sonitron Piezo Audio Speakers & Amplifiers are the perfect answer for audio sound, voice messages and complex audio information into portable devices. When there is no place .... “a piezo speaker feels comfortable”. “Perfect fit” and “slim line” are the words you can add to your design.

No more worries anymore about water drops that can damage the front of your speaker. The piezoelectric speakers of Sonitron embrace these problems and nevertheless EMC/EMI is history.

The Basic Four of Piezoelectric Audio Speakers

Piezoelectric speakers have a total different working principle than an electro dynamic speaker. There is no coil, no magnetic field and no large current consumption.

“No electro-magnetic field (EMC/EMI)”

The heart of each piezoelectric speaker is a ceramic disc that interacts when it feels a certain voltage difference. An increase of the signal amplitude Vpp (Voltage peak to peak), will result in a larger piezo deformation and result in a larger sound output.

“Interacting with voltage variations”
“More Vpp creates more sound output”

Patented multilayer Technology

A few years ago piezoelectric speakers were only known as piezo tweeters. Loudspeakers that are able to produce only high audio frequencies, typically from around 2 kHz to 20 kHz.

Sonitron, established in 1977 and European leader in piezoelectric audio components, started with intensive research to develop broadband audio speakers who have a frequency response graph beneath 1kHz.

Sonitron developed and patented a completely new principle of piezoceramics and a composite polymer/metal membrane. The composite polymer/metal membrane reduces unwanted resonance peaks to provide a more even frequency response than can be achieved with conventional designs. High sound quality and low distortion guarantee perfect reproduction of music and speech.

“Polymer/ metal membrane”
Piezo Speaker Technology, an answer to your request...

**Capacitive load**

Because piezoelectric speakers mainly act as a capacitive load, the complex impedance will decrease with an increase of the frequency. The capacitive reactance is an asymptotic function.

\[ Z_c = -jX_c \]
\[ X_c = \frac{1}{\omega C} \]

**Amplifier configurations**

The construction of a Piezo Audio Amplifier (PAA) consists of two basic electronic concepts.

- **DC-DC converter**
- **Amplifier topology**
- **Speaker**

A DC-DC converter brings a lower voltage to a higher level and creates the maximum voltage level for the end amplifier.

**Fundamental acoustic mountings**

Piezoceramic speakers produce sound by the forward and backward movement of a flat membrane.

During this movement the membrane creates an air pressure wave in front and at the backside of the membrane.

A forward movement will create a slight overpressure at the frontside and a slight underpressure at the backside and vice versa. It is therefore important that the front and backside are acoustically isolated from each other to avoid air pressure cancellation and consequently a serious reduction of the sound output.

When a speaker is mounted in a panel or in the wall of a housing, the front side is acoustically isolated from the backside.
Piezoelectric Speaker Terminology

**Piezo**, derived from the Greek piezein, which means to squeeze or press

**Piezoelectricity**, is the charge which accumulates in certain solid materials (notably crystals, certain ceramics) in response to applied mechanical stress. The word piezoelectricity means electricity resulting from pressure.

**Piezoceramic**, is a ceramic disc with piezo characteristics. The disc will expand when a certain voltage level is applied.

**Piezoelectric audio speaker**, is a broadband loudspeaker made out of piezo material. Start frequency from 200Hz up to 20kHz.

**SPL**, Sound Pressure Level refers to a certain dB level at a certain distance.

**dB**, Decibel is a logarithmic unit that indicates the ratio of a physical quantity (usually power or intensity) relative to a specified or implied reference level.

A change in power ratio by a factor of 10 is a 10 dB change. A change in power ratio by a factor two is approximately a 3dB change.

**Vpp**, Voltage peak to peak is the voltage difference between the maximum and minimum voltage level of a signal.

**PAA**: Piezo Audio Amplifier is a single integrated circuit, or a PCB developed to amplify small audio signals, that drives piezoelectric audio loudspeaker elements.

**Pink Noise**: 1/f noise is a signal with a frequency spectrum such that the power spectral density is inversely proportional to the frequency. In pink noise, each octave carries an equal amount of noise power. There is equal energy in all octaves (or similar log bundles)

Power consumption

The average power consumption of piezoelectric speakers can be calculated by multiplying the RMS-voltage and RMS-current.

