PANPHONICS
Audio Innovations

Plane Wave Loudspeaker with Signal Processing Enhancements

The presented electrostatic loudspeakers are exceptionally useful in several audio reproduction usages. The amount of reflections deteriorating the sound quality is minimized and the amount of disturbance in the surrounding space is diminished by their high directivity. The created plane waves travel long distances with minimal spatial spreading and attenuation.

Loudspeaker Technology and Characteristics

The presented electrostatic transducer is constructed by attaching a flexible diaphragm between two porous, relatively rigid plates. Cavities are produced to the stator plates to allow the movement of the diaphragm. A constant bias voltage is applied to the diaphragm, and a signal voltage is applied to the inner surfaces of the cover plates. The resulting structure is safe to operate, as the porous material encloses the charged layers. An input signal produces a uniform electric field between the stators, causing the diaphragm to move and to produce sound accordingly. The patented construction allows mass production of one-piece loudspeaker elements of many sizes and shapes having thickness of only 4 mm and weight of only 1.4 kg/m^2. Due to the thin construction, low voltage levels are used compared to typical electrostatic constructions.

Usage Examples

The narrow audio beam created by an electrostatic loudspeaker element allows reproduction of high quality audio to well defined areas. As reflections from surrounding boundaries are minimized and the sound source is well localized, the intelligibility of the audio message is remarkably better than with traditional cone speakers.

The plane wave transducers are efficiently used in digital signage applications, mostly with flat screens. Sound Signs® produce audio in the same area where an advertisement is seen over an aisle, at escalators, or at a queuing location. The audio feed played at moderate level can be clearly heard even from far away.

Focused audio is useful when multiple audio feeds are wanted in a space, or the sound is wanted to be played in a restricted part of an open space. The applications include office cubicles and waiting areas at banks and pharmacies, for example. Privacy Solutions® products have been created for these uses. They can be easily attached to the ceiling or even be part of lamps or other architectural constructions. The audio feed may also be experienced as a Sound Shower®. In a museum or a store, a person may step into an audio spot and out of it.

Signal Processing Enhancements: Missing Fundamental - Directive Bass

To produce low frequencies with a dipole element would require large diaphragm movement amplitude. Increasing the voltage levels and thickness of the structure would be needed, which conflicts with the specific characteristics of the presented loudspeaker. Also, the directivity of the sound deteriorates at low frequencies, as the wavelength approaches the element dimensions.

A known solution creates the sensation of a low frequency tone by playing a harmonic series of its overtones, without creating the fundamental frequency itself. When this principle is used in signal processing for the presented element, the benefits of high directivity and sensitivity at high frequencies are maximally utilized. The perceived audio bandwidth can be extended to reach about one octave below the physical cutoff frequency.

Stereo Dipole - Extended Spatial Image

A technique of extending the experienced space in a stereophonic sound reproduction, the stereo dipole, is demonstrated. Essentially, the signals for each ear are processed separately to produce the sounds with the interaural time and level differences related to the wanted sound source locations. The resulting signals are played from respective loudspeakers. To create the spatial sensation, the crosstalk has to be dealt with an opposite phase signal that perfectly cancels the first signal at the location of the opposite ear.

The spatial sensation created with the stereo dipole system is disturbed by any reflections from the nearby walls, for example, reaching the listeners ears at uncontrolled time instants. Use of directive plane wave loudspeakers minimizes these reflections and creates the correct sound image even far away.

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