Microphone University

The Pro Audio Learning Center

How to read microphone specifications

By Mikkel Nymand

Gydevang 42-44, 3450 Alleroed, Denmark • Phone +45 4814 2828 • Fax +45 4814 2700 •

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By Mikkel Nymand (Tonmeister), DPA Microphones A/S

When you read microphone specifications, 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.

What you *cannot* determine from specifications

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. Specifications can detail objective information but cannot convey the subjective sonic experience. For example, a frequency response curve can show you how faithfully the microphone will reproduce the incoming pure sinusoidal frequencies, but not how detailed, well dissolved or transparent the result will be.

The decibel (dB) scale

The basis for most microphone specifications is the decibel scale. The dB scale is logarithmic and is used because of its equivalence to the way the human ear perceives changes in sound pressure. Furthermore, the changes in dB are smoother and more understandable than the very large numbers that might occur in pressure scales (Pascal, Newton or Bar). ***The dB scale states a given pressure in proportion to a reference pressure***, mostly 20 µPa. The reference pressure 20 µPa is chosen equal to 0 dB. Please note that 0 dB does not mean, that there isn't any sound; it only states the lower limiting sound pressure level of the average human ear's ability to detect sounds.

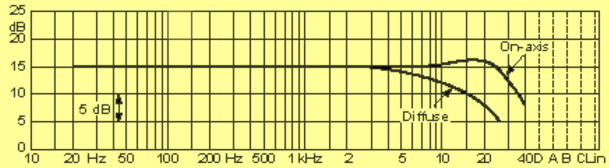
Frequency Response

The frequency response curve illustrates the microphone's ability to transform acoustic energy into electric signals, and whether it will do so faithfully or will introduce colouration. ***Take care not to mistake frequency response for frequency range***. The microphone's frequency range, will only give you a rough indication of which frequency area the microphone will be able to reproduce sound within a given tolerance. The frequency range is sometimes also referred to as "bandwidth".

Example: DPA Type 4006 Omnidirectional Microphone, P48:

Frequency Range:
On-axis: 20Hz - 20kHz ±2dB

Frequency Response:



Multiple frequency response curves

Manufacturers of professional equipment will always provide more than one frequency response curve, as it is essential to see how the microphone will respond to sound coming from different directions and in different acoustic sound fields.

On-axis response

The on-axis response demonstrates the microphone's response to sound coming directly on-axis towards its diaphragm (0°). ***Be aware that the on-axis response may be measured from different distances***, which may influence the response on directional microphones because of the proximity effect.

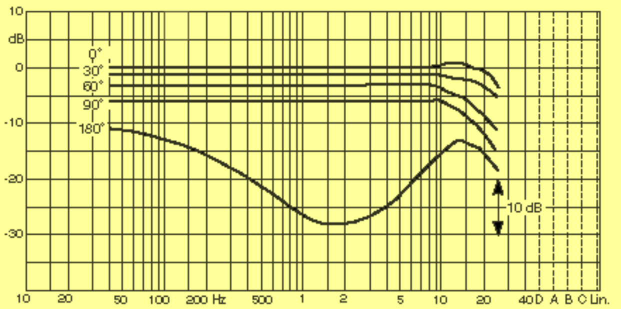
Diffuse field response

The diffuse field response curve will illustrate how the microphone will respond in a highly reverberant sound field. This will be an acoustic environment where the sound has no specific direction but where all directions are equally probable. The reflections from walls, floor, ceiling etc. are as loud or louder than the direct sound and the sound pressure level is the same everywhere. This is especially interesting when considering omnidirectional microphones, because they are able to register the full frequency range in the lower frequencies. The diffuse field response will show a roll-off in the higher frequencies, partly due to the air's absorption of higher frequencies.

Off-axis responses

The off-axis responses will reveal the microphone's response to sound coming from different angles. This is particularly interesting when you want to discover how a directional (i.e. cardioid) microphone will eliminate sound coming from other angles than directly towards the diaphragm. Even though the off-axis responses are attenuated on directional microphones, it is of extreme importance that these curves also show a straight frequency response, as it will otherwise introduce an off-axis coloration (curtain effect).