The RMS-voltage (V\text{rms}) is defined by the input signal. The used signal is a standard pink noise signal with a value of 10,6 / 21,21 V\text{rms}. The signal has the same energy as a sine wave of 30 / 60Vpp

The RMS-current (I\text{rms}) is measured with a true rms multimeter (Fluke 87IV) in series with the speaker. A piezoelectric speaker can mainly be seen as a capacitive load and therefore there will be no DC current consumption. The only current consumption will be of the AC-current component

\[ P_{\text{average}} = I_{\text{RMS}} \cdot V_{\text{RMS}} \]

**Values Blue Line SPS series speakers:**

<table>
<thead>
<tr>
<th>Model</th>
<th>10.6 V\text{RMS}(30 V\text{pp sine}) I\text{RMS}=m\text{A}</th>
<th>21.21 V\text{RMS}(60 V\text{pp sine}) I\text{RMS}=m\text{A}</th>
</tr>
</thead>
<tbody>
<tr>
<td>SPS-29-T00</td>
<td>0,25 Watt (= 24mA.10,6V)</td>
<td>1,00 Watt (= 47mA.21,21V)</td>
</tr>
<tr>
<td>SPS-41-T00</td>
<td>0,48 Watt (= 45mA.10,6V)</td>
<td>1,87 Watt (= 88mA.21,21V)</td>
</tr>
<tr>
<td>SPS-53-T00</td>
<td>0,78 Watt (= 74mA.10,6V)</td>
<td>3,05 Watt (= 144mA.21,21V)</td>
</tr>
<tr>
<td>SPS-68-T00</td>
<td>1,38Watt (= 130mA.10,6V)</td>
<td>5,51 Watt (= 260mA.21,21V)</td>
</tr>
</tbody>
</table>

**Values SPS series speakers:**

<table>
<thead>
<tr>
<th>Model</th>
<th>10.6 V\text{RMS}(30 V\text{pp sine}) I\text{RMS}=mA</th>
<th>21.21 V\text{RMS}(60 V\text{pp sine}) I\text{RMS}=mA</th>
</tr>
</thead>
<tbody>
<tr>
<td>SPS-3530-03</td>
<td>0,25 Watt (= 24mA.10,6V)</td>
<td>1,06 Watt (= 50mA.21,21V)</td>
</tr>
<tr>
<td>SPS-4640-03</td>
<td>0,27 Watt (= 25mA.10,6V)</td>
<td>1,06 Watt (= 50mA.21,21V)</td>
</tr>
<tr>
<td>SPS-6555-03</td>
<td>0,46 Watt (= 43mA.10,6V)</td>
<td>1,85 Watt (= 87mA.21,21V)</td>
</tr>
<tr>
<td>SPS-8770-03</td>
<td>0,76 Watt (= 72mA.10,6V)</td>
<td>2,86 Watt (= 135mA.21,21V)</td>
</tr>
</tbody>
</table>

Piezoelectric audio speakers will have more power consumption in the lower frequencies than electromagnetic speakers but have less power consumption in the higher frequencies.

The main power consumption will not come from the piezoelectric speaker but from the amplifier that is driving the speaker. The total concept has to be seen. How more efficient the Piezo audio amplifier is in combination with the piezoelectric speaker, how less the power consumption will be.
Piezo Audio Amplifier IC’s

With the benefits of piezoelectric speakers:

- very flat
- small dimensions
- low weight
- .....  

A lot of big electronic component companies have added specific amplifier IC’s for piezoceramic speakers to their product range.

- => MAX9788
- => MAX9738
- => TPA2100P1
- => LM4960
- => LM4961
- => LM4962
- => LT3469
- => SN4915
- => AK7846
- => AK7845

Waterproof Speaker

The piezoelectric speakers from Sonitron can be used in an application with an IP rating of 65 to 66.

To have the best sound output a grid pattern can be made in the house of your application. A fine grid pattern is recommended.

The piezoelectric speaker has to be fixed with silicone glue above the pattern holes.

In this way the sound can go into the air true the grid pattern. The acoustic waves created by the front and the back side of the speaker are separate from each other. Which is one of the basic rules.

Frequency Response graph

The amplification graph of a speaker is showed in a logarithmic scale.

A theoretical ideal response graph for a speaker would be a flat line that covers the complete human audio frequency range from 20Hz to 20kHz.

A pink noise, which has equal energy in all octave bands, results in such a flat line on a logarithmic scale. It reflects the working of our human ear.

When a pink noise with a certain Vrms is sent to a speaker and the produced sound of the speaker is recorded with a microphone, the amplification response of the speaker can be showed.

The frequency response graph gives you an idea about the quality of the speaker.

The total SPL gives you an idea about the complete loudness you can expect with a certain signal on a certain distance.

