generate sound through the bending vibrations of a thin metalplate adhered to a piezoelectric element. These buzzers feature a low power consumption, a safe, spark-free and non-contact structure, and a small size and light weight for an easy mounting to printed circuit boards. As a result, an increasing number of piezoelectric buzzers are now used to generate an artificial voice in combination with voice synthesizing ICs. To produce high-quality piezoelectric buzzers, FDK has capitalized on many years of piezoelectric production and outstanding ceramic processing technologies and thin film forming techniques. By adding a sophisticated audio know-how to this manufacturing expertise, FDK offers a large array of electronic tone generating products, such as piezoelectric diaphragms, sounders and buzzers, to meet loud sound outputs, wide frequency ranges, and many other requirements.

**Features**

- Use of high-performance piezoelectric elements to meet loud sound volume and wide frequency range needs.
- High quality achieved by integrated in-house production, from piezoceramic materials to buzzers.
- Clear, pleasant electronic tone.
- Reliable, effective operation in a wide variety of equipment and ambient conditions.
- A wide, convenient selection from elements to complete buzzer products.

**Applications**

- **Consumer electronic appliances**: Refrigerators, microwave ovens, washing machines, electric fans, VCRs, air conditioners, bath heaters, sewing machines
- **Clocks and toys**: Digital clocks and watches, alarm clocks, calculators, game machines, greeting cards
- **Office equipment**: Photocopiers, typewriters, cash registers, personal computers, facsimiles
- **Automotive instruments**: Speed alarms; reverse drive buzzers; light, oil, battery, seatbelt check sounders, keyless entry
- **Safety and security equipment**: Fire alarms, burglar alarms, gas leakage alarms
- **Other electronic equipment**: Vending machines, automatic controllers, bicycle horns, telephones, cameras

**Makeup of piezoelectric buzzer products**
How to use piezoelectric buzzers

Piezoelectric diaphragms have a simple structure consisting of a piezoceramic disc (piezoelectric element) adhered to a thin metal (or plastic) plate. When a voltage is charged in the polarization direction, the piezoelectric element contracts, and expands when voltage is charged in the reverse direction. The quick contraction-expansion motions of the piezoelectric element cause the elastic disk underneath to vibrate and generate sound waves. (See Fig 1)

How the piezoelectric diaphragm generates sound

The piezoelectric diaphragm generates sound by either the external-drive or the self-drive oscillation technique.

<table>
<thead>
<tr>
<th>Oscillating mode</th>
<th>Oscillating frequency</th>
<th>Features</th>
</tr>
</thead>
<tbody>
<tr>
<td>External-drive Fig. 2 (a)</td>
<td>Operation at any frequency</td>
<td>Easy generation of sound by nonstable multivibrator circuit (see recommended circuit example on page 4).</td>
</tr>
<tr>
<td>Self-drive Fig. 2 (b)</td>
<td>Resonance at frequency corresponding to minimum acoustic impedance of diaphragm</td>
<td>Derives loud sound output through positive feedback oscillation circuit (see recommended circuit example on page 6).</td>
</tr>
</tbody>
</table>

How piezoelectric diaphragms are supported

Piezoelectric diaphragms are placed in casings equipped with a resonator, to obtain a required sound output. These diaphragms are supported inside the casings by either the nodal-circular support or peripheral support technique, and should be attached to the support by an elastic adhesive such as a silicone agent.

Design of the resonator

The piezoelectric diaphragm cannot produce a loud sound volume only by a nodal-circular or peripheral support, and it is necessary to tune the diaphragm to the air acoustic impedance, a job done by the resonator (see Figure 4, cavity v). The resonator is designed according to the equation below.

\[
 f_{cav} = \frac{c}{2\pi} \sqrt{\frac{\pi a^2}{(16a/3\pi+t)d^2 \pi h}} (\text{Hz})
\]

- \( c \): Speed of sound \((331+0.6T) \times 10^3 \text{ mm/sec}\)
- \( T \): Temperature
- \( a \): Radius of sound hole (mm)
- \( d \): Radius of supporting ring (mm)
- \( h \): Height of cavity (mm)
- \( t \): Thickness of sound hole (mm)
● Booster coil

When the generated sound is less audible due to muffling by the casing, a booster coil is used to amplify the sound (see the right hand figure for an example of a circuit with a booster coil). Given the rise time and breaking time, $t$ sec., of the switching of the transistor by a voltage output from an LSI or other components, a counter voltage is generated in proportion to the coil inductance $L$ and $1/t$. Since this counter voltage has a $V_{p-p}$ several times greater than the power supply voltage, a proportionally greater sound pressure is obtained. In some cases, a capacitor and a diode are included in the circuit to absorb surge current and thus protect the transistor.

