03

CHAPTER 3
MICROPHONES

MICROPHONE TYPES

▶HOW DO YOU CHOOSE WHICH MICROPHONE TO USE?

Many factors determine your choice of microphones. Before you can decide you will need to know about:

- **The main types of microphone** (dynamic and capacitor), their characteristics and how they are used
- **Pick-up patterns:** the directions from which microphones will pick up sound
- **Frequency response:** how good a microphone is at picking up different ranges of pitches
- **Sensitivity:** how well a microphone will pick up quiet sounds.

There are large numbers of microphone manufacturers around the world and the price and quality varies greatly. It's important to understand the above factors when choosing your microphones for live sound or recording.

▶DYNAMIC AND CAPACITOR MICROPHONES

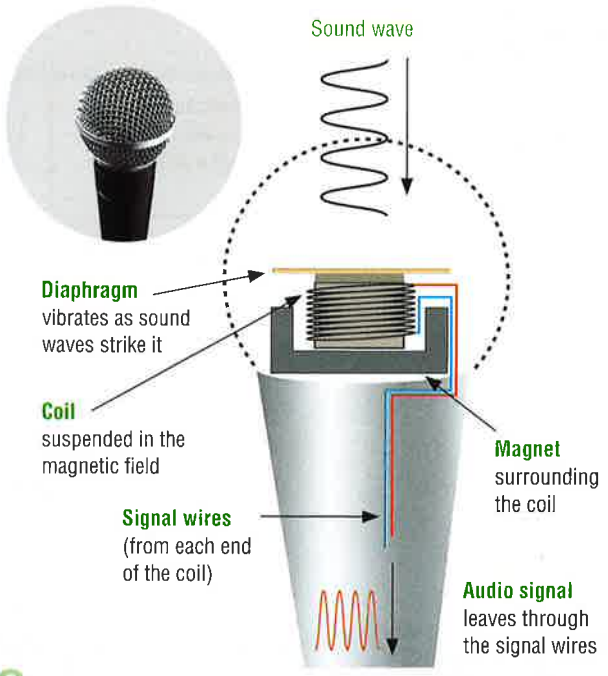
There are two main types of microphone: dynamic and capacitor. They both work in different ways:

- A **dynamic** microphone generates its own power (like a dynamo)
- A **capacitor** microphone makes use of capacitance – the storage of an electrical charge between two conductors – and so needs to be supplied with some power. Capacitor mics are also known as condenser mics.

FACT
As the capacitor mic's diaphragm doesn't have to drive a coil, it can be much lighter and more sensitive.

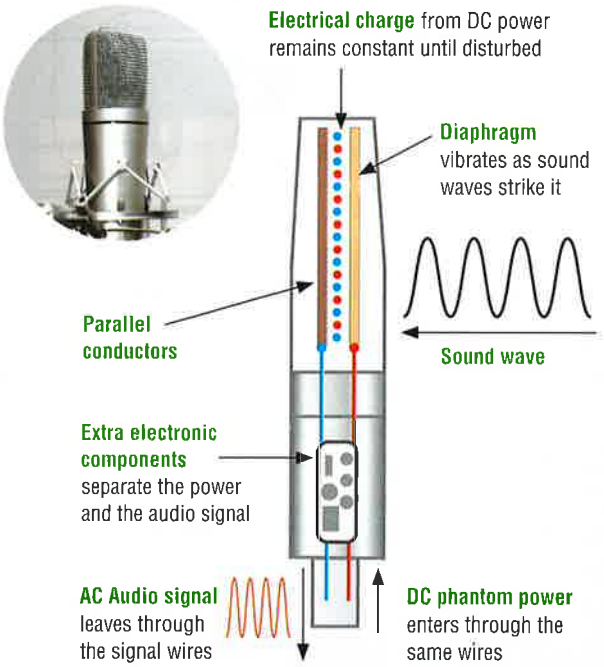
▶DYNAMIC

A dynamic microphone contains a diaphragm (a light and thin piece of material) attached to a metal coil, which is placed inside a magnet. As sound waves make the diaphragm vibrate, the coil moves rapidly in the magnetic field. This makes electricity flow in the wires, producing a very small electrical signal.



