

How Microphones Work

Microphones are components in virtually all audio systems. Thus, you'll hear about studio microphones for recording, PA microphones for live sound, boom microphones for broadcast or film shoots, instrument microphones which attach directly to guitars or horns, boundary microphones for conference systems, lapel mics for seminars and business meetings, and even headset microphones for telephone call centers. The reason for this diversity is that while all microphones perform the same basic function, they are adapted to a wide variety of different environments and uses.

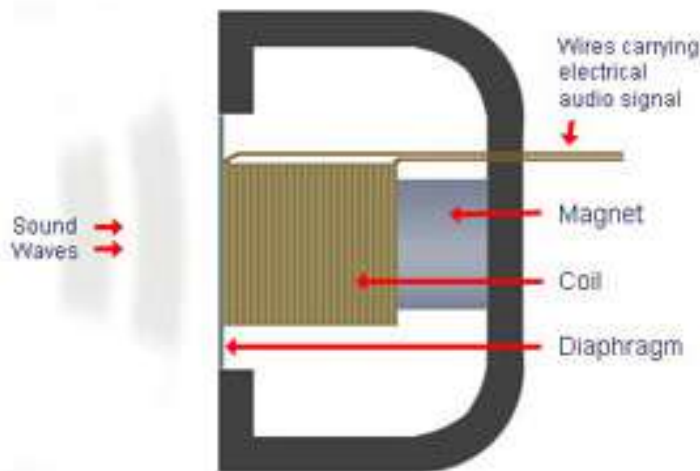
That said, all microphones have one thing in common: microphones convert a sound wave into an electrical signal in which the voltage and current are proportional to the original sound. To perform this task microphones use a thin membrane, known as a diaphragm, which mimics the function of the human ear.

When sound waves strike a microphone's diaphragm, they cause it to move within an electro-magnetic field, which, in turn, creates a variance in an electrical current. This signal is then transmitted to output devices, which reproduce the original sound wave and reinforce it. Typical output devices for microphones are power amplifiers, sound mixers, PA systems and audio recorders.

Generic Microphone



Cross Section of a Microphone's Diaphragm



The internal configurations of microphones used for 99% of all audio systems have one of three basic designs, which are often used to organize microphones into distinct categories. These three categories are dynamic microphones, condenser microphones, and ribbon microphones.

The link between the microphone's diaphragm and the output device can be either wired or wireless. Wired microphones are physically connected by a cable to the output device. Wireless microphones, which are more portable, must come with both a transmitter (either FM or InfraRed) and a compatible receiver.

Finally, to fully understand how microphones work, and the differences among them, it's important to consider the way different microphones gather sound from the ambient environment. Microphones can be classified by three types of pickup patterns: unidirectional or cardioid, bidirectional or figure 8, omnidirectional or boundary and switchable.

Types of Microphones

Audio engineers and sound technicians classify microphones using the following criteria:

The internal configuration of microphones including dynamic, condenser and ribbon diaphragms:

Dynamic Microphones



In dynamic microphones a physical cone acts like a lens to concentrate the incoming sound waves. The concentrated energy of these sound waves moves the cone and its attached coil of wire back and forth inside a magnetic field. The magnetic field induces electricity to flow through the wire to produce an electrical signal which is the microphone's output. The electrical signal is analogous to the original sound wave: the voltage and current are proportional to the original sound. Dynamic microphones are well known for their versatility and their durability, but are not the best choice for reproducing high and low frequencies; dynamic microphones require significant energy to move the coil of wire and therefore lose definition at the extremes.

Ribbon Microphones



Ribbon microphones consist of a thin strip of metallic foil suspended in front of a magnetic plate. Sound waves cause the foil to vibrate, producing fluctuations in the electrical current, creating the audio signal.

This extremely sensitive configuration picks up a wide range of frequencies and produces an extraordinarily rich representation of the original sound. The trade off for this sensitivity is the delicacy of the mechanism. These ribbon microphones are also sensitive to physical impacts and therefore are not considered portable and can be easily damaged by power overdrive.

Condenser Microphones



Rather than a vibrating wire coil, condenser microphones have a thin diaphragm and solid back plate which make up an electronic component known as a capacitor. As the diaphragm vibrates, the distance from the back plate to the diaphragm varies accordingly. This is known as fluctuating capacitance. It's the fluctuation that produces an electrical current, resulting in the signal output.

Condenser microphones are used for a variety of applications, making them an optimal compromise between the sound reproduction of ribbon microphones and the durability of dynamic microphones.

The external configuration of microphones including wired or wireless signal transmission:

Wired Microphones



Wired Microphones Traditionally, microphones - like Model T Fords - came in any external configuration you wanted, so long as it was wired. The connection between the diaphragm and the sound system was a hard wired cable that carried the electrical current to the speakers.

Wireless Microphones

The main advantage of wireless microphones as compared to wired microphones is freedom of movement. With wireless microphones a vocalist or presenter has much greater flexibility to move around a stage or among an audience. The biggest disadvantage is price, as wireless microphones in general are more expensive.

Characteristically, wireless microphone systems require a wireless transmitter, and a wireless receiver.

