

Microphones | Pickup Patterns

The different types of directional patterns in microphones are a common source of inaccurate graphical representations as well as numerical data that are not entirely correct or complete. In this reference you will see a table of complete parameters as well as polar curves. Numerical data and curves are derived from accurate mathematical models.

The curves and data shown here correspond to the theoretical curves for each of the directivity patterns.

In practice, the actual patterns often deviate slightly from theory.

For example, variations between the polar graphs for different frequencies of a cardioid microphone will be observed.

Also referenced the relatively infrequently used supercardioid pattern (also called wide cardioid) as well as the subcardioid microphone.

Each type of directivity is briefly described below:

Omnidirectional. This microphone picks up sound equally from all directions.

Cardioid. This pattern is named after the shape of an idealised heart (in 3D it would look like an apple). Its rejection is total to the sound that comes from behind (180 degrees).

Subcardioid. Its response falls somewhere on between cardioid and omni, with 10 dB rejection of sound coming from behind (180 degrees) and wider frontal pickup angle.

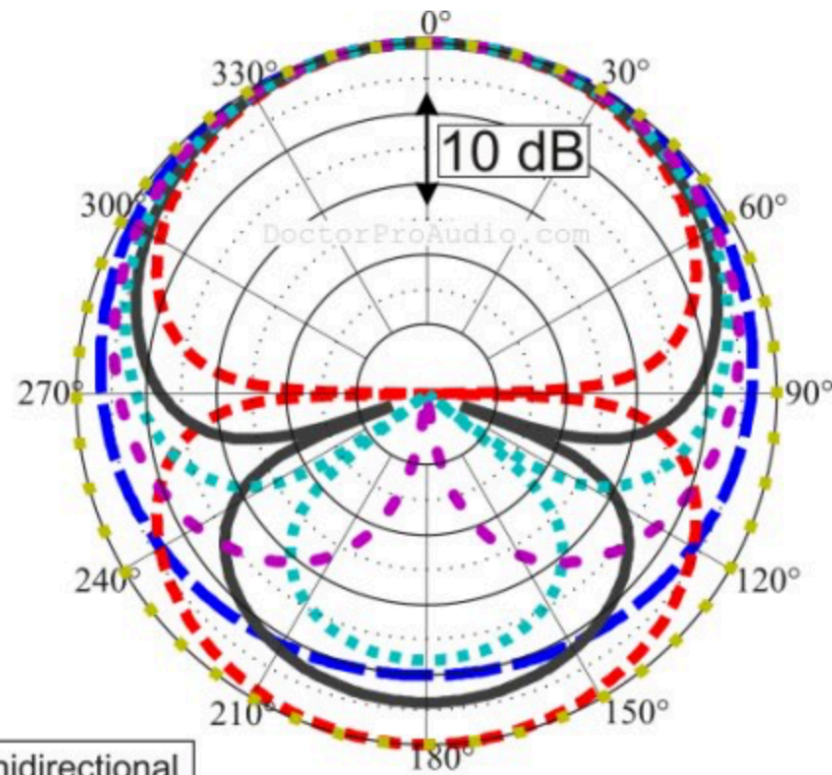
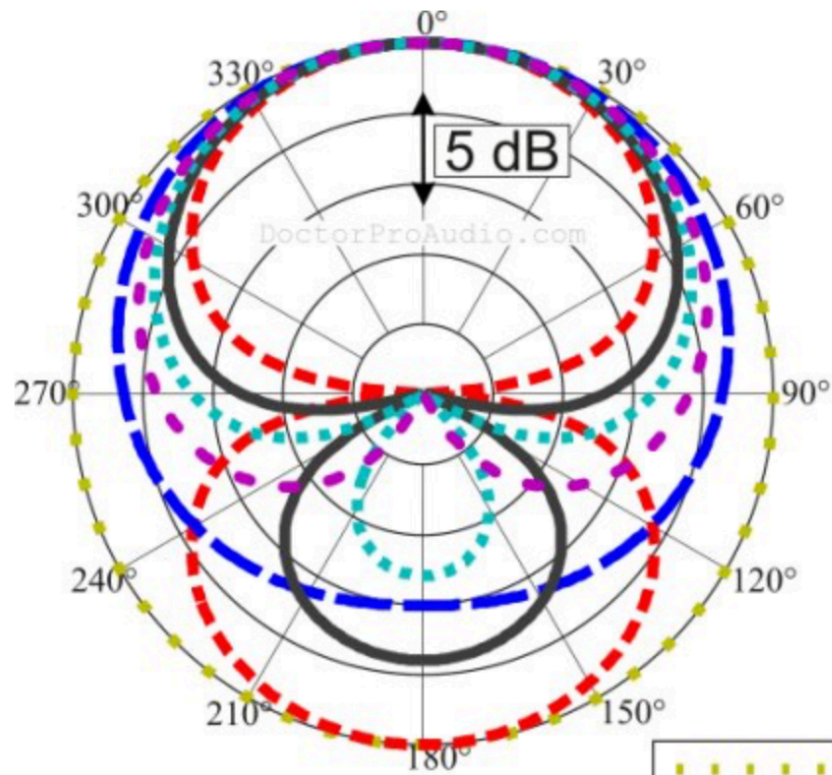
Supercardioid. This is a slightly more directional pattern than the cardioid, but with a rear lobe. Its maximum rejection angle (also referred to as the null angle) is at 127 degrees.