▶CAPACITOR

Two 'plates' – very thin sheets of conducting materal – are held a tiny distance apart. A standing electrical charge rapidly builds up between them when they are positive and negative respectively. When the diaphragm plate vibrates, the charge is disturbed and electricity flows between the two.





DYNAMIC AND CAPACITOR

DIFFERENCES

▶ DYNAMIC

1. Less expensive and more easily available.
2. Robustly made and can survive the occasional knock or drop.
3. Produces a very low level audio signal which needs lots of gain from a preamp before being useable.
4. Doesn't need a power source as it makes its own.
5. Used for close/loud sounds.
6. Less sensitive at high frequencies than a capacitor microphone. This can be an advantage in some uses.

▶ CAPACITOR

1. Generally costs more than a dynamic microphone.
2. The mechanism is delicate and needs to be handled with care. Humidity and extreme cold need to be avoided too.
3. Needs preamplifying – but not so much as a dynamic microphone.
4. Needs power – some use a battery in the casing, most need phantom power which is sent along the signal wires.
5. Can be used close up but is also good for low level and distant sounds.
6. Has a very good frequency range, sometimes up to the limit of human hearing or beyond. This makes capacitor microphones the choice for high-quality capture of complex, wide ranging sounds.

USES

▶ DYNAMIC

1. Their strong construction makes dynamic microphones ideally suited to situations where there are high levels of sound, such as close to drums, amplifiers and loud singers.
2. Typical uses include:
   - Kick drum
   - Snare drum
   - Toms.
3. Close mic trumpet, sax and similar instruments in loud conditions, small rooms and bands.
4. Guitar amplifier.
5. Live vocals, including hand-held microphones.

▶ CAPACITOR

1. Capacitor microphones need more careful handling and don't always survive at very high sound pressure levels.
2. Typical uses include:
   - Stereo or ambient recording
   - Drum overheads.
3. Instrumental recording – trumpet, sax etc. but in more controlled conditions to capture the full range of sound.
4. Acoustic/classical guitar amplification and recording.
5. Recording vocals, to capture the maximum frequency range and quality of sound.

MICROPHONE CHARACTERISTICS

▶DIRECTIONALITY

The shape of the microphone body and the construction of its capsule (the part that picks up the sound) affect its sensitivity to sound from the front, rear or sides. A directional microphone is designed to pick up sounds in a certain pattern. A selection of different **pick-up patterns** are shown on the page *opposite*.

▶WHY IS THIS USEFUL?

If you are amplifiying a band or recording a number of instruments or singers, you will probably want to separate the signals as much as possible. If everyone's sound is spread across all the microphones it is difficult to adjust individual levels or panning.

If you are trying to capture the sound of one instrument and another instrument can be heard from the same microphone, this is known as **spill**. Directional microphones significantly help to reduce spill. In studios and on stage, screens are sometimes used to maintain some acoustic separation between players as well.

▶WHAT ARE PICK-UP/POLAR PATTERNS?

These are simply diagrams which show how well microphones pick up sounds from different directions. A new microphone usually has a chart supplied with it showing how it has been tested for its response. These are sometimes called polar patterns, as they look like maps of the world seen from the poles.

Pick-up actually happens in three dimensions. Sound is coming at the microphone from above and below as well to the sides. So ceiling and floor surfaces have a big effect in shaping the sound that is picked up by the microphone.

To understand the pattern, imagine that you are looking down on the microphone and listening on headphones to the signal coming from it. Beneath you, someone is walking around playing an instrument. As they move into the area marked on the chart, you can hear them clearly. As they move to the edge of the pattern and beyond, the sound becomes muffled and increasingly dim.