The wireless transmitter is either built into the microphone itself (as in handheld microphones), or is connected by a short cable to a body pack transmitter (as in handsfree microphones). All wireless transmitters require a battery (typically 9-volt or AA batteries) and broadcast through an internal or external antenna.

The wireless receiver is tuned to the same electromagnetic wavelength as the transmitter (usually **VHF**, **UHF** or **IR**) and is physically attached to the output device such as a PA system or a closed system headset.



Handheld wireless microphones

Handheld Wireless Microphones are literally held in the hand of a presenter or a vocalist. In this way the microphones can be used as a prop in a performance.



Handsfree Wireless Microphones

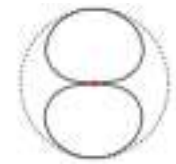
Handsfree Wireless Microphones come in three popular configurations, lapel (or lavalier) wireless microphones, collar wireless microphones and headband wireless microphones.

The pick-up pattern of microphones including unidirectional, bidirectional and omnidirectional:



Unidirectional Microphones

Unidirectional or cardioid pickup patterns are most sensitive to sound produced on the front side of the microphone capsule. Super-cardioid pickup patterns have a greater sensitivity than cardioid pickup patterns.



Bidirectional Microphones

Bidirectional or figure 8 pickup patterns are sensitive to signals emanating from the front and back sides of the microphone capsule while rejecting sounds from the left and right sides of the microphone capsule.



Omnidirectional Microphones

Omnidirectional or boundary pickup patterns are sensitive to sound from all directions of the microphone capsule.



Switchable Pickup Pattern Microphones

Switchable pickup pattern microphones are hybrid microphones that can be switched from one pickup pattern to another for all-in-one flexibility in different environments.

How Microphones Work - Worksheet

1. In a microphone, this mimics the function of a human ear.
 - a. Diaphragm
 - b. Condenser
 - c. Ribbon
 - d. Wireless transmitter
2. What type of mic would you use for the following scenario:
 - You want a microphone that will be versatile, Your **budget is limited**, You need a microphone that will be durable , You use it for live vocals and recording , You work with relatively loud sound sources
 - a. Ribbon
 - b. Condenser
 - c. Dynamic
3. What type of mic would you use for the following scenario:
 - You want to pick up a wide range of frequencies , You are looking for an extraordinarily rich representation of the original sound, You seek smooth, detailed sound, You want to capture the subtle nuances in a **recording studio**, You expect and appreciate subtle, sensitive sound
 - a. Ribbon
 - b. Condenser
 - c. Dynamic
4. What type of mic would you use for the following scenario:
 - You need **versatility** because you work in a variety of applications for example speech as well as music, You want accurate sound reproduction and clarity, You like sound that is natural, clean and clear, with transparency and detail, You need exceptionally sensitive pickup, which requires phantom power for silent audio amplification
 - a. Ribbon
 - b. Condenser
 - c. Dynamic
5. Pickup patterns are sensitive to sound from all directions of the microphone capsule.
 - a. Unidirectional
 - b. Bidirectional
 - c. Omnidirectional Microphone
 - d. Switchable Pickup Pattern Microphones
6. Pickup patterns are most sensitive to sound produced on the front side of the microphone capsule. Super-cardioid pickup patterns have a greater sensitivity than cardioid pickup patterns.
 - a. Unidirectional
 - b. Bidirectional
 - c. Omnidirectional Microphone
 - d. Switchable Pickup Pattern Microphones
7. Pickup pattern microphones are hybrid microphones that can be switched from one pickup pattern to another for all-in-one flexibility in different environments.
 - a. Unidirectional
 - b. Bidirectional
 - c. Omnidirectional Microphone
 - d. Switchable Pickup Pattern Microphones
8. Figure 8 pickup patterns are sensitive to signals emanating from the front and back sides of the microphone capsule while rejecting sounds from the left and right sides of the microphone capsule.
 - a. Unidirectional
 - b. Bidirectional
 - c. Omnidirectional Microphone
 - d. Switchable Pickup Pattern Microphones
9. Come in three popular configurations, lapel (or lavalier) wireless microphones, collar wireless microphones and headband wireless microphones.
 - a. Condenser
 - b. Wired
 - c. Hands-free Wireless
 - d. Handheld Wireless

10. Rather than a vibrating wire coil, these microphones have a thin diaphragm and solid back plate which make up an electronic component known as a capacitor. As the diaphragm vibrates, the distance from the back plate to the diaphragm varies accordingly.

- a. Ribbon
- b. Condenser
- c. Dynamic

11. In these types of microphones a physical cone acts like a lens to concentrate the incoming sound waves. The concentrated energy of these sound waves moves the cone and its attached coil of wire back and forth inside a magnetic field. The magnetic field induces electricity to flow through the wire to produce an electrical signal which is the microphone's output.

- a. Ribbon
- b. Condenser
- c. Dynamic

12. These microphones consist of a thin strip of metallic foil suspended in front of a magnetic plate. Sound waves cause the foil to vibrate, producing fluctuations in the electrical current, creating the audio signal.

- a. Ribbon
- b. Condenser
- c. Dynamic