

MICROPHONES

Adapted from Philip Tan, ©1996

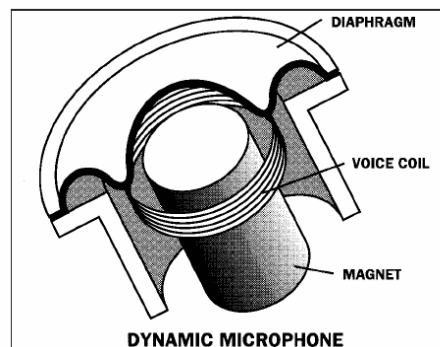
How microphones work

Microphones just convert a real sound wave into an electrical audio signal. In order to do so, they have a small, light material in them called the diaphragm. When the sound vibrations through the air reach the diaphragm, they cause the diaphragm to vibrate. This in turns will somehow cause an electrical current in the microphone to vary, whereupon it is sent out to a mixer, preamplifier or amplifier for use.

Microphones are typically classified according to how the diaphragms produce sound.

Dynamic Microphones

Dynamic microphones typically use moving-coil technology. This consists of a diaphragm of usually thin plastic being attached directly to a dense coil of wire. The coil has a magnet either surrounding it or at the centre. As the diaphragm vibrates, the coil vibrates, and its changing position relative to the magnet causes a varying current to flow through the coil. This current is your audio signal.



Dynamic microphones have hardy diaphragms, but are typically damaged when the suspension wires break, due to dropping or rough handling. These are the little things that hold the coil and diaphragm in a floating position relative to the magnets.

Dynamic microphones have to cause a whole coil of wires to move, a mountain when you're talking about little movements of air. This makes them not as sensitive as higher-grade microphones, especially to very soft sounds or high-pitched sounds, such as sibilants in speech or harmonics in music. They have a reputation of being very hardy, and some higher grade dynamic microphones can give a very clean and sensitive sound. Dynamic microphones are also known to give a 'fat' sound, which is flattering to those frequencies that the human ear can hear. They are usually not expected to reproduce the sounds they pick up very faithfully.



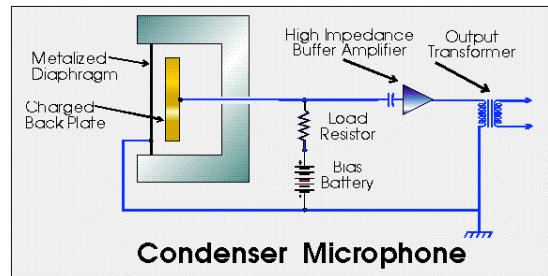
Because of their hardiness, they are usually used in live performances, where mic droppages and rough handling are the norm. As such the dynamic sound has also been identified as a 'live performance' sound that sounds cruder and more powerful at the expense of pin-sharp clarity. Performers such as Bono from U2 favour simple dynamic microphones over the more standard studio condensers for precisely that reason.

Condenser Microphones

In condenser microphones (also called “capacitor microphones”—a “condenser” is an arcane term for a capacitor), a fixed charge is impressed on the diaphragm or on a back-plate to the diaphragm. As the diaphragm vibrates, the distance from the back-plate to the diaphragm vibrates, altering the

capacitance of the diaphragm and the back-plate. This fluctuating capacitance results in a fluctuating electric current. Voila! You have an audio signal!

Instead of moving a whole coil of wires, condenser microphones only have a thin diaphragm and solid back-plate making up a capacitor. The smaller and lighter the diaphragm, the more accurate and pin-sharp the sound will be.



Large-Diaphragm Condenser Mics

This has led to the creation of large-diaphragm condenser microphones, which use the same basic technology, but have special larger high-quality diaphragms to produce a more flattering sound. Studios usually have an array of expensive large-diaphragm condenser microphones, as each microphone would reproduce the sound in its own special way. When the correct microphone is chosen for a vocalist, the results can be extremely flattering, making the singer much better than he or she really is.

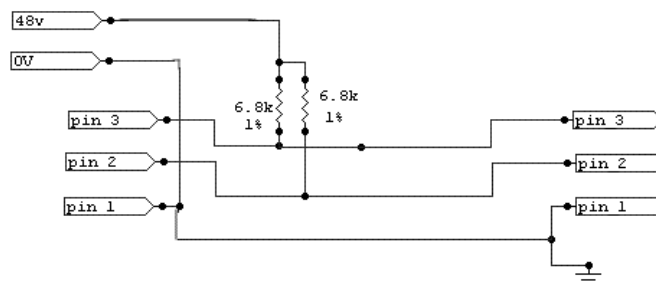
The cost of a large-diaphragm microphone is not only due to the materials (which can include precious metals like gold), but also to the R&D cost of creating a microphone that records sound the way you want it, instead of the way it really sounds. Large-diaphragm mics can also maintain most of the high-frequency sensitivity of regular condenser microphones, making them sharp enough for digital recording to do the sound justice. Up until recently, large-diaphragm mics were made by only a few companies in the US and Western Europe, but in the last decade or so a flood of them have appeared from China and Eastern Europe which have significantly brought prices down.



Phantom Power

Condenser microphones need a source of power to impress the charge on the capacitor. One of three methods is used. Either a battery will be inserted inside the microphone, a permanent charge is retained on the diaphragm or backplate (“electret”) thanks to some clever material scientist, or phantom power is used.