▶WHAT IS THE PROXIMITY EFFECT?

When you sing very close to a directional microphone, the lower frequencies are enriched. This effect is used by skilful singers, presenters and announcers to colour their performances as they move closer to or further away from the microphone.

▶PHANTOM POWER

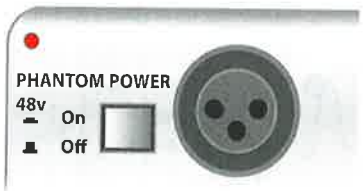
Capacitor microphones always need power and this usually comes from a mixing desk or recording machine. The power simply flows along the cable to the microphone at the same time as the signal travels from the microphone to the mixer (along the same wires). It is usually set at 48 volts, and sometimes the switch is only labelled with the voltage.



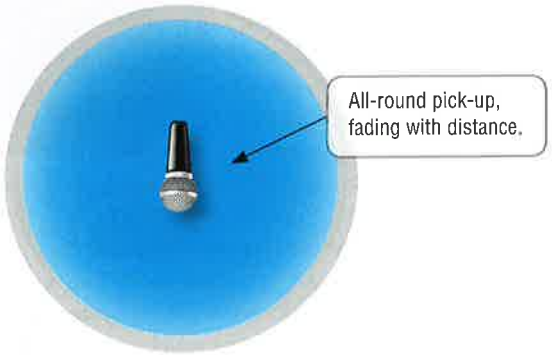
TIP

Balanced cables should be used whenever possible, and are essential when using phantom power.

It is important to put faders down and to switch off phantom power before connecting microphones.



PICK-UP PATTERNS



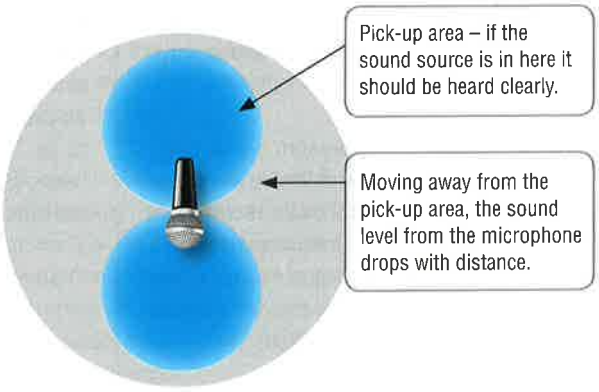
▶OMNIDIRECTIONAL (ALL DIRECTIONS)

Picks up sound well from all around it.

Advantages: Has a natural sound and will pick up room sounds and reflections if wanted.

Disadvantages: For individual recording there may be too much spill and room sound. Feedback is more likely in live situations.

Common uses: Ambient recording and close microphone for smaller groups or individuals where the spill can be controlled.



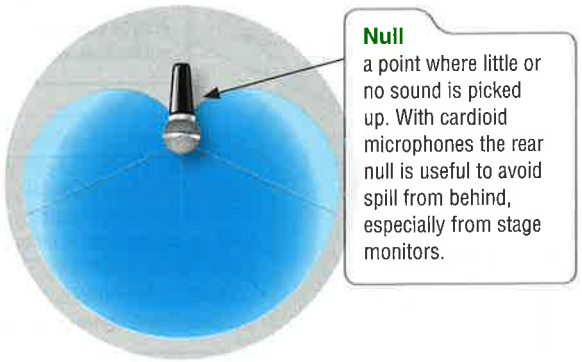
▶DIRECTIONAL: FIGURE-OF-EIGHT

Picks up sound from the front and rear – but very little from the sides.

Advantages: Good for eliminating spill from the sides.

Disadvantages: Could pick up unwanted sound from behind.

Common uses: Recordings with two vocalists either side of the mic, or an interview involving two people.



