Technical Note 1401

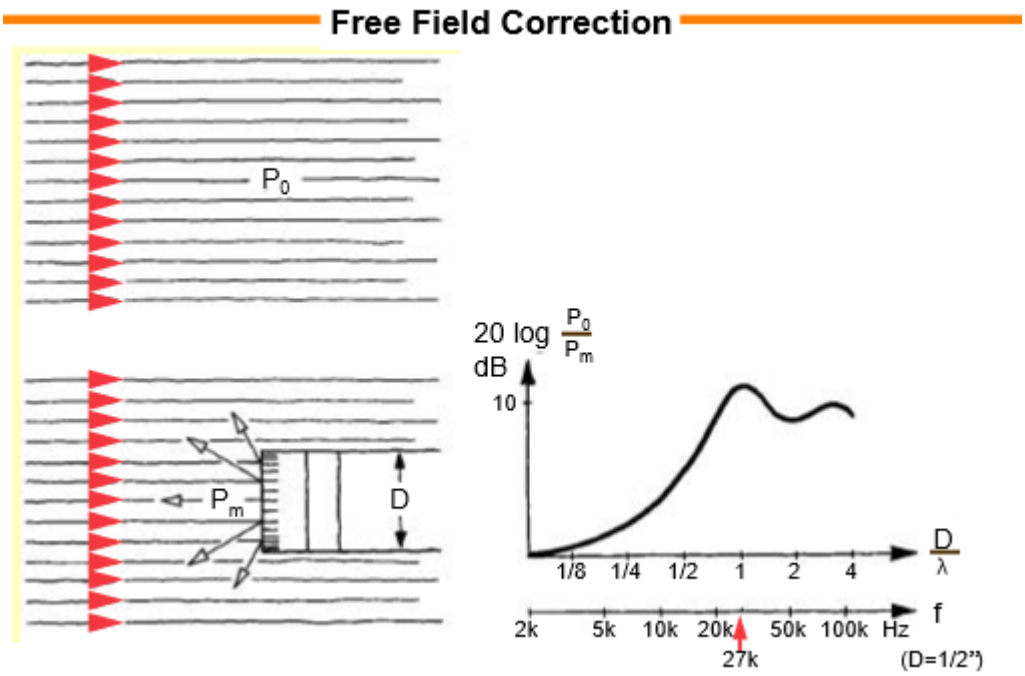
Sound Fields and Measurement Microphones

Types of Microphones

Microphones are divided into 3 types according to their response in the sound field: free field, pressure, and random incidence (or called diffuse field). Free field microphones have uniform frequency response for the sound pressure that existed before the microphone was introduced into the sound field. It is of importance to note that any microphone will disturb the sound field, but the free field microphone is designed to compensate for its own disturbing presence as discussed later. The pressure microphone is designed to have a uniform frequency response to the actual sound level present. The random incidence microphone is designed to respond uniformly to signals arriving simultaneously from all angles. In the following we will have a closer look at the reason for the difference between the microphones and when each type should be used.

Free Field Correction

When a microphone is placed in a sound field, it modifies the field. The illustration shows a free field where sound comes from only one direction. The sound pressure in this field without the microphone is called p0. When the microphone is placed in the field a pressure rise will take place in front of the microphone caused by local reflections and the microphone will measure too high a sound pressure pm. This rise in “sensitivity” is frequency dependent, with a maximum at the frequency where the wavelength is equal to the diameter of the microphone, D/l. If the corresponding frequency axis for a 1/2" microphone is plotted along the D/l axis it is seen that the increase starts at 2 kHz with a maximum of approximately 10 dB at 27 kHz.



1/2" Microphone Free Field Correction.

Use of Free Field Microphones

The free field microphone is used in all applications where the sound mainly comes from one direction. Therefore the microphone must be pointed directly at the sound source during a measurement. Typical applications of the free field microphone are in outdoor measurements and for measurements indoors where there are very few or no reflections, so that the sound is mainly from one direction only. An example of the latter is measurements in an anechoic chamber where a free field microphone should always be used

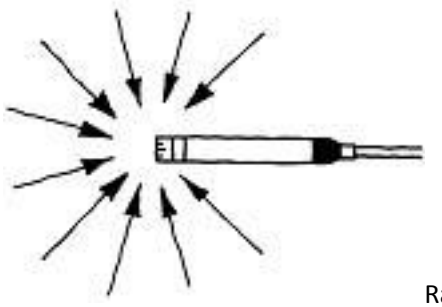
Use of Pressure Microphones

The main application of the pressure microphone is for measurement in closed cavities e.g. coupler measurement and audiometer calibration, and for measurements at walls or surfaces, where the microphone can be mounted with its diaphragm flush with the surrounding surface.

Pressure field

Use of Random Incidence Microphones

The random incidence microphone is designed to respond uniformly to signals arriving simultaneously from all angles. It should therefore not only be used for measurement in reverberation chambers, but in all situations where the sound field is a diffuse sound field e.g. in many indoor situations where the sound is being reflected by walls, ceilings, and objects in the room. Also in situations where several sources are contributing to the sound pressure at the measurement position a random incidence microphone should be used.



Random Incidence (diffuse) Field

Measurement Errors in Different Sound Fields

The free field microphones are calibrated to flat frequency response at 0° incidence in free field. When this type of microphone is used in pressure and random field, the measurement errors are occurred in high frequencies. Figure 1 shows a 1/2" free field microphone responses in free field, pressure and random fields.

