ISCE

The Institute of Sound and Communications Engineers

Engineering Note 30.1

The dynamic range of a microphone

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The dynamic range of a microphone

This Engineering Note was prompted by someone asking why microphone manufacturers do not specify the dynamic range and why it is not mentioned in IEC/EN 60268-4.

It's easy to see what the dynamic range must be - the difference between the highest sound pressure level (SPL) the microphone will handle and the lowest SPL it can convert to an electrical signal. But both of those are 'moveable feasts', and that's where the problem arises.

Highest sound pressure level

In most cases, this is limited by non-linearity, producing harmonic (and, inevitably, intermodulation) distortion. Not always; a ribbon mic in front of a trumpet will have the ribbon snapped before it has a chance to distort!

So, how much distortion (on very loud peaks) can you accept? The answer is usually, 'quite a lot' - 10% is quite a useful guide. What really matters is how abrupt is the rise in distortion with increasing SPL, and this varies between designs, like the different behaviour of amplifiers with large and small amounts of negative feedback. Large amounts give a very abrupt rise in distortion with input level, while small amounts give a 'softer' overload at the expense of perceptible distortion at levels below the maximum. Of course, some types of microphone, such as dynamics, don't have on-board electronics, so there is no effect due to negative feedback, but the same sort of effect occurs according to how the diaphragm suspension stiffens up at its extremes of travel.

However, some sounds, mostly produced by musical instruments, are unusually degraded in quality by quite small amounts of distortion, so for those sounds, the maximum SPL has to be lower, or a more linear microphone used. On the other hand, many microphones used in our field are not exposed to very loud sounds when in use, so the real 'highest sound pressure level' is that experienced in the programme, and is independent of the microphone characteristic.

Lowest sound pressure level

There is, of course, no such thing as silence. Not even in Outer Space - there are still a few billion vibrating gas molecules floating about in each cubic light-year. In air, the reference level for SPL (0 dB SPL, 20 µPa in pressure terms) is approximately the sound level due to the thermal vibration of the molecules in the air. But only people with good hearing can hear that, and then only in an isolated room. All microphone and amplifier combinations have inherent electrical noise which corresponds to a sound level several decibels above 0 dB SPL. For example, a 25 mm diameter precision measurement capacitor microphone, with its cathode-follower, has a noise level corresponding to 15 dB SPL. The acoustic noise level, even in a very quiet normal room, is rarely less than 30 dB SPL. Obviously, for practical purposes, the 15dB noise level of the microphone is irrelevant when it is used in a normal room.

No single value

So we can see that for microphones used in our field (as opposed to measurement microphones used in anechoic or isolated rooms) the practical dynamic range is limited at the low end by the 'quiet' acoustic noise level and at the high end by the 'loud' sound level, which we hope is a wanted sound and not something going 'bang!'.

It simply isn't helpful for a manufacturer to specify a dynamic range. IEC 60268-4 requires the specification of the 'equivalent sound pressure level due to inherent noise' and the overload sound pressure at a specified distortion, so you can, if you really want to, calculate the 'ultimate dynamic range', but it is almost always irrelevant.