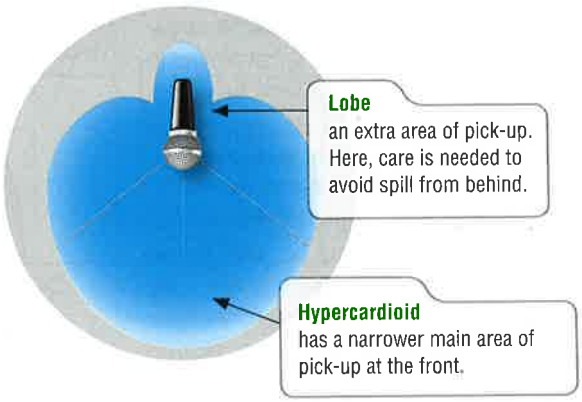
▶DIRECTIONAL: CARDIOID

Picks up sound well from the front, some from the sides and much less from behind. Named from the Greek word for heart, which the shape suggests.

Advantages: Mainly focused to the front, so little spill or room noise picked up.

Disadvantages: Needs to be used with care for close microphone vocals, as a 'boxy' sound can result depending on the acoustic space.

Common uses: Close-mic recording and live sound in many situations. Cardioid mics are used to create an ambient stereo coincident pair.



▶DIRECTIONAL: HYPERCARDIOID

Similar to cardioid but more focused to the front and has some side rejection.

Advantages: Greatly reduces the possibility of spill. Can help avoid feedback in live situations.

Disadvantages: Will pick up some sound immediately to the rear.

Common uses: Any situation in which spill is a problem, such as close-mic drums. Also useful for stage sound, where directional focus and side rejection is important.

MICROPHONE CONSTRUCTION

In any microphone, a diaphragm of some kind has to vibrate to transfer the sound wave to an audio signal.

To do this easily, the diaphragm needs to be very thin and flexible. Today, these are made of specially designed materials, sometimes only a few microns (thousandths of a millimetre) thick. In capacitor microphones, the diaphragm material is coated with a good electrical conductor such as gold.

Microphones vary in size. When they were first invented they were necessarily very large. Now they can be made small enough to fit on a circuit board and be barely visible, such as in mobile phones.

Very small microphones are also available for live sound. Some miniature capacitor microphones can capture very high-quality signals.

Capacitor microphones in particular vary in the size of their diaphragms. A larger diaphragm is often used for vocal recording – these are likely to have a wide frequency range and a 'warm' sound, responding well to the singer being directly in front (on-axis).

If you hold a large capacitor microphone up to a window, you may be able to see the diaphragm silhouetted inside the casing (see *right*). Smaller microphones have the diaphragm and associated pick-up mechanism enclosed in a 'capsule'.

Capacitor microphones with a small diaphragm are more commonly used for instrumental and ambient recordings, often off-axis (not directly in front of the sound source).

▶HIGH SOUND PRESSURE LEVELS

A kick drum microphone will have to withstand tremendous levels of air pressure when it is placed next to or inside the skin. Specialist, heavy-duty dynamic microphones are made for this purpose.



▶POP SHIELDS

When speaking or singing some consonants such as 'p' or 'b', a powerful blast of air heads towards the microphone and can cause unwanted noise. These consonant sounds are called 'plosives'.

To prevent these sounds from being picked up by the microphone, you can use a pop shield. This consists of a thin fabric stretched across a circular frame. The fabric breaks up the pressure wave from the plosive and prevents the intrusive noise that would result. You can see an example of this *below*.



