Large vs. small microphone diaphragms – Part 1

http://www.dpamicrophones.com/en/Mic-University/Technology-Guide/Large-Diaphragm.aspx

	Small Diaphragm	Large Diaphragm
Self Noise	Higher	Lower
Sensitivity	Low	High
SPL Handling capability	High	Lower
Frequency Range	Wide	Narrower
Influence on sound field	Small	Large
Dynamic Range	Higher	Lower

Before choosing between a large and a small diaphragm microphone it is important to know the difference in features between them, and microphone behavior can not be compared with that of a loudspeaker when considering size.

A large diaphragm microphone is not better at reproducing low-frequencies, but it may be less precise in reproducing high frequencies, which may make it sound as if it has more low end.

Both diaphragm sizes have their respective advantages and disadvantages. This is illustrated in the table to the left.

A small diaphragm has a higher self noise due to the fact that the small diaphragm is less compliant and therefore more sensitive to the bombardment of air molecules that causes some of the self noise of a microphone. And since the large diaphragm is softer than the small, it is easier to move and therefore more sensitive – even at very low levels. This means that the small diaphragm, because it's stiff, can handle a higher sound pressure without clipping or distortion, but is less sensitive and needs more amplification, which also adds a little noise.

When reproducing very high frequencies, large diaphragm microphones have a more limited range than the small diaphragms. This is caused by three factors:

1. A large diaphragm tends to break up and will no longer act as a true piston. This phenomenon is also recognized in loudspeaker technology and is the reason why loudspeakers are manufactured with different sizes of diaphragms to handle different frequencies.
2. The weight of the diaphragm will attenuate the displacement of the diaphragm for higher frequencies.
3. The diffractions around the edges of the microphone capsule will limit the microphone's capability to handle very high frequencies.

Diaphragm Size	Small 4004 (Ø12mm)	Medium 4003 (Ø16mm)	Large 4041-S (Ø24mm)
Self Noise	Higher 24 dB (A)	Lower 15 dB (A)	Lowest 7 dB (A)
Sensitivity	Low 10 mV/Pa	High 40 mV/Pa	Highest 90 mV/Pa
SPL Handling 1% THD @ Max SPL	High 148 dB SPL 168 dB SPL	Lower 135 dB SPL 154 dB SPL	Lowest 126 dB SPL 144 dB SPL
Frequency Range	Wide 20Hz - 40kHz	Narrower 20Hz - 20kHz	Narrower 20Hz - 20kHz
Influence on sound field	Little	Medium	Larger
Dynamic Range	High 124dB	Lower 120dB	Lowest 119dB

Conclusion

Both diaphragm sizes have their respective advantages and disadvantages. This is illustrated in this table, which compares the specifications of DPA's small, medium and large diaphragm microphones:

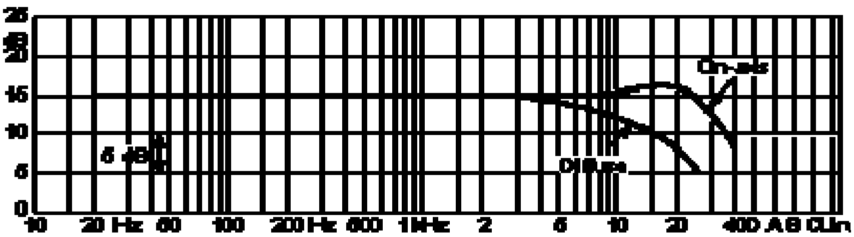
How to read microphone specifications

When you read microphone specifications in order to compare different microphones, it is extremely important that you understand how to interpret them. In most cases the specifications can be measured or calculated in many different ways. This article is designed to help evaluate specifications in a meaningful way.

While microphone specifications provide an indication of a microphone's electro-acoustic performance, they will not give you the total appreciation of how it will sound – just as it is with cars. Knowing that it is a 3.0 turbo-engine with 4WD gives you an idea of a pretty good driving experience, but for the exact feeling, you need to drive the car yourself.

