Cardioid Microphones

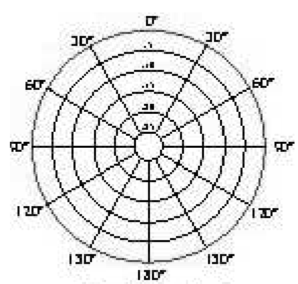
Adapted from: http://www.allchurchsound.com/ACS/edart/micbasics.html

Pickup Patterns. For live sound, there are two main types of microphone pickup patterns:

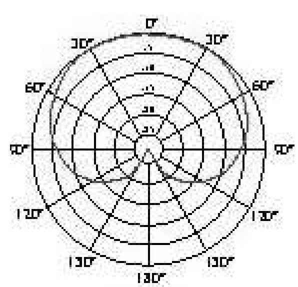
1. Omni-directional
2. Cardioid

Omni-directional microphones "hear" or pick up sound from all directions equally. Whether you speak into the front, the side, or even the back, the microphone will pick up your voice at the same volume. Omni-directional microphones are not ideal for live sound reinforcement since they can pick up the amplified sound and other noises in the room very easily and cause feedback and other problems.

A cardioid microphone blocks sound from the rear. If a child were to hold a cardioid microphone upside-down, they would not be heard too well. On the other hand, if a speaker is delivering a prepared speech, the audience would hear less rustling of notes from in front of the speaker (assuming the rear of the mike is towards the audience). The graphs below illustrate how sensitive each pickup pattern is at different angles from the top; the audibility threshold curve for the cardioid microphone is an example of a cardioid curve, and this explains the reason for such a microphone's name. The audibility at the side of the cardioid microphone is about half the audibility at the front.



Omni-Directional



Cardioid

Information about the physics of cardioid microphones appears on the next two pages.

How A Cardioid Microphone Works

Bruce Bartlett, Editor

Adapted from
http://www.prosoundweb.com/install/spotlight/cardioid/cardioidmics.shtml

As if by magic, cardioid microphones can pick up what they are aimed at, but reject sounds to the side and rear.

For example, talk into a cardioid mike from all sides while listening to its output. Your reproduced voice will be loudest when you talk into the front of the mike and softest when you talk into the rear.

Because they discriminate against sounds to the sides and rear, cardioids help reject unwanted sounds such as room acoustics (reverberation), feedback or leakage. Cardioids are the most popular choice for this reason.

How do they work? In other words, how do you make a mike directional?

Start by making an omni-directional mike. Take a mike transducer, made of a diaphragm and some hardware that changes diaphragm motion into a signal. Then put this transducer in the end of a sealed can, so that incoming sound contacts the diaphragm only on its front surface.

Sound from the front presses on the front of the diaphragm and makes a signal.

Sound from the side or rear bends around to the front of the mike. This sound also presses on the front of the diaphragm and makes a signal. So the mike responds the same to sounds from all directions. In other words, it has an omni-directional polar pattern.

Note that the omni mike becomes directional at high frequencies. That's because the mike housing blocks high frequencies that arrive off-axis.

Now suppose we put some holes in the can behind the diaphragm. We carefully size these holes and add acoustic damping such as felt or foam to create an acoustic phase-shift network. It's like an RLC circuit, which delays the signal passing through it. The holes or "rear ports" let sound into the back of the diaphragm. Also, the ports delay the sound reaching the back of the diaphragm.

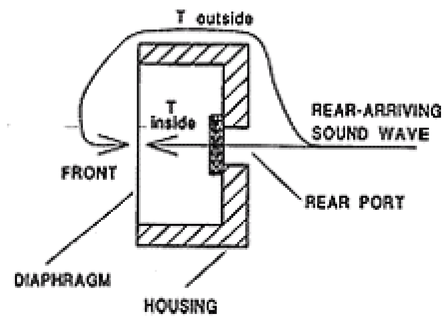


FIGURE. *Sound wave traveling outside and inside a cardioid mike*

How does this arrangement cancel sound from the rear? Suppose a sound wave approaches the mike from the rear. It travels to the diaphragm by two paths: outside the mike and inside the mike through the ports (See the Figure at the left).

Some of the sound wave travels to the front of the diaphragm, outside the mike. The sound travel time, from the rear port location to the front, is what we call **T**.

Some sound also enters the rear ports and is delayed. If the delay inside the mike is set the same as the delay outside the mike, sounds arrive at the front and rear of the diaphragm at the same time, in phase. Sounds push on opposite sides of the diaphragm, also in phase. The diaphragm cannot move, so sounds from the rear make a very weak signal. Rear sounds cancel out. You have created a cardioid polar pattern.

Sounds coming from the front do not cancel out. Why? Frontal sound waves travel to the rear ports during time **T.** Inside the mike, the phase-shift network further delays the sound by time **T.** The total delay is **2T.** Since there is a big delay or phase shift between the signals at the diaphragm's front and rear, a frontal sound makes a strong signal.

High frequencies do not reach the rear of the diaphragm because they are filtered out by the rear port's RLC filter. The cardioid mike is directional at high frequencies because its housing blocks high frequencies off-axis.

How about a bidirectional ribbon mike? The ribbon is fully open to sound on its front and rear. Sounds from the front and rear experience a phase shift as they travel around the ribbon, so you get an output signal. But sounds from the side press equally on the front and rear of the ribbon, in phase. The ribbon cannot move, so you get a weak output from side sounds.

By changing the delay of the rear ports, you can get almost any pattern between bidirectional and cardioid, such as ***supercardioid*** or ***hypercardioid*** (*graphs of the pickup patterns for these types of microphones are given at the previously quoted site*

http://www.prosoundweb.com/install/spotlight/cardioid/cardioidmics.shtml).

Each of these two patterns has a rear lobe that is in opposite polarity with the front lobe.