Phantom power is puts a DC voltage on the two “hot” conductors in the audio cable. Ranging from 9 volts to 52 volts, typically 48 volts, this power can be put into the cable either from a mixer, a phantom power box or a battery pack. A mixer might have a button that turns on phantom power through the mic cable. A phantom power box is an intermediate component between a mixer and a mic. A battery pack does exactly the same thing, but works with batteries instead of mains power.



Ribbon Microphones

Ribbon mics consist of a thin ribbon of a metallic foil suspended in front of a metal plate. Sound waves cause the foil to vibrate, causing fluctuations in the electrical current. Thus, an electrical audio signal is created. They tend to be sensitive to shock and large sound volumes, and can be damaged easily, and should not be used with phantom power.

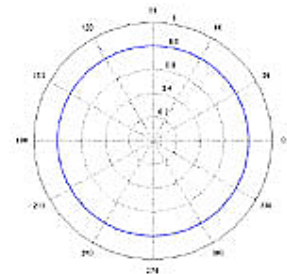


Pickup Patterns

Microphones are made with certain applications in mind. For example, stage use, studio use or field recording use. Microphones are not always expected to pick up sound universally and from all directions. The way that a microphone picks up sound from various directions is known as its pickup pattern. There are a few standard pickup patterns: Omnidirectional, Unidirectional, Bidirectional and Cardioid. Pickup patterns are usually depicted as polar diagrams, a circular graph of sensitivity of a microphone from various directions

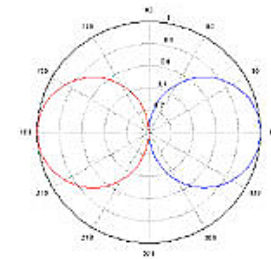
Omnidirectional

Literally, from all directions. Omnidirectional microphones pick up sound well from all directions, and are frequently used for recording ambient and background sound. Omnidirectional microphones are also used for vocals, because of their lack of proximity effect. They could be used for recording of a group of vocalists, although the preferred method would to split the group into individual singers and each one having their own microphone.



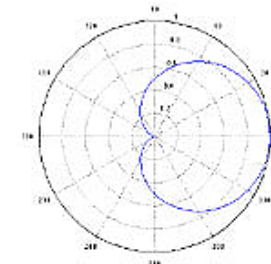
Bidirectional

Picks up sound from two opposite directions. Also known as the figure-8 pickup, as the pickup pattern resembles a figure-8 when viewed from above. They used to be popular in the old days when two people would stand around a microphone and sing a duet, but now it is usually preferred to mic each person up separately. Still used extensively with larger ensembles and in good-sounding rooms since they pick up the room sound along with whatever's in front of them. Most ribbon mics are bi-directional.

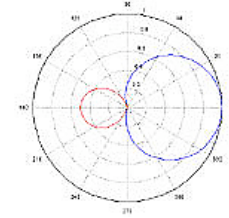


Cardioid

Cardioid microphones (also called "unidirectional") have a heart-shaped pickup pattern. Probably the most common microphones in use today, They reject sound coming from the back of a microphone and are progressively more sensitive to sounds as the direction approaches the front of the microphone. They are favoured for stage use as they do not pick up the sound from on stage speakers or monitors so readily, thus preventing feedback.



There are versions of the Cardioid pattern called **Supercardioid** and **Hypercardioid**, which represent increasingly limited ranges of pickup. As the pattern narrows, feedback rejection improves even more, but due to limitations of construction, a narrowing of the pattern does add a little sensitivity directly behind the microphone. The narrowing does cause the sound recorded to be more pinched and less flattering, but in a stage situation

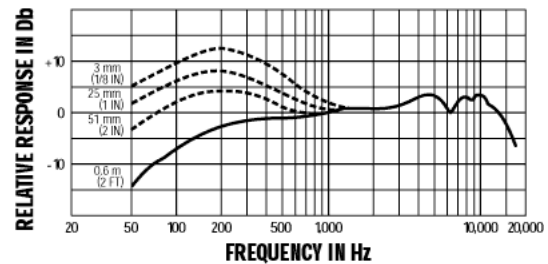


with many speakers placed in unsuitable places, a hypercardioid microphone can be a highly effective feedback prevention measure. An extreme version of the hypercardioid mic is the shotgun mic, used commonly in broadcast sports and news gathering.

Many microphones, especially large-diaphragm condenser mics, can operate in a variety of patterns, and have switches on the body to select among the patterns.

Proximity Effect

Cardioid microphones have a funny phenomenon called the Proximity Effect. This describes the increase in bass as the microphone moves nearer the sound source. Similarly, the further a cardioid microphone is from a source of sound, the more pinched it will sound. Experienced vocalists and producers have used this phenomenon to great effect, especially in simulating a punchy, 'live' effect by almost eating the microphone while singing. The proximity effect can also cause problems, especially when dealing with inexperienced singers, as the tonal qualities of their voices will change as they move their head.



Pressure Zone Microphones (PZM)

A general purpose microphone for amplifying a large source of sound, like a choir or a stage performance. These typically use condenser pickups, mounted a few millimeters over a flat surface, usually a metal plate integrated into the microphone. The concept is the sound reaching the metal plate will bounce back into the pickup, adding to the sound directly going into the pickup.



They are also known as Boundary Microphones or Phase-Coherent Cardioids. They have remarkably good pickup, and when placed properly, give very little feedback for sound reinforcement. They are not very discerning in what they pick up, so they aren't that good for recording, but they are great for amplifying vocal and instrumental ensembles on a stage.