Principal Characteristics of the Different Microphone Types

Pressure Transducers

...are characterized by an omnidirectional polar pattern, i.e. they pick up sound from all directions to an (ideally) equal degree. Microphones of this type do not have "proximity effect" (low-frequency emphasis with close placement to a sound source). But condenser microphones operating on this principle can have flat frequency response down to the lowest audible frequencies, permitting full, impressive low frequency sound reproduction. Unlike a loudspeaker, a microphone's membrane size has no effect on its low-frequency capabilities since it operates purely as a sensor, like an eardrum; it doesn't have to move large volumes of air at low frequencies as a loudspeaker must do.

For reasons of physics (capsule dimensions), the omnidirectional pattern can be maintained in its ideal form only up through the midrange frequencies. At higher frequencies, sounds arriving on axis are progressively emphasized by the interaction of the capsule housing with the shorter wavelengths. The larger the diameter of the housing, the greater the difference in high-frequency response between on-axis and off-axis sound. This effect can be seen clearly in the capsules' polar diagrams. It is the reason for their differing frequency response in the direct versus the diffuse sound field.

When the high-frequency emphasis is corrected so that the response measures flat on axis, the result is a pressure transducer type such as the MK 2 or CCM 2. These microphones are ideally suited to picking up acoustic sources in the near field. But if a microphone of this type is placed in the reverberant sound field, where reflections from walls, ceiling, floor, etc. predominate, there will be a loss of overall brilliance. These reflections, with their high-frequency content attenuated by surface absorption, reach the microphone at oblique angles of incidence and suffer additional losses as compared with sounds picked up directly. Here (in the diffuse sound field, beyond the reverberation radius) a microphone with some high-frequency emphasis (MK 2H, MK 2S, MK 3 or the corresponding CCM Compact Microphones) is required so that at high frequencies there will be balanced sound rather than a rolloff. This, of course, adds brilliance to sounds picked up at close range and on axis – an effect which may be desired in some circumstances.

A pressure transducer with ideal response in all situations does not exist. A very small capsule could allow the high-frequency response to be flat regardless of direct- or diffuse-field placement, but such small capsules are quite noisy. The user must therefore consider the nature of the pickup and make an appropriate choice. Please note that the design of of the MK 2S or CCM 2S achieves a technically sophisticated compromise between the requirements of working in the direct and the reverberant sound fields (in the region of the reverberation radius).

Particularly for two- and three-microphone stereo pickups, which are usually made near the reverberation radius (where the direct and reverberant sound fields are of equal level), the MK 2S and CCM 2S have become favorites of many sound engineers. This is also true for the MK 2H and CCM 2H, whose characteristics are somewhat closer to those of the free-field models MK 2 and CCM 2.

Principal Characteristics of the Different Microphone Types

Pressure-Gradient Transducers

Note: Usually, any directional microphone is referred to as a "pressure-gradient transducer" even when it has only a limited pressure-gradient component (e.g. a cardioid). This usage is technically not quite correct, since a true pressure gradient transducer always has a bidirectional (figure-8) pattern. Nevertheless, we have adopted this nearly universal practice.

SCHOEPS makes many different types of directional capsules and microphones, each having specific features and a range of typical applications.
What they all have in common, as you can see from their polar response diagrams, is that their sensitivity to any sound depends on the angle of incidence of that sound; they "favor" sound that arrives from particular directions. This allows them to maintain the same balance of direct to diffuse (reverberant) sound when placed at a greater distance from the sound source than an equally sensitive omnidirectional microphone.

The bidirectional MK 8 and CCM 8 are pure pressure-gradient transducers. Our other directional microphones use combinations of the pressure and pressure-gradient principles; their various directional characteristics result from differing proportions of these ingredients.
All our microphones, including the multi-pattern ones, are single-diaphragm – a feature unique to SCHOEPS. This results in polar patterns that are less frequency-dependent than any dual-diaphragm design can offer, a high-frequency response that is distinctly more extended, and low-frequency response (with our single-pattern omnidirectional microphones or in the omnidirectional setting of our multi-pattern microphones) that is essentially perfect.