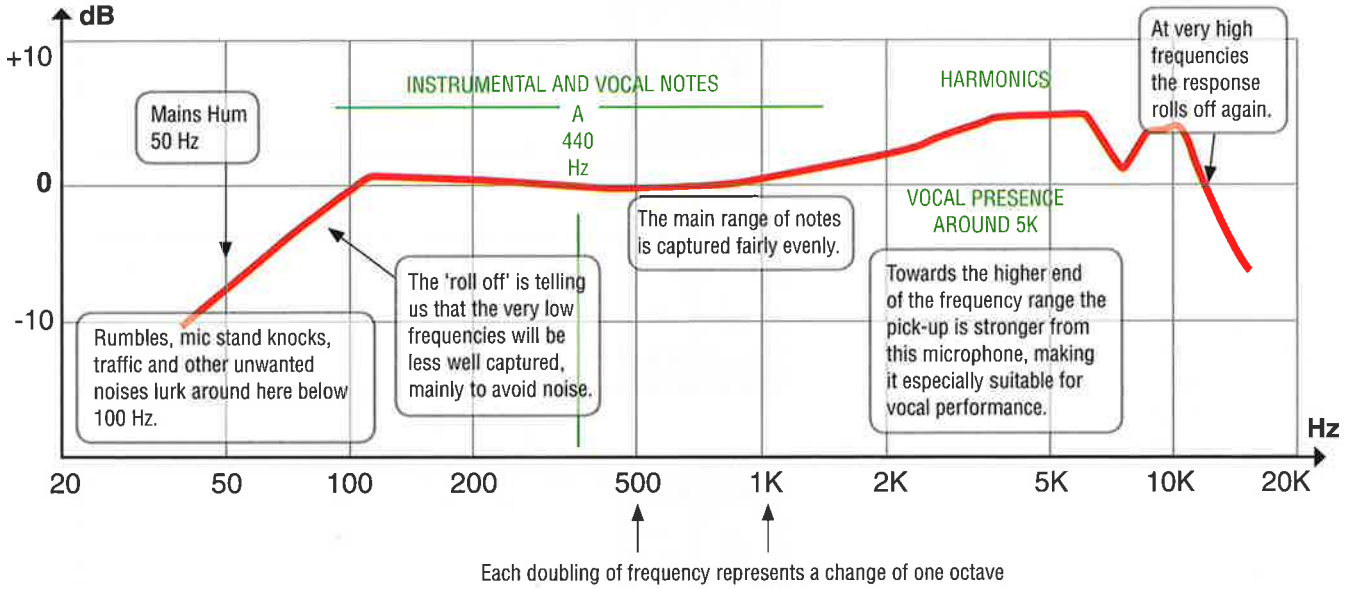
FREQUENCY RESPONSE

The range of frequencies that we can hear is roughly from 20 Hz to 20 kHz. We don't hear evenly across this range, and neither do microphones. Manufacturers supply charts showing which frequencies are more favoured or rejected by their products. Some are designed with particular instruments or circumstances in mind, and it is well worth having a look at the booklet that comes with your microphone.

When you sing or play an instrument, **overtones** are produced as well as the main (fundamental) note. These are additional notes at frequencies above the fundamental that add character to the sound. For example, although the fundamental notes you sing are likely to be in the range 100 Hz to 1 kHz, the overtone frequencies around 5 kHz are very important for the 'presence' of the voice. You can hear this by adjusting the EQ on a mixer while singing into a microphone that runs through it.

It's very important to capture the overtones of a sound for good-quality recording or amplification. The chart below shows how the capture response of a typical **dynamic** vocal microphone varies from low to high frequencies. Capacitor microphones generally have a wider frequency range that is captured more evenly, so the chart will be flatter across more of the range.

This chart shows the frequency response of a typical dynamic vocal microphone. The chart is not to scale, but is divided into frequency bands, each covering approximately one octave. Notice how at high and low frequencies the microphone picks up sounds less strongly.



Each doubling of frequency represents a change of one octave



▶ROLL-OFF

Some microphones have a switch that will reduce the sensitivity below a certain frequency to help reduce unwanted noise. The symbol for this looks like the sharp slope at the beginning of the frequency response graph *above*.



KICK DRUM MICROPHONE

The shape of the microphone body, the size of the diaphragm and the design of the pick-up components all affect the frequency response and general sensitivity. A set of drum microphones will include specialist microphones for kick drum, snare, high and low toms as well as overheads. They will vary in shape and size to reflect their different purposes.