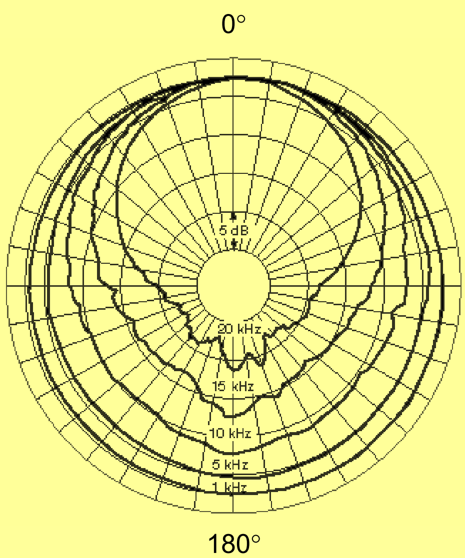
Example: DPA Type 4011, Cardioid Microphone, P48:



Polar Response

A polar diagram is used to show how certain frequencies are reproduced when they enter the microphone from different angles. The polar diagram can provide an indication of how smooth (or uneven) the off-axis coloration will be.

Example: DPA Type 4006 Omnidirectional Microphone, P48:



A reference point on the outer circle is defined, often by a 1kHz sinusoidal tone aiming the microphone directly towards its diaphragm (0° = on top of the circle). Each shift between emphasised circles normally indicates a -5 dB step, unless otherwise indicated. In this way you will be able to determine how much weaker the signal will be around the microphone for certain frequencies, commonly 5kHz, 10kHz, 15kHz and 20 kHz.

The response curves should be smooth and symmetric to show an uncoloured 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.

Equivalent noise level

The equivalent noise level (also known as the microphone's self-noise) indicates the sound pressure level that will create the same voltage, as 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 dB(A) 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 dB(A).
2. The CCIR 468-1 scale uses a different weighting, so in this scale, good results are below 25 - 30 dB.

Example: Type 4041-S Omnidirectional Solid State Microphone

Equivalent noise level A-weighted:
Max. 7dB(A) re. 20 µPa

Equivalent noise level CCIR 468-1:
Max. 19dB

Sensitivity

Sensitivity expresses the microphone's ability to convert acoustic pressure to electric voltage. The sensitivity states what voltage a microphone will produce at a certain sound pressure level. A microphone with high sensitivity will give a high voltage output and will therefore not need as much amplification (gain) as a model with lower sensitivity. In applications with low sound pressure levels, a microphone with a high sensitivity is required in order to keep the amplification noise low.

According to the IEC 268-4 norm, the sensitivity is measured in mV per Pascal at 1kHz (measuring microphones at 250 Hz). As an alternative, the sensitivity can be submitted according to the American tradition, which states the sensitivity in dB, relatively to 1V/Pa, which will give a negative value. A serious microphone manufacturer will also state tolerances in sensitivity, according to production differences - such tolerances would normally be in the region of 2 dB.

Example: DPA Type 3530 A-B Stereo Kit, P48:

Sensitivity:
Nominally 10mV/Pa; -40dB re. 1V/Pa unloaded (at 250Hz) Max difference 1dB

SPL handling capability

In many recording situations it is essential to know the maximum Sound Pressure Level (SPL) the microphone can handle. ***Please note that in most music recording maximum peak SPL's easily supersede the RMS value by more than 20dB.***

The RMS value indicates an average SPL and will not show the true SPL peaks.

It is important to know

1. The SPL where a certain Total Harmonic Distortion (THD) occurs.
2. The SPL where the signal from the microphone will clip, that is the waveforms will become squares. This is the term: Max. SPL and it refers to peak values in SPL.

A commonly used level of THD is 0,5% (1% is also often seen), which is the point where the distortion can be measured, but not heard. ***Ensure that the THD specification is measured for the complete microphone (capsule + preamplifier),*** as many manufacturers only specify THD measured on the preamplifier, which distorts much less than the capsule. The distortion of a circular diaphragm will double with a 6dB increase of the input level, so you can calculate other levels of THD by using this factor.

Example: Type 4004 Hi-SPL Omnidirectional Microphone, 130V

Maximum sound pressure level:
168dB SPL peak

Total harmonic distortion:
142dB SPL peak (<0.5% THD)
148dB SPL peak (<1% THD)

Conclusion

Microphone specifications do not tell the whole story about a microphone's quality, and are no substitute for the sonic experience. Although microphone specifications may not be fully comparable between manufacturers, when properly evaluated they do provide useful objectivity and will help in the search for the optimal microphone.