USING A PIEZO BENDER AS A SWITCH

In 1883 when Pierre Curie discovered the piezoelectric effect, he noted that certain materials, such as quartz crystals, produce a voltage when they are mechanically stressed. As a result, they can be used as switches, converting mechanical vibration into an electrical signal.

Since that time, audio piezo benders and piezo actuators have been used for switching or monitoring devices in various applications.

Piezo devices have proven to be long lasting, weather resistant, high quality, with excellent repeatability of the output signal. Some switching applications of piezo benders in use today consist of, cross walk switches, hot tub switches, vibration monitors, earthquake and underground detonation monitors, garage door closing switches, RC cars, and vehicle axle counting used on highways.

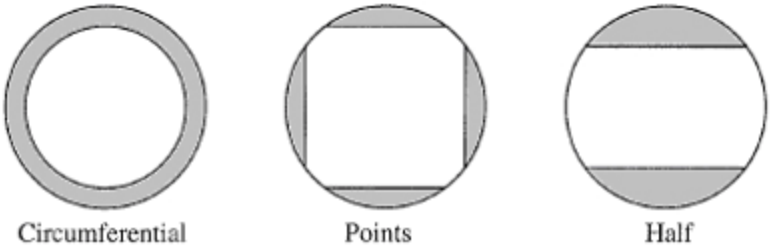
Mounting

There are no clear instructions for mounting a piezo bender in a switch application. The mounting of the bender may have to be tailored to meet the desired signal and use. Some different types of mounting are, circumferential, point, and half.

Circumferential mounting is providing a solid mounting surface around the full circumference of the piezo device, allowing a clean and uniform bend when activated.

Point mounting is providing mounting surfaces along various points around the circumference. These points should be equidistant from each other and of consistent size and shape. This allows a slight amount of distortion into the bend without causing physical damage to the bender. This slight distortion can give a slightly higher output from the bender when activated.

Half mounting is providing two mounting surfaces, one on each side of the bender that is wide enough to support the bender when activated. This type of mounting is primarily used when excessive force is to be used on the bender, requiring a deeper flex to the bend. This deeper flexion can give a slightly higher output from the bender when activated, but care must be taken not to cause damage to the ceramic substrate during heavy bending.



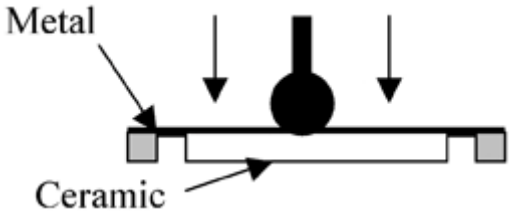
Electrical Connection

Making the electrical connection to the piezo device should be done through connected wires, either soldered or conductive epoxy. Connected wires add a small amount of mass to the piezo ceramic, and minimally affect the output signal.

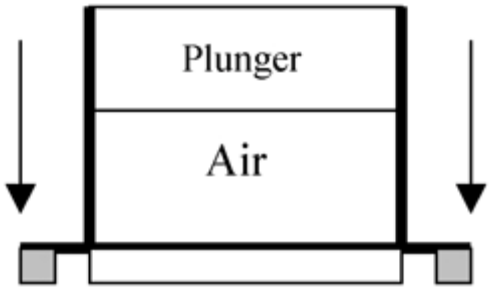
Spring contacts should be avoided when using a piezo as a switching device. The springs can work against the flexion of the ceramic. While this is a minor issue, the friction of the springs moving against the ceramic can wear down the conductive silver layer and cause intermittent or loss of output.

Activation

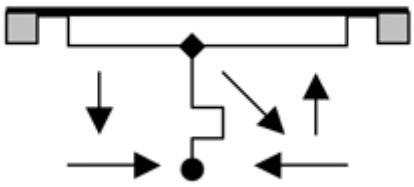
There are many different ways to activate the piezo bender either directly or indirectly. Application of physical force directly to the bender, is the least difficult type of activation, but care should be taken to not flex the piezo excessively and cause damage to the ceramic. The direct pressure should also be directed to the metal substrate and not the ceramic.



