Types of microphones

Microphones are frequently described by their "pick-up" patterns, or the electronic fields from which they capture sound waves. Here are four of the most common pick-up patterns and microphones.

**Bi-directional Microphones**

Think of a television news person conducting an interview with a member of the public, and chances are the reporter will be using a bi-directional microphone. These mics excel in picking up sound from two distinct, oppositely sited sound sources and excluding all other sounds.

**Cardiod Microphones**

This pick-up pattern is popular with stage mics used by singers and public speakers. The name of the pick-up pattern derives from its shape which resembles the human heart. The pick-up pattern focuses on sound sources in front of the mic (say, Mariah Carey!) and excludes sounds from behind the mic (say, her happy fans!)

**Omni-directional Microphones**

If you've experienced the fun of working with USPNet satellite system, then you've worked with an omni-directional microphone. These microphones indiscriminately pickup sounds from throughout a defined area. They are popularly used in group situations.

**Shotgun Microphones**

No, they're not used to hunt for dinner! Shotgun mics are long-range microphones frequently used in commercial film production. They are quite sensitive and focused and excel at capturing sound at a distance. But they can also be large and cumbersome to handle.
**How Microphones Work**

A Comprehensive Guide to the different types of microphones and how they work
courtesy of: www.audio-technica.com

**Simply put - it's a transducer**

Like phono cartridges, headphones and loudspeakers, the microphone is a transducer -- in other words, an energy converter. It senses acoustic energy (sound) and translates it into equivalent electrical energy. Amplified and sent to a loudspeaker or headphone, the sound picked up by the microphone transducer should emerge from the speaker transducer with no significant changes.

While there are many ways to convert sound into electrical energy, we'll concentrate on the two most popular methods: dynamic and condenser. These are the types of microphones most often found in recording studios, broadcast and motion picture production, home hi-fi and video recording, and on stages for live sound reinforcement.

**Dynamic Microphones**

![Dynamic Microphone Element](https://www.audio-technica.com/)

Comparison of microphone types to loudspeakers may help you more readily understand their operation. Dynamic microphones can be considered as similar to conventional loudspeakers in most respects. Both have a diaphragm (or cone) with a voice coil (a long coil of wire) attached near the apex. Both have a magnetic system with the coil in its gap. The difference is in how they are used.

With a speaker, current from the amplifier flows through the coil. The magnetic field created by current flowing through the voice coil interacts with the magnetic field of the speaker’s magnet, forcing the coil and its attached cone to move back and forth, producing sound output.

**Like a speaker 'in reverse’**

dynamic microphone operates like a speaker "in reverse." The diaphragm is moved by changing sound pressure. This moves the coil, which causes current to flow as lines of flux from the magnet are cut. So, instead of putting electrical energy into the coil (as in a speaker) you get energy out of it. In fact, many intercom systems use small speakers with lightweight cones as both speaker and microphone, by simply switching the same transducer from one end of the amplifier to the other! A speaker doesn't make a great microphone, but it's good enough for that application. Dynamic microphones are renowned for their ruggedness and reliability. They need no batteries or external power supplies. They are capable of smooth, extended response, or are available with "tailored" response for special applications. Output level is high enough to work directly into most microphone inputs with an excellent signal-to-noise ratio. They need little or no regular maintenance, and with reasonable care will maintain their performance for many years.
Condenser Microphones

Condenser (or capacitor) microphones use a lightweight membrane and a fixed plate that act as opposite sides of a capacitor. Sound pressure against this thin polymer film causes it to move. This movement changes the capacitance of the circuit, creating a changing electrical output. In many respects a condenser microphone functions in the same manner as an electrostatic tweeter, although on a much smaller scale and "in reverse."

Condenser microphones are preferred for their very uniform frequency response and ability to respond with clarity to transient sounds. The low mass of the membrane diaphragm permits extended high-frequency response, while the nature of the design also ensures outstanding low-frequency pickup. The resulting sound is natural, clean and clear, with excellent transparency and detail.

Two Basic Types
Two basic types of condenser microphones are currently available. One uses an external power supply to provide the polarizing voltage needed for the capacitive circuit. These externally-polarized microphones are intended primarily for professional studio use or other extremely critical applications.

A more recent development is the electret condenser microphone (Fig.2). In these models, the polarizing voltage is impressed on either the diaphragm or the back plate during manufacture, and this charge remains for the life of the microphone.

The Big Difference - Less Noise
Due in part to their low-mass diaphragms, condenser microphones are inherently lower in handling or mechanical noise than dynamic microphones. For all of its electret condenser designs, Audio-Technica has elected to apply the polarizing voltage, or fixed-charge, to the back plate rather than the diaphragm. By doing this, a thinner material may be used for the diaphragm, providing a considerable performance advantage over electret microphones of conventional design. Many Audio-Technica microphone diaphragms, for example, are only 2 microns thick (less than 1/10,000th of an inch)!

Smaller in Size and Weight
Condenser elements have two other design advantages that make them the ideal (or the only) choice for many applications: they weigh much less than dynamic elements, and they can be much smaller. These characteristics make them the logical choice for line - or "shotgun" - microphones, lavaliers and miniature microphones of all types.

Attempts at miniaturizing dynamic microphones result in greatly reduced low-frequency response, overall loss in acoustic sensitivity, and higher mechanical or handling noise.
Phantom Power for Condenser Microphones
While the electret condenser microphone doesn't need a power supply to provide polarizing voltage, an FET impedance matching circuit inside the microphone does require some power. This may be supplied by a small low-voltage internal battery or by an external "phantom" supply.

Delivering DC Voltage where needed
Phantom powering is a technique which delivers a DC voltage to the microphone through the same shielded two-conductor cable that carries the audio from the mic. The phantom power may be supplied either by the mic mixer or from an external supply that is "inserted" into the line between the microphone and mixer input. For phantom power to function, the line between the power supply and the microphone must be balanced to ground, and uninterrupted by such devices as filters or transformers which might pass the audio signal but block DC. Phantom power also requires a continuous ground connection (Pin 1 in the XLR-type connector) from the power supply to the microphone. The supply delivers positive DC voltage equally to both signal-conducting leads, and uses the shield as a return path, or negative. Balanced-output dynamic microphones are not affected by the presence of phantom power, since there is no connection between the shield and either signal lead and, therefore, no circuit for the DC voltage.

Pure Condensers
Phantom power supplies are available in various output voltages ranging from as low as 9 volts up to 48 volts. They may be designed to operate from AC line voltages or from internal batteries.

Externally polarized or "discrete" condenser microphones seldom have internal battery power. Instead, a phantom power source is used to provide both the polarizing voltage for the element and to power the impedance converter. This type is sometimes called a "pure condenser."

Other Types of Microphones
There a number of ways to translate sound into electrical energy. Carbon granules are used as elements in telephones and communications microphones. And some low-cost microphones use crystal or ceramic elements that are generally OK for speech, but are not seriously considered for music or critical sound reproduction.

One other type sometimes found in recording studios is the ribbon microphone. It is a form of dynamic mic, with a thin metallic ribbon (which serves as both voice coil and diaphragm) suspended between the poles of a magnetic circuit. While it is capable of excellent performance, the ribbon element must be protected against high acoustic pressures or wind, since it is relatively fragile. For this reason, ribbon microphones are rarely seen in sound reinforcement applications or non-studio recording.

Ribbon microphones are often designed to respond to sound from both the front and back, and are sometimes used when a bidirectional pickup pattern is required - which brings us to the next major microphone classification.