Hypercardioid. Similar to the supercardioid, although somewhat more directional in the front (although with a less directive rear lobe). Its maximum rejection angle is at 127 degrees.

Bi-directional. Also called "figure of eight". Its rejection is total to the sound that comes from the sides at 90 degrees and its front and rear pickup is the same.

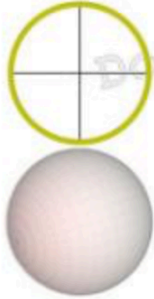
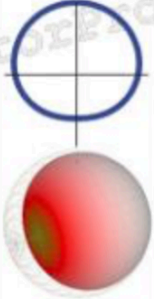
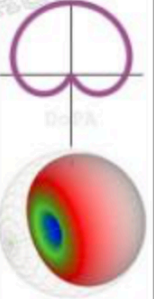
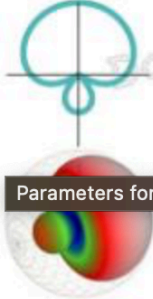


Sometimes people use the term "unidirectional", a somewhat diffuse term that encompasses cardioid, supercardioid or hypercardioid patterns. You may also see a hyphen in the names (such as sub-cardioid). **Boundary (PZM)** microphones feature hemispherical pickup characteristics (they only pickup sound from the front) and could use capsules with any of the pickup patterns covered in this article.

Shotgun microphones are the directive that the microphones described here, but they are rarely used for sound reinforcement purposes and their pickup pattern will depend on a model's specific design. Similarly, **parabolic microphones** (like a satellite dish but with a microphone) are not commonly seen in SR. There also exist microphone arrays that combine a number of capsules and can even be controlled electronically (beam-forming).



- ● ● ● ● omnidirectional
- ● ● ● ● supercardioid
- hypercardioid
- - - bi-directional
- - - subcardioid
- ● ● ● ● cardioid

The table below shows a number of parameters for the microphone pickup patterns in the polar plots

Microphone polar patterns						
Pattern	omnidirectional	subcardiod	cardiod	supercardiod	hypercardiod	bi-directional
Polar plot (2D/3D)						
-3 dB pickup angle	360°	164°	131°	116°	105°	90°
-6 dB pickup angle	360°	236°	180°	157°	141°	120°
-10 dB pickup angle	360°	360°	223°	191°	170°	143°
Relative level at 90°	0 dB	-3.6 dB	-6 dB	-8.5 dB	-12 dB	- inf
Relative level at 180°	0 dB	-9.9 dB	- inf	-12.0 dB	-6 dB	0 dB
Angle of maximum rejection (null angle)	---	180°	180°	+/- 127°	+/- 110°	+/- 90°
Directivity Q factor (DI, directivity index)	1.0 (0 dB)	2.1 (3.2 dB)	3.0 (4.8 dB)	3.7 (5.7 dB)	4.0 (6.0 dB)	3.0 (4.8 dB)
UI (Unidirectional Index)	0 dB	4.5 dB	8.5 dB	11.4 dB	8.5 dB	0 dB
Distance factor	1	1.4	1.7	1.9	2	1.7

NOTES:

- The pickup or acceptance angle is equivalent to a loudspeaker's coverage angle, though for microphones a 3 dB attenuation level is more commonly used. The table provides the angles for additional attenuation levels for comparison.
- "-Inf" stands for minus infinite, i.e. absolute rejection. In practice, the attenuation of a cardioid microphone at 180 degrees is between 10 and 25 dB, depending on the frequency and microphone.
- The unidirectional index (UI or UDI) represents the difference between front and rear energy pickup.
- DI = Directivity index. This is the decibel representation of the Q factor. Check the article titled 'A game of numbers. Understanding directivity specifications' for more info on that.
- The distance factor represents the relative distance, referenced to an omnidirectional microphone, from which the microphone picks up the same ratio between direct sound and reverberant sound. For example, a cardioid mic may be placed 1.7 times further back than an omnidirectional to achieve the same direct-to-reverberant sound ratio as an omnidirectional microphone. This distance factor is also related to the distance at which the microphone must be placed to prevent feedback.
- Table based on coefficients 1, 0.66 (some might use 0.75), 0.5, 0.375, 0.25 and 0 respectively.

Below are the different patterns compared graphically in detail. Although we have represented them in two dimensions, the patterns are three-dimensional. I.e., if we have, for example, minimum pickup (maximum rejection) at 90 degrees to the right and to the left in a bidirectional microphone, we will also have it at 90 degrees up and down.

The graph on the left uses a scale of 25 dB, which is the scale typically used for microphones. For reference and comparison, we have also plotted the data with a scale of 50 dB (right), which is the most common scale for loudspeakers (yes, a hypercardioid is not really that directive when compared to a loudspeaker):