It can be seen that at 1000 Hz below, there is no error to any types of sound fields. When the

frequencies increase, the errors become larger. At 20kHz, the difference between free field and random field could be 7 dB. It is important to select the right type of microphone for measurements, especially in high frequencies.

When the diameter of microphone becomes smaller, such as a 1/4" microphone, the differences in free, pressure and random fields also become smaller.

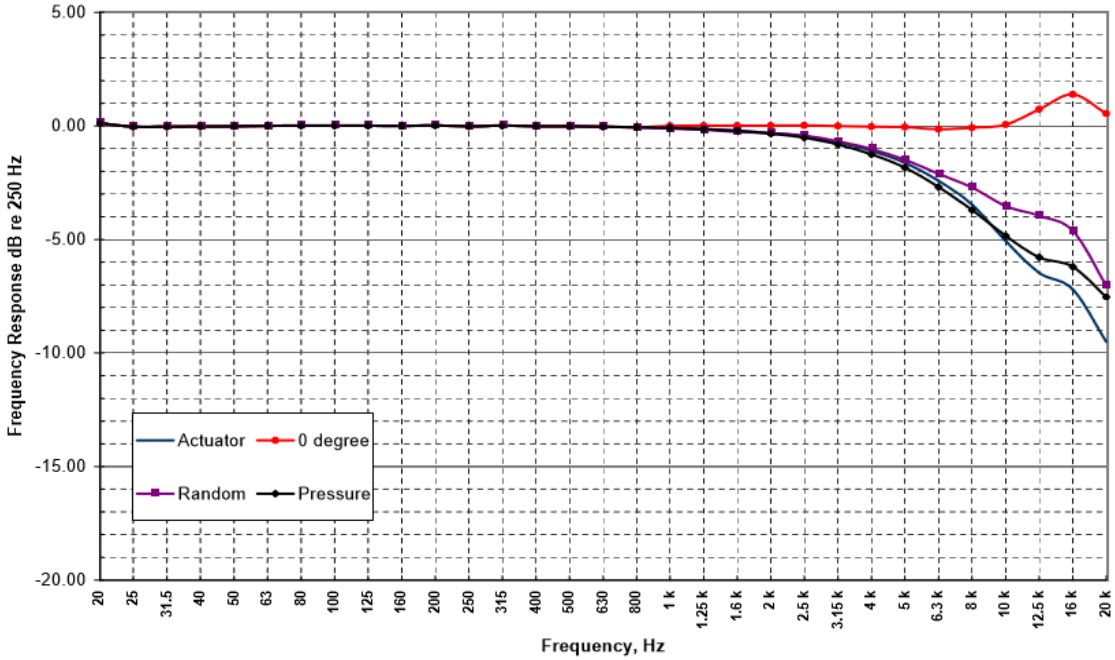
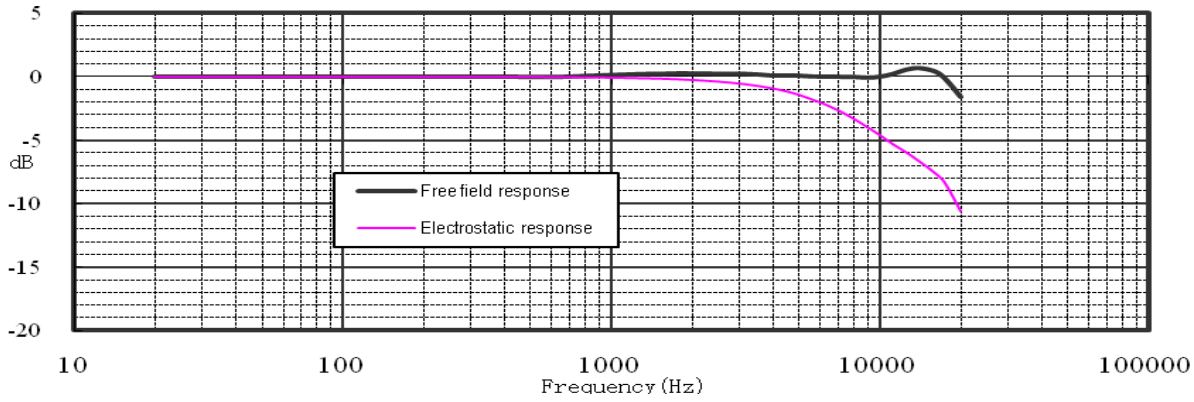


Figure 1: 1/2" Free field microphone responses to three types of sound fields.

Calibration Chart

Each MicW microphone has its own serial number and is provided with its own calibration chart which gives the exact sensitivity of the microphone and a summary of its general specifications. It also includes the relevant individually measured frequency response curves. The example here is for a free field microphone showing the pressure (electrostatic) response and the free field response (0° incidence).

The pressure response obtained from the Electrostatic response.



MicW Measurement Microphones

MicW manufactures measurement microphones according to IEC standards. All MicW measurement microphones (i436, M416 and M215) are free field microphones. If you require pressure field or diffuse field microphones, please refer to BSWA Technology at www.bswa-tech.com.

References

[1] IEC 61094-1: 1991, Measurement microphones - Part 1: Specifications for laboratory standard microphones

[2] IEC 61094-4: 1995, Measurement microphones - Part 4: Specifications for working standard microphones

[3] IEC 61094-6: 2004, Measurement microphones - Part 6: Electrostatic actuators for determination of frequency response

[4] IEC 61094-7: 2006, Measurement microphones - Part 7: Values for the difference between free-field and pressure sensitivity levels of laboratory standard microphones.