Frequency range/ frequency response

Frequency range tells you the range of the frequencies (for example 20 Hz to 20 kHz) that the microphone can pick up and reproduce, but not how well the different frequencies are reproduced. To see that you need the frequency response:



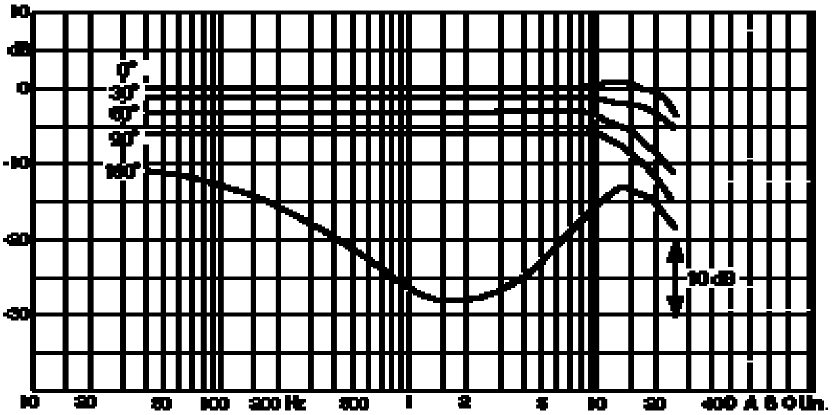
Ex. DPA Type 4006 Omnidirectional Microphone, P48

Here you see how linear the response is or if the microphone has any 'spikes', but pay attention to the scale on the left. The number of dB each step represents can vary a lot.

Large vs. small microphone diaphragms – Part 2

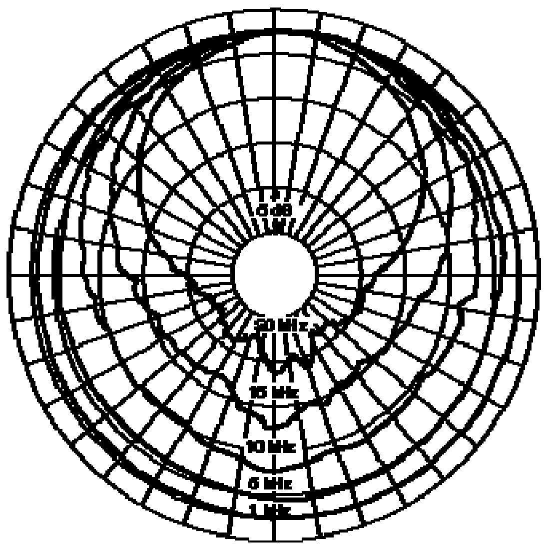
The frequency response normally refers to the ‘on axis’ response, which means from a sound source right in front of the microphone. The diffuse field response curve will illustrate how the microphone will respond in a highly reverberant sound field.

The off-axis response is also important to examine. A microphone always takes in sound from the sides too, the question is just how much and how good it sounds. In particular, directional microphones can, in their attempt to suppress sound from the sides, get an uneven off-axis response:



On-and off-axis responses of Types 4011/12/21/22/23 cardioid microphones measured in 30 cm

Finally a polar plot can show the 360° response of selected frequencies. The response curves should be smooth and symmetric to show an uncolored sound. Extreme peaks and valleys are unwanted and the response curves should not cross each other. From the polar diagram you can also see how omnidirectional microphones usually become more directional at higher frequencies.



Type 4006 Omnidirectional Microphone

Equivalent noise level / self noise

The equivalent noise level indicates the sound pressure level that will create the same voltage that the self-noise from the microphone will produce. A low noise level is especially desirable when working with low sound pressure levels so the sound will not "drown" in noise from the microphone itself. The self-noise also dictates the lower limitation in the microphone's dynamic range.

There are two typical standards:

1. The dBA scale will weight the SPL according to the ear's sensitivity, especially filtering out low frequency noise. Good results (very low noise) in this scale are usually below 15 dBA.
2. The ITU-R BS.468-4 scale uses a different weighting, so in this scale, good results are below 25 dB.

Sensitivity, Sound Pressure Level (SPL) handling & Total Harmonic Distortion (THD)

Sensitivity tells you how well the microphone can convert the acoustic sound into electricity and according to the IEC 60268-4 norm, the sensitivity is measured in mV per Pascal (air pressure) at 1 kHz. The higher the sensitivity the better it is, because it reduces the need for amplification and therefore reduces the amplification noise.

SPL handling tells you how much sound pressure in dB the microphone can handle before it either clips (the diaphragm hits the back plate or the amplifier overloads) or reaches a certain level of distortion (THD or total harmonic distortion), typically either 0.5 % or 1 %. The higher the level of sound pressure before clipping or distortion the better it is.

Example: Type 4004 Hi-SPL Omnidirectional Microphone, 130 V: Maximum sound pressure level: 168 dB SPL, Total harmonic distortion: 142 dBSPL (<0.5 % THD), 148 dBSPL (<1% THD)