One advantage of small pressure-gradient transducers such as SCHOEPS microphones is that their directional pattern can be kept constant across a wider frequency range than with a pressure transducer. On the other hand, their low-frequency response in a free sound field is not as extended as that of a pressure transducer. Placement in the near field can compensate for this bass rolloff via proximity effect, but there is also a risk of overcompensation.

Proximity effect may also be used to suppress environmental noise by choosing a microphone type having a large bass rolloff and/or by the use of a corresponding electronic filter. A cardioid microphone at a distance of less than 40 cm, for example, will pick up a speaking voice quite clearly, while environmental noise will be suppressed due to the directivity of the cardioid pattern and its bass rolloff. At the same time, the lower frequencies in a person's voice will be restored to normal by virtue of proximity effect, resulting in a clear and full sound.

By choosing a microphone of high directivity it is also possible to avoid acoustic feedback. If a loudspeaker is set up within the reverberation radius, it should, for obvious reasons, be positioned where the microphone has its minimum sensitivity. If the loudspeaker is beyond the reverberation radius, its radiated sound will reach the microphone after being reflected by the walls, floor and ceiling of the room, arriving as reverberant sound from many directions. The microphone will pick this up less strongly than the direct sound from the source on the main axis.

Off-axis attenuation increases with greater microphone directivity. The greater this is, the less danger there will be of acoustic feedback. This is true only in the direct sound field, however; in a diffuse sound field (beyond the reverberation radius*), a directional microphone will offer no help for this problem.

When dealing with pressure-gradient transducers, their greater sensitivity to wind and vibration should be kept in mind. Suspensions that damp solid-borne noise (elastic suspensions and/or sound-isolated stands) are highly recommended, as well as popscreens and windscreens wherever appropriate.

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Principal Characteristics of the Different Microphone Types

Shotgun Microphones

Certain types of recording are frequently made with shotgun microphones. SCHOEPS has never offered this type of microphone, and we are often asked why not. We agree that good shotgun microphones have their uses, but we suggest that their peculiarities be well understood; shotguns may not be the optimal choice as often as people suppose.

A shotgun microphone contains a directional transducer (e.g. a supercardioid capsule) and an "interference tube." The tube causes any sound energy arriving from the sides to undergo partial cancellation before it can reach the capsule. The exact degree of this cancellation depends greatly on the wavelength of the sound. For wavelengths longer than the tube – at low and midrange frequencies – the tube has little effect except, unfortunately, to distance the capsule further from the sound source than it would otherwise be. (The transducer is located behind the tube – not at the front end of the microphone.)

Thus throughout much of the audio range, a shotgun microphone has no greater rejection of off-axis sound than the capsule on which it is based. At higher frequencies the pickup pattern becomes narrower, but with great variations in response for different angles and frequencies. The result is a much more complex directional characteristic than ordinary polar diagrams (drawn only at certain "spot" frequencies) can indicate directly.

A shotgun microphone must therefore be well aimed at the intended sound source, and that source must fit within the microphone's front pickup angle. Otherwise, comb-filter-like effects will result from any reflected sound, off-axis sound sources, or motion of the direct sound source (or of the microphone itself, if it is used in a reverberant space). If an actor moves across a room while speaking or singing, his or her motions can no doubt be followed – but sound from any other actors nearby, and any sound reflections within the room, will be picked up with varying coloration. Conditions in which there is little reflected sound energy (e.g. outdoor recording) and limited off-axis sound in general are thus best for shotgun microphones. In a diffuse sound field (i.e. at significant distances indoors) they are less effective than one might wish, and they tend toward a harsher sound quality.

Stereophonic recording with shotgun microphones can be awkward (how does one set up an X/Y pair of shotguns?) and fraught with compromise because of their irregular polar patterns. However, M/S recording is possible with a shotgun "M" microphone (see the Colette accessory KMSC) for sound sources that are not too wide.

A small directional microphone with smooth off-axis response, such as the SCHOEPS CCM 41, can often be placed closer to a sound source than a shotgun microphone and still stay outside the frame for film or video production. It is also simpler to provide any needed shock mounting or wind screens for small microphones. A trial comparison between a good small supercardioid and a shotgun can be surprising and enlightening; the pickup quality can be substantially improved in many cases. Thus we propose that in any given situation, users should consider carefully whether using a supercardioid rather than a shotgun might yield equal or better results.

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