The most common type of indirect force is using a sealed volume of air and a moveable plunger to activate the piezo. Applying pressure to the plunger increases the air pressure inside the sealed chamber, which then flexes the piezo.



A third type of activation consists of applying an off center weight directly to the ceramic. This is used when picking up small motions in all three axes, especially useful in vibration and ground wave sensing applications. The figure below is one configuration style.



This type of activation is for picking up very small motions, and as a result, will generate very small outputs from the piezo bender, that must be greatly amplified.

Regardless of how you activate the device, care must always be taken to not over flex the ceramic or damage the silver layer on the ceramic.

Choosing The Correct Device

The size of the piezo bender used in the switching application is defined by the size constraints of the application. If you have plenty of room, in general the larger the bender diameter used, the higher the output, given the same activation pressure and duration. This is of course dependant upon the thickness of the base metal and base metal type.

A brass base metal with a thickness of 0.1mm is going to flex easier and have a higher output than a brass

base metal with a thickness of 0.2mm. A brass base plate is going to flex easier and have a higher output than a similarly sized stainless steel base plate.

The different metal bases that are generally available for piezo benders are brass, nickel alloy (alloy 42), and stainless steel (301, 304, 316).

The brass plate is a low cost, general-purpose base for commercial and industrial use, where the piezo bender will not be subjected to extreme environments.

The nickel alloy base is used where the piezo bender will be subjected to extreme environments. The nickel alloy will resist the corrosive effects of humidity and temperature changes better than brass.

The stainless steel base is used where the piezo bender will be subjected to solvents, corrosive chemicals, underwater and salt-water applications, or in the medical field where chemical interaction cannot be tolerated.

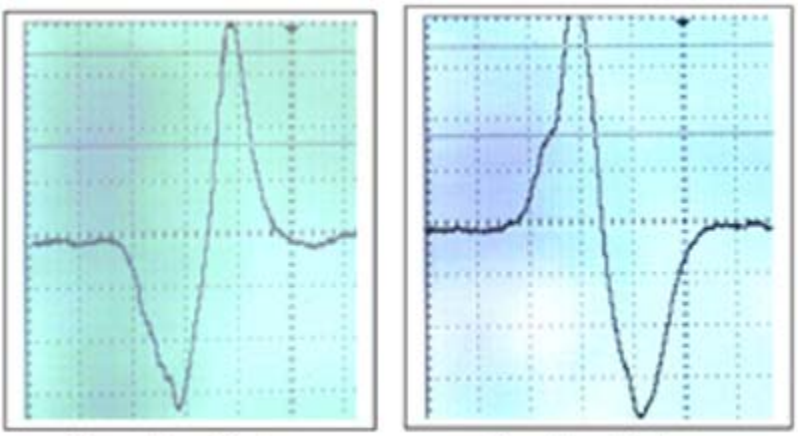
There is no clear indication that the resonant frequency or capacitance of a piezo bender has any effect, either positive or negative on the output signal.

Choosing The Required Output

One of the more important items to understand in choosing your piezo bender is the required operating polarity of the device.

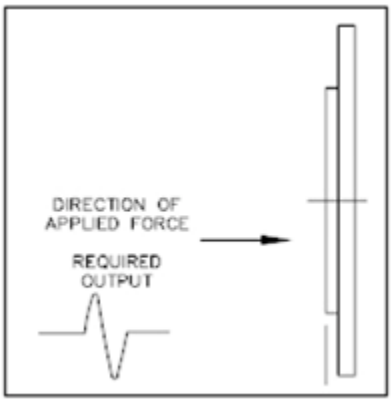
A piezo bender is primarily an audio device. In the manufacturing of audio devices, the polarity of the ceramic is not an issue, as there is no difference in the output regardless of the polarity.

When using the piezo bender as a switch, if the applied circuitry is designed to support a positive pulse, a bender with a negative pulse as the initial output, may not register and be seen as a defect.



These signals were acquired using circumferential mounting and indirect pressures.

If the acquisition circuitry is designed to capture a specific polarity of pulse, it will be necessary to define the direction of the force and the desired polarity of the output signal in order to guarantee the device will consistently work in the desired application.



In general, piezo devices work great when used as a switch, with benefits of high reliability, high repeatability, and good longevity.