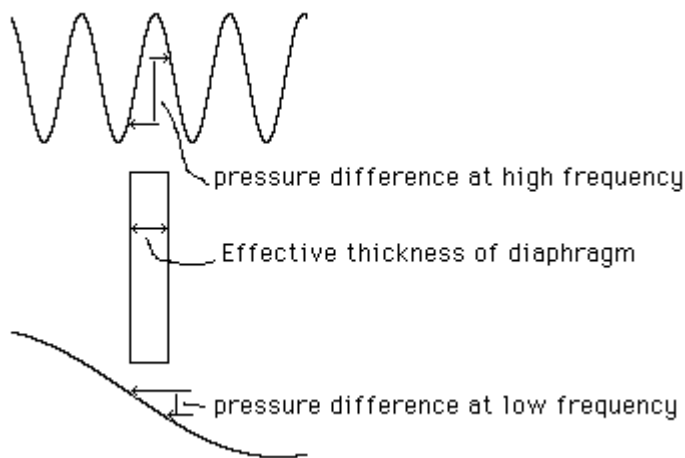


Proximity Effect

When you get close to a cardioid or bidirectional mic, the bass is exaggerated. Why does this happen? First we have to examine what is making the microphone diaphragm move in the first place.

Pressure Gradients

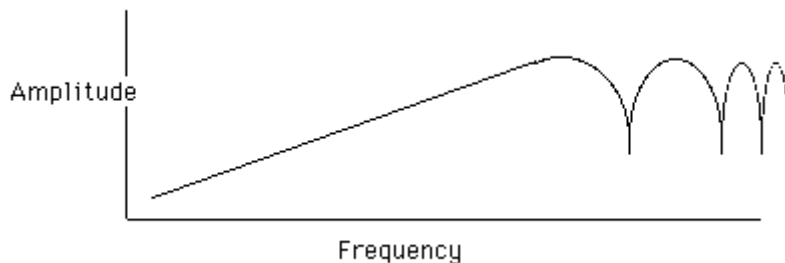
The diaphragm will move when the pressure behind it is different from the pressure in front. If we have an omni mic, the pressure behind the diaphragm is always the same because it is enclosed. On a cardioid or bidirectional mic, the pressure on the back changes just as the front pressure does, but a bit later, because the sound waves have further to go, traveling around the diaphragm, and through whatever delay structure is there to provide a cardioid pattern. (See Pickup Patterns). I can illustrate this by imagining the diaphragm is rather thick:



As you can see, with a high frequency sound, there is a large difference in pressure between the front and rear of the diaphragm. With a low frequency sound of the same amplitude, the pressure difference is less. This means the diaphragm is going to move more vigorously at high frequency and the electrical output will be higher.

Comb Filtering

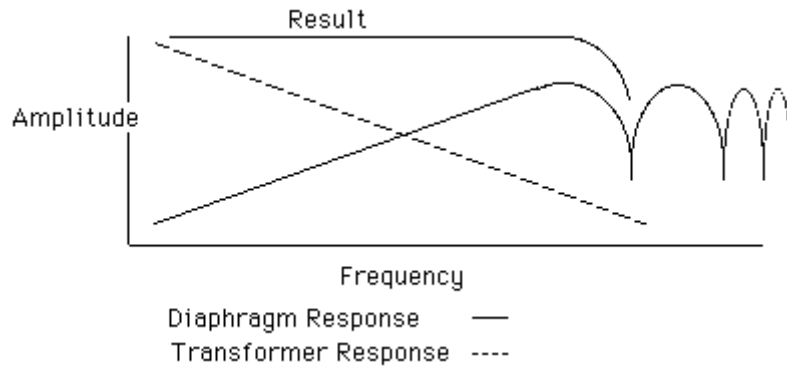
This only works up to a point. Eventually, as the wavelength gets down to twice the effective thickness of the diaphragm, the pressure difference falls. (In fact, the drawing shows this situation. The output was maximum when the wavelength was four times the thickness.) A graph of the output looks like this:



The output falls to nothing at a magic frequency, then rises again only to fall at the second harmonic of that frequency and so on, with a null at each harmonic. This kind of behavior is called comb filtering. We don't usually have to worry about the nulls except to make sure that they fall above the range of hearing. The steadily rising response through most of the range must be compensated for electrically.

Compensation

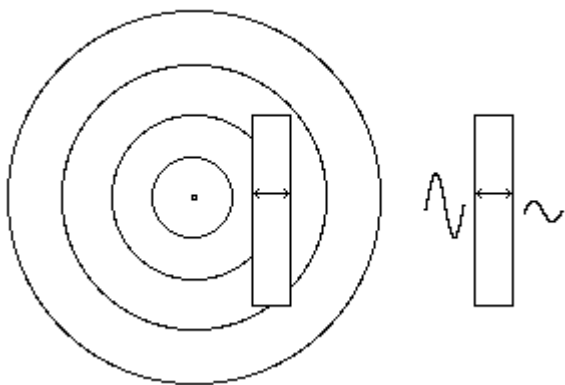
Luckily, it's very easy to get a complimentary response (that falls as the frequency rises) from the output transformer. The two compliment each other to provide a more or less flat response:



Real diaphragms and transformers do not have such perfect response curves, so the result is usually rather bumpy.

Up Close, in the Spherical Sound Field

This is all well and good, and shows how tricky it is to design a microphone, but where does the proximity effect come in? It turns out that propagation delay is not the only reason the pressure might be different on the back of the diaphragm. The back of the diaphragm is further from the source than the front, therefore the amplitude of the pressure waveform is less.



This is insignificant at any large distance, because of the inverse square nature of the relationship, but if the microphone is close to the source, the majority of the signal is produced this way. This mechanism is not affected by frequency, but remember the deliberate rise in low frequency response of the transformer? That combined with the flat diaphragm response obtained up close results in accentuated lows.

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