![Circuit diagram of a booster coil](image)

- **Piezoelectric buzzer measurement method**

- **Standard measurement conditions**
  - Temperature: $25 \pm 2^\circ C$
  - Humidity: 45—60% RH

- **Electrical characteristics**
  1. Resonant frequency and resonant resistance
    - Measured by an impedance analyzer
  2. Capacitance
    - Measured by a universal bridge or LCR meter (measured between poles at 1 kHz)

- **Acoustic characteristics of piezoelectric sounders and buzzers**

  The oscillating frequency, current consumption and sound pressure are measured by the measuring instruments shown below.

![Diagram of measuring methods](image)

*Fig. 1: Measuring formats for acoustic characteristics*

In the measuring test, sounders and buzzers are placed as follows:

![Diagram of sounder and buzzer placement](image)

*Fig. 2: Sounder and buzzer placement for measurement*

- **Measuring distance**
  - **Piezoelectric sounder** (self-vibration and separate vibration types)
    - After measuring the sound pressure level from 10 cm away, the measured value is converted according to the rated distance of each sounder model.
  - **Piezoelectric buzzer**
    - After measuring the sound pressure level from 5 cm or 10 cm away, the measured value is converted according to the rated distance of each buzzer model.


**Conversion of sound pressure by distance**

The sound pressure values shown in this catalog are not directly comparable because of different measuring distances. Therefore, the following conversion equation should be used for any comparison.

\[ B = A + 20 \log \left( \frac{L_a}{L_b} \right) \]

- **A**: Sound pressure value at measuring distance of \( L_a \)
- **B**: Sound pressure value at measuring distance of \( L_b \)

The relationship between an increase in measuring distance and a lowering of sound pressure can be estimated by consulting the table below.

<table>
<thead>
<tr>
<th>Distance increase</th>
<th>2 times</th>
<th>3 times</th>
<th>4 times</th>
<th>5 times</th>
<th>6 times</th>
<th>7 times</th>
<th>8 times</th>
<th>9 times</th>
<th>10 times</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sound pressure drop (dB)</td>
<td>-6.02</td>
<td>-9.54</td>
<td>-12.04</td>
<td>-13.98</td>
<td>-15.56</td>
<td>-16.90</td>
<td>-18.06</td>
<td>-19.08</td>
<td>-20.00</td>
</tr>
</tbody>
</table>

**Standard conditions for reliability tests**

- **High-temperature placement**
  The product is subjected to its upper limit operation temperature \( t_2 \) for 240 hours.

- **Low-temperature placement**
  The product is subjected to its lower limit operation temperature \( t_1 \) for 240 hours.

- **High-temperature and high-humidity placement**
  The product is placed in a 60°C, 90—95% RH condition for 240 hours, during which the ON-OFF operation is checked every 30 minutes.

- **Temperature cycle**
  One cycle consists of one hour of the \( t_1 \) routine and one hour of the \( t_2 \) routine, and a total of 24 cycles are imposed.

- **Vibration**
  The product is shaken for two hours in the same direction for a total of six hours in three directions, at a frequency of 10-55-10 Hz, an amplitude of 1.5 mm, and a sweep time of one minute.

- **Shock**
  The product is dropped three times continuously in the same direction under a gravitational force of 100G, for a total of nine drops in three directions.

After the completion of each test, the product is left under room temperature for 2 hours or more, and then undergoes standard tests; the measured values, i.e., the value of oscillating frequency, current consumption, or sound pressure, should not deviate by more than ±10% from the initial measurement values.