How to read Microphone specifications

by Mikkel Nymand

DPA MICROPHONES

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When reading microphone specifications, it is extremely important to 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 can and 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 shows 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.

The dB scale can be used for quantifying absolute sound pressure levels. In this case the reference is 20 µPa that is referred to as 0 dB SPL or 0 dB re 20 µPa.

The dB scale is also found on frequency response curves. Here 0 dB is a reference output (a voltage), basically the sensitivity of the microphone.

Power supply

This defines the type of power supply used for the microphone. For DPA microphones it is either P48 (48 V Phantom supply), 130 V (from the dedicated HMA5000 high-voltage supply), or 5-50 V (via DPA adapters) for the miniature microphone types.

Phase

Phase equals time and phase shifts can be explained as changes in time arrival of specific frequencies. If a microphone treats frequencies with mutual different timing, phase shifts occur. It is also important that matched microphones used for stereo or surround recordings exhibit matching phase characteristics, preferably a maximum of 10° in the frequency range the microphone type is specified within.

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 high sensitivity is required in order to keep the amplification noise low. The sensitivity is measured in the free field at 250 Hz (omnidirectional microphones) or at 1 kHz (directional microphones). A serious microphone manufacturer will also state the tolerances in sensitivity, according to production differences - such tolerances would normally be in the region of 2 dB.

Example:

4006 Omnidirectional Microphone, P48
Sensitivity, nominal: ±2 dB: 10 mV/Pa; -40 dB re. 1 V/Pa

Equivalent noise level

The equivalent noise level (also referred to as the microphone's self-noise) indicates the sound pressure level that will create the same voltage as the self-noise from the microphone produces. 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 indicates the lower limitation in the microphone's dynamic range. When expressed in "dB(A)", a special frequency weighting - called A-weighting - has been used. This weighting corresponds roughly to the way the human may perceive the noise. The level is carried out using a so-called RMS detector. Good results (very low noise) expressed this way are usually below 15 dB(A).

Example:

4041-S Large Diaphragm Microphone, Solid State, 130 V

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

Signal to noise ratio, S/N

The signal to noise ratio, or S/N, expresses the relation between a reference sound pressure level and the A-weighted equivalent noise level (self-noise). The reference sound pressure level is 94 dB re. 20 µPa. Hence the signal to noise ratio is 94 dB minus the equivalent noise level.

Example:

4041-T2 Large Diaphragm Microphone, Tube, 130 V
S/N ratio, re. 1 kHz at 1 Pa (94 dB SPL): 85 dB

Dynamic Range

The range from the equivalent noise level in dB(A) to the SPL where 1%THD occurs. Beyond this value a headroom up to the clipping point will be obtained.

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 recordings maximum peak SPLs easily supersede the RMS value by more than 20 dB. 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 percentage 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 6 dB increase of the input level, so you can calculate other levels of THD by using this factor.

Example:

4004 Reference Microphone, 130 V
Maximum sound pressure level: 168 dB SPL peak
Total Harmonic Distortion: <0.5% up to 142 dB SPL peak, <1% up to 148 dB SPL peak

Output Impedance

The Impedance is defined as the microphone's internal impedance, measured between the output terminals.

Polar pattern

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

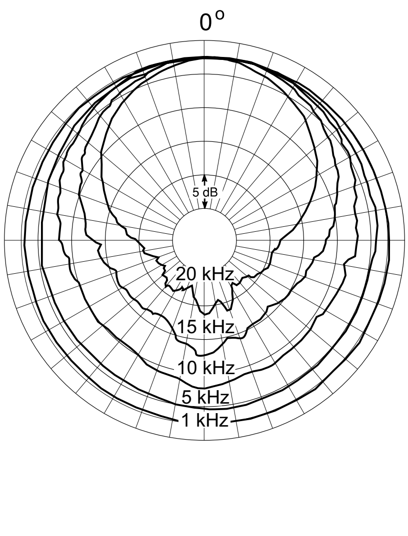
A reference point on the outer circle is defined, often by a 1 kHz sinusoidal tone aiming the microphone directly towards its diaphragm (0° = on top of the circle). Each shift between emphasised circles normally indicates a -5 dB step, unless otherwise indicated. In this way you will be able to determine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

Normalised means that every frequency pattern is set to 0 dB at 0°.

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 pattern you can also see how omnidirectional microphones usually become more directional at higher frequencies.

Example:

4006 Omnidirectional Microphone, P48 with DD0251 Free-field Grid (normalised)

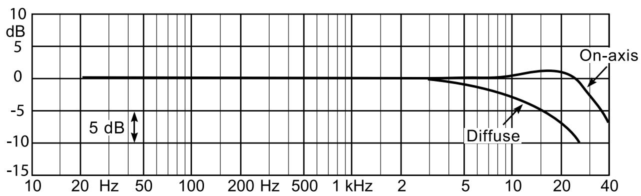


Frequency response

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 in, and within a given tolerance field. The frequency range is sometimes also referred to as "bandwidth"

Example:

4006 Omnidirectional Microphone, P48
Frequency Range:
On-axis: 20 Hz – 20 kHz ±2 dB



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

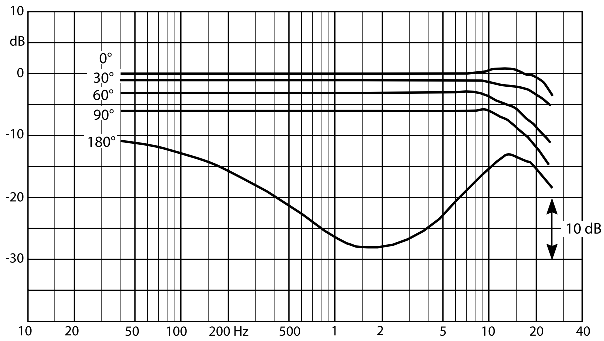
The diffuse-field response curve will illustrate how the microphone will respond in a highly reverberant sound field. This will be an acoustic environment where the sound has no specific direction but where all directions are equally probable. The reflections from walls, floor, ceiling, etc., are as loud as or louder than the direct sound and the sound pressure is more or less constant throughout the room. 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 compared to on-axis measurements in the free-field.

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 angles other 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 colouration (curtain effect).

Example:

4011 Cardioid Microphone, P48
On and off-axis responses of 4011 measured in 30 cm (1 ft).



Proximity effect

Proximity effect is an inherent characteristic of pressure gradient microphones, resulting in a boost in the low-frequency response when the microphone is brought closer to a source and a roll-off when moved farther from the source.

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.