Acoustics - Sound generators in electronic devices

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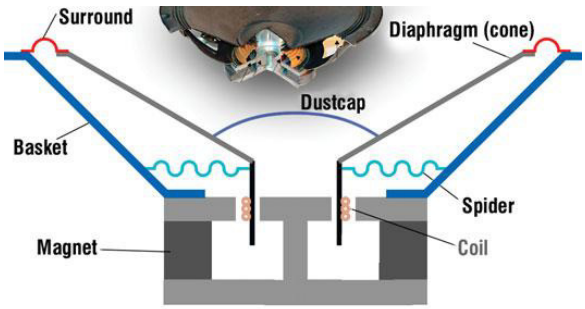
Generate a kind of sound is a common requirement in a lot of electronics circuits. All devices, what we call sounders convert electrical energy into mechanical energy that is called acoustic sound energy. This article is made to give an overview of the different sound sources. By clarifying some definitions, working principles, and application areas engineers have easier way to understand the product portfolio of the acoustics manufacturers.

1. Signaling devices - Sound generators

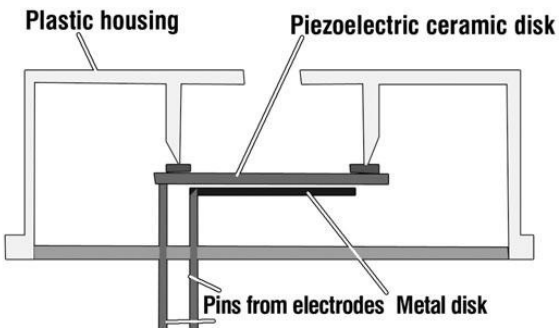
When the main purpose of using sound generators is to signal or alert rather than reproduce quality sound or human speech, piezo or electromagnetic transducers or buzzers are used. Transducers' disks are driven from external oscillators (AC signal) while buzzers have built in oscillating electric circuit, only DC voltage needs to be applied to generate sound. The advantage of these simple structured acoustic components is their low current driving, robustness and cost-efficient sound solution.

1.1 Piezo sound generators

The core element in all of the piezo sound generators is a piezoelectric ceramic plate mounted on a metal diaphragm (brass, stainless steel or nickel alloy of a thickness less than 0.5mm). The working principle is the physical concept known as the piezoelectric effect. According to the frequency of the applied AC voltage the thin piece of piezoelectric ceramic bonded to the metal disk expands and contracts, this vibration produces air pressure waves that human ear considers as sound. The best sound pressure level is achieved when the mechanical resonant frequency matches the frequency of the driving signal. By increasing the voltage up to the maximum allowed on the buzzer both SPL and frequency can be increased, which allows for high sound output. Piezo buzzers use less power, than other sounders. Since they do not need magnetic field for operation, they pose no problems with electromagnetic interference (EMI) or electromagnetic compatibility (EMC). Piezo sounders need low current to drive (few mA). They're very high impedance and can be driven directly by a TTL output of the MCU, by using square waves at different rates to make different pitches of beep. A piezo sounder can be also driven by a transistor or any simple oscillator circuit. Piezo sound generators are the ideal choice for applications which need a simple sound signal within a small frequency range, e. g. warning and control sound signals of household appliances, medical and health care products.



Structure of dynamic loudspeaker



1.2 Piezo speakers

When there is no need to have an excellent sound quality, just understandable speech or enjoyable sound a smart combination of piezzo sounder and loudspeaker can be used. The piezoelectric speaker consists of a flexible sound supporting plastic diaphragm and a piezoelectric ceramic disc. This simple structure is capable to provide a wider frequency range than standard piezo sound generators and achieves loud Sound Pressure Levels (SPL). Combined with a well designed housing, SPL over 110 dB at 2 m are possible. This performance makes the piezoelectric speaker the perfect choice for alarm and siren devices.

Piezoelectric speakers have several advantages over conventional loudspeakers being resistant to overloads, simple and solid state construction that resists environment (especially water) better than a ribbon or cone based devices.

Disadvantage is the frequency response, in most cases, is inferior to that of other technologies, mainly regarding to bass and midrange. This is why they are generally used in applications where volume and high pitch are more important than sound quality.

1.3 Electromagnetic sound generators

Electromagnetic sound generators consist of a swinging metal diaphragm driven by an electromagnetic circuit. When voltage is applied to the pins, a magnetic field is created, which causes the magnet to move and the diaphragm to vibrate. When the diaphragm moves, the resulting airwaves produce what the human ear recognizes as sound. These transducers are small and provide a wider frequency range compared with piezoelectric sound generators. They are the right choice for applications, where different frequencies are used to create different sounds. Typical applications are kitchen devices, medical and health care accessories, cellular phones, PDS, etc. In general, electromagnetic sound generators have a higher current consumption than piezo sound generators (100mA range vs. piezo's 10 mA) , due to the generation of electromagnetic energy, but they need lower voltage to achieve their maximum sound pressure level output (2-4V).

2. Dynamic loudspeakers

The universal solution for wide frequency acoustic sound reproduction is dynamic loudspeaker. It uses a rigid, light, thin paper, plastic or even metal diaphragm, held by a basket via a flexible suspension, which is called a spider.The voice coil is fixed to this cone, and moves axially through a cylindrical magnetic air gap. When the AC electrical signal is applied to the voice coil, the magnetic field generated by the alternating current turns this construction to an electromagnet. The coil's magnetic field and the field of the loudspeaker's permanent magnet interact, generating a mechanical force that causes the coil and the connected diaphragm to move back and forth according to the change of the AC current flowing in the coil. This action moves the air in front of the cone, which generates waves that human ear recognizes as sound. Today's loudspeakers permanent magnets are made of ceramic, ferrite, Alnico (an alloy of Aluminium), or rare earth. The design trend requires lighter devices, therefore using rear earth magnets instead of heavier ferrite types is popular.

The Endrich product range comprehends several round (∅ 15 mm to 57 mm) and rectangular shapes (25 mm x 10 mm to 50 mm x 50 mm), which are assembled according to custom design. These loudspeakers are available with impedances from 4 Ω to 150 Ω, rated input power from 0.1 W to 5 W with frequency ranges from 200 Hz to 20 kHz for an operation temperature range of - 40 °C up to + 85 °C (special designs up to + 120 °C).

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