The piezoelectric audio speakers of Sonitron have a start frequency less than 1kHz even up to 200Hz, which gives an excellent result for multimedia applications.
From crystals to sound

“Advanced Technology with smart materials such as piezoceramic offer many new applications in audible components and devices. This new technology is a continuous development work that will bring you to the forefront in this world”

Hugo Michiels
President & CEO Sonitron nv

Blue Line SPS series

The Blue Line SPS piezoelectric audio speakers are designed for a broad range of applications. Equipped with a high power adhesive tape and soldering connection pads, the speaker is ready for easy mounting and fast production in every application.

These series are reproducing sound signals at very low distortion (below 1%) and broad frequency range. The casing is designed to avoid sound wave reflection in the air outlet. The power consumption and current drain are extremely low over the entire frequency response range.

Models:
- SPS-29 => 29 mm X 32mm
- SPS-41 => 41 mm X 43.5mm
- SPS-53 => 53 mm X 61.2mm
- SPS-68 => 68 mm X 83.5mm

Specifications:

<table>
<thead>
<tr>
<th>Model</th>
<th>SPS-29-T00</th>
<th>SPS-41-T00</th>
<th>SPS-53-T00</th>
<th>SPS-68-T00</th>
</tr>
</thead>
<tbody>
<tr>
<td>Distance 10cm</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pink noise signal 60Vpp (21,21Vrms)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Frequency response graph with total SPL
**SPS series**

Sonitron’s SPS speakers have a very flat design and are delivered with an open front. They can be used in difficult environmental conditions and applications since the front is resistant to water, humidity, vibrations and dust.

The described models are developed for applications such as mobile phone, PDA, flat LCD computer screens and computer monitors, consumer products, car audio, instrumentation, portable devices, public address systems, paging systems, etc.

**Models:**
- SPS-2220-03
- SPS-3530-03
- SPS-4640-03
- SPS-6555-03
- SPS-8770-03

**Specifications:**

<table>
<thead>
<tr>
<th>Model</th>
<th>Operating voltage (Vac pp)</th>
<th>Frequency range (Hz)</th>
<th>Max. SPL dB (1m, average 4 points)</th>
<th>Applications</th>
<th>Capacitive Load</th>
<th>Dimensions mm (LxWxH)</th>
</tr>
</thead>
<tbody>
<tr>
<td>SPS-2220-03</td>
<td>1-24</td>
<td>700-20000</td>
<td>85*</td>
<td>Earphones</td>
<td>70nF</td>
<td>22x20x2</td>
</tr>
<tr>
<td>SPS-3530-03</td>
<td>5-60</td>
<td>700-20000</td>
<td>81</td>
<td>PDA, GPS, notebook, etc.</td>
<td>220nF</td>
<td>43x39x2</td>
</tr>
<tr>
<td>SPS-4640-03</td>
<td>5-60</td>
<td>400-20000</td>
<td>83</td>
<td>PDA, GPS, notebook, etc.</td>
<td>225nF</td>
<td>50x43.6x2</td>
</tr>
<tr>
<td>SPS-6555-03</td>
<td>5-60</td>
<td>300-20000</td>
<td>83</td>
<td>Multimedia</td>
<td>480nF</td>
<td>65x55x2</td>
</tr>
<tr>
<td>SPS-8770-03</td>
<td>5-60</td>
<td>200-20000</td>
<td>84</td>
<td>Computers</td>
<td>380nF</td>
<td>87x70x2</td>
</tr>
</tbody>
</table>

**Best mounting method:**

Mounted with glue or silicone

*This model is only for earphone applications!*

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**Frequency response graph with total SPL**

- **Model SPS-2220-03**
  - Pink Noise, 60Vpp (21.21Vrms), 10cm
  - Total SPL
  - **Total SPL**

- **Model SPS-3530-03**
  - Pink Noise, 60Vpp (21.21Vrms), 10cm
  - Total SPL
  - **Total SPL**

- **Model SPS-4640-03**
  - Pink Noise, 60Vpp (21.21Vrms), 10cm
  - Total SPL
  - **Total SPL**

- **Model SPS-6555-03**
  - Pink Noise, 60Vpp (21.21Vrms), 10cm
  - Total SPL
  - **Total SPL**

- **Model SPS-8770-03**
  - Pink Noise, 60Vpp (21.21Vrms), 10cm
  - Total SPL
  - **Total SPL**

- **Distance 10cm**
- **Pink noise signal 60Vpp (21.21Vrms)**
Piezo Audio Amplifiers

The Piezo Audio Amplifier PCB's of Sonitron are a total solution to drive piezoelectric sound components. A range of different PCB sizes, amplifier topologies and maximum voltage peak to peak outputs, cover a wide solution to piezo audio amplification.