▶MICROPHONES

In recent times the quality of microphones has improved while their price has steadily reduced.

If your budget is tight, a good choice for multi-track recording is to get a set for drums plus one or two good-quality vocal or instrumental microphones.

Large-diaphragm capacitor microphones are a popular choice for vocals. They are usually supplied with a 'spider' suspension mount, which prevents them picking up noise from vibration.

It's a good idea to keep your microphones in the original cases or a foam-lined flight case. Dynamic ones tend to be more rugged but any microphone will be damaged with very rough handling.

Use the best-quality cables you can afford and avoid treading on them. Always lower the faders on your mixer and turn off the phantom power before connecting.

Modern dynamic microphones are usually designed to ignore phantom power, but it is a good idea to turn it off to avoid surges of power through mixers and loudspeakers when you connect them.

▶TEST YOURSELF

01 What is the proximity effect?

02 Which type of microphone can use phantom power?

☐ Dynamic ☐ Capacitor

03 Which type of microphone has a wider frequency range?

☐ Dynamic ☐ Capacitor

04 Which polar pattern shows sound being picked up from all around the microphone?

05 Why do some microphones roll off the low frequencies?

06 What is the approximate frequency range of human hearing?

▶TRY THIS

☐ **Look at as many microphones as you can**. If you're at a school or college offering music technology, there should be a range of microphones available. Compare the shapes and sizes of the various types.

☐ **Read the leaflets that come with the microphones** – most have a pick-up chart and a frequency response graph. They often have a description of the characteristics with recommended uses and positioning.

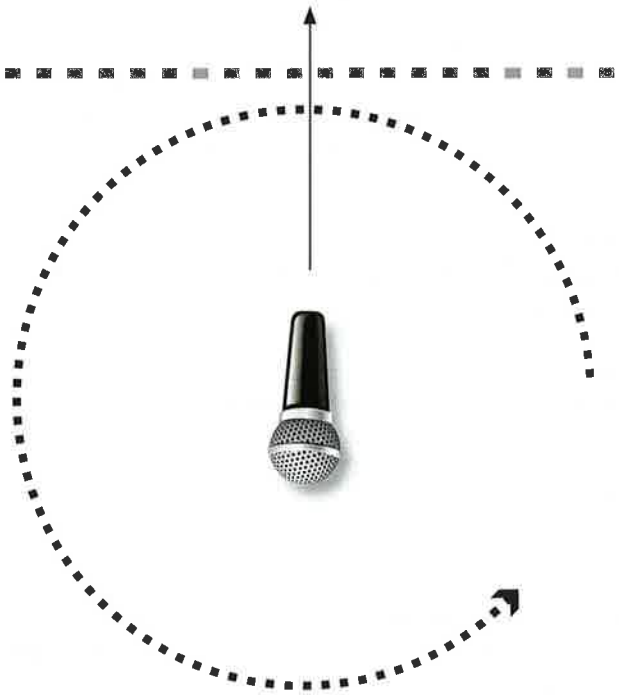
☐ **Become familiar with the well-known manufacturers and microphone types**. Some have been studio favourites for decades, and some are new to the market.

Look through magazines and websites and visit shops – you will soon notice the microphones that have made a name for themselves.

☐ **Look inside a microphone**. On some, the body or top section will unscrew. Some have adaptors to change the polar pattern. You may come across one that is broken and can be taken apart to view the structure.

☐ **Find some articles about microphone positioning**. There is an enormous amount to be learnt about using them well.

TIP
Listen in a different room if possible.



Set up a microphone in the middle of a large room. Ask someone to walk around it making a steady level of noise – perhaps describing where they are as they move around the microphone. Notice where the sound is strongest and clearest and where it becomes muffled and weak. Does it correspond with the pick-up pattern? Do the sound reflections from the wall and ceiling affect the result?