7. Microphones

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- Most microphones are made for communication systems, where low price and high reliability are essential. Linearity, frequency range, long-term stability, and sensitivi-ty to temperature, humidity, and magnetic fields may be inferior and should be checked by the user, who also needs to calibrate the microphones relative to a precision microphone.

- Precision measurement microphones are condenser microphones. The condenser consists of a steel membrane and a backplate, which are separated by a gap of about 20 μm. There may either be a 200 V DC voltage between the membrane and the backplate, or the membrane may be prepolarized. In both cases, a vibration of the membrane generates an AC voltage. Design parameters of precision microphones are size, membrane mass and tension, and system damping.

- The range of pressure amplitude that can be measured is limited from below by the noise of the microphone and preamplifier and from above by the non-linear output at membrane vibrations that approach the size of the gap. A 100 dB (= 1 to 100,000) range is typical.

- Smaller microphones tend to have a larger frequency range, but be less sensitive, than larger ones. At a given frequency, a small microphone (mounted on a slim preamplifier) causes less diffraction of sound than a larger one and is thus better suited for measurements of, for example, diffraction around objects like animals. Probe microphones (with a tube of 1 mm diameter) are even better, but they are high-tech and cannot be made cheaply. Several investigators have built their own probe microphones and used them for measuring sounds in small volumes, often with catastrophic results because of ignorance about impedance matching.

- The most common pitfall in the use of microphones is the failure of the user to distinguish between pressure- and free field types. All microphones cause diffraction of sound above a certain frequency. When pointing towards the sound source, a microphone may record a sound pressure, which is up to 9 dB above the sound pressure at the same spot without the presence of the microphone! Free field microphones have been made correspondingly less sensitive and thus record the correct sound pressure, but only when they are pointing towards the sound source. Pressure microphones record the pressure that actually exists and will be up to 9 dB in error if pointed towards the source. However, pressure microphones record almost (within ½ dB) the correct pressure if they are pointed 90° relative to the direction to the source.

In pressure gradient and pressure difference microphones the sound has access to both surfaces of the membrane. These microphones are more directional than those discussed above. Their properties are discussed in the lecture on directional hearing.