Piezo Audio Amplifiers are designed to handle capacitive loads and have the possibility to deliver large voltages peak to peak over the complete audio frequency range.

The PAA series gives a quality amplifier solution where a quality sound is needed.

- PAA-LT3469-01
- PAA-MAX9788-01
- PAA-LM4960SQ-02
- PAA-StepUpBTL-01

PAA-LT3469-01
A PCB of only 2.25cm². The LT3469 is a very small signal amplifier up to 30Vpp.

- Integrated charge pump power supply
- Class A Amplifier
- Single ended
- Capacitive load up to 250nF
- 10 components

PAA-MAX9788-01
Designed on a printed circuits board of only 2.31 cm², the “Max9788” piezo audio amplifier of Maxim fulfills the needs of very small designs in portable applications. A maximum output of 20Vpp and very low power consumption makes it even more attractive.

- Integrated charge pump power supply
- Class G Amplifier
- Fully differential inputs and outputs
- Capacitive load up to 1µF
- 15 components

PAA-LM4960SQ-02
A perfect balance of a bridge tied load and step up converter on a small PCB, the “LM4960”IC of National Semiconductor reaches 24 Vpp for a load of 600nF. Small design and great sound output makes it very understandable.

- Integrated Step Up Converter
- Bridge tied load
- Very small inductor
- Up to 24Vpp
- 22 components

PAA-StepUpBTL-01
To go loud is to amplify the input signal to a large Voltage peak to peak swing of maximum 60Vpp. Tuned on the SPS piezo speakers the “StepUpBTL” piezo audio amplifier is designed for a very loud audio sound in a room. The creation of a 60Vpp swing derives from a stable DC power source of 30 V DC.

The boost converter is designed to a minimum surface with a maximum variaty at the input source. A variation of the input voltage between 5V and 25V gives at the end a stable 30VDC to power the opamps with efficient power consumption. The amplifier circuit is a perfect balance between power consumption and space design. The Bridge Tied Load amplifier topology makes it possible to swing the signal to 60Vpp.

- Input voltage 5V-25V
- Max. output 60Vpp
- Two electronic circuits
- Ideal: +input: 9Vdc +output: 40Vpp

<table>
<thead>
<tr>
<th>Model</th>
<th>PAA-LT3469-01</th>
<th>PAA-MAX9788-01</th>
<th>PAA-LM4960SQ-02</th>
<th>PAA-StepUpBTL-01</th>
</tr>
</thead>
<tbody>
<tr>
<td>Measurements PCB</td>
<td>15x15mm</td>
<td>14x16.5mm</td>
<td>25x25mm</td>
<td>40x35mm</td>
</tr>
<tr>
<td>Voltage input (V)</td>
<td>5V</td>
<td>5V</td>
<td>5V</td>
<td>5V-25V</td>
</tr>
<tr>
<td>MAX Capacitance</td>
<td>200nF</td>
<td>1µF</td>
<td>600nF</td>
<td>1µF</td>
</tr>
<tr>
<td>Piezo Speaker</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Max Output Vpp</td>
<td>33Vpp</td>
<td>20Vpp</td>
<td>24Vpp</td>
<td>60Vpp</td>
</tr>
<tr>
<td>Voltage Topology</td>
<td>Integrated Step Up converter</td>
<td>Integrated Step up converter</td>
<td>Integrated Step up converter</td>
<td>Step up converter</td>
</tr>
<tr>
<td>Amplifier classification</td>
<td>Class A</td>
<td>Class G</td>
<td>Class AB</td>
<td>Class AB</td>
</tr>
<tr>
<td>Used amplifier configuration</td>
<td>Single ended</td>
<td>Fully Differential</td>
<td>Bridge Tied Load</td>
<td>Bridge Tied Load</td>
</tr>
<tr>
<td>Average current</td>
<td>45mA</td>
<td>15mA</td>
<td>85mA</td>
<td>40mA-400mA (2 Watt)</td>
</tr>
<tr>
<td>consumption of speaker and amplifier (mA)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Fixed amplification ratio: +/- 131
Voltage input: 5 V

Fixed amplification ratio: +/- 80
Voltage input: 5 V

Fixed amplification ratio: +/- 74
Voltage input: 5 V

Fixed amplification ratio: +/- 90
Voltage input: 5-25 V
Piezo Speaker Technology, an answer to your request...