It's all about the bass

KEITH HOWARD TAKES AN IN-DEPTH LOOK AT ONE OF THE MOST DIFFICULT ASPECTS OF THE COMPLICATED PROCESS OF MEASURING A LOUDSPEAKER'S PERFORMANCE – EXPLORING WHAT HAPPENS IN THE LOWER FREQUENCIES

Time was when if you wanted to measure a loudspeaker's frequency response with acceptable accuracy, you needed either an extremely large anechoic chamber or a hoist – typically hydraulic, although more practicable pneumatic ones are now available – to lift the speaker (and measurement microphone) high off the ground. Both are means of obviating the effects of reflection, to give something close to a true free-field measurement.

Both are also, for most people who might want to measure loudspeakers, impractical and/or prohibitively expensive. Even quite large loudspeaker manufacturers often don't boast an anechoic chamber which works well to low bass frequencies (for which it needs to be large), while the hoist option – although cheaper – is prone to the vicissitudes of wind and rain, particularly in a climate like the UK's. You might also discover, as I believe James Moir did decades ago, that your neighbours don't take too kindly to strange noises emanating from loudspeakers atop a pole.

Plus there are obvious practical difficulties involved with hoisting a loudspeaker high into the air. When Raymond Cooke assessed this technique in one of the early KEFTOPICS [1] he concluded that the speaker needs to be at least 8m – 26 feet – above ground level for a microphone distance of 1m above the speaker, which was assumed to be laid on its back firing upwards. It would take a courageous development engineer or reviewer (that's 'courageous' in the *Yes Minister* meaning of the word!) to even contemplate hoisting, say, a B&W 801 D4 (101kg) to such a height, let alone a Wilson Audio Alexandria XLF (297kg).

Democratisation of loudspeaker measurement arrived in the 1980s with the introduction of quasi-anechoic measurement hardware/software in the form of Doug Rife's MLSSA (Maximum-Length Sequence System Analyzer) and Richard Heyser's TDS (Time Delay Spectrometry), both of which allowed the effect of reflections to be removed from the measurement. Suddenly it was possible to measure loudspeakers in normal, reverberant rooms – Alleluia! But this new-found freedom came at a cost.

Let's assume the use of MLSSA at this point, as this is the technology (if not the commercial realisation) which eventually won out and, in modified form, typically utilising a sound card rather than MLSSA's dedicated computer board, is still widely used today in products from a variety of software providers. (I use Arta Labs' ARTA for my loudspeaker and headphone measurements, although alternative packages are also available.)

The outcome of a MLSSA – or MLSSA-like – measurement is an impulse response (IR), but the test signal is not an impulse or train of impulses because the low signal energy gives rise to signal-to-noise problems. Instead a periodic noise signal is used (a maximum length sequence in MLSSA's case, although other methods of generating periodic noise are often now used instead, as are logarithmic sine sweeps) and the impulse response of the loudspeaker extracted by cross-correlating the source signal with that captured by the measurement microphone. An example loudspeaker impulse response obtained this way, using ARTA, is shown in Figure 1, from which you can see how easy it is to apply a time window which includes the loudspeaker's initial output (beginning here at 2.9ms) while excluding that part corrupted by room reflections (beginning at 7.0ms, allowing a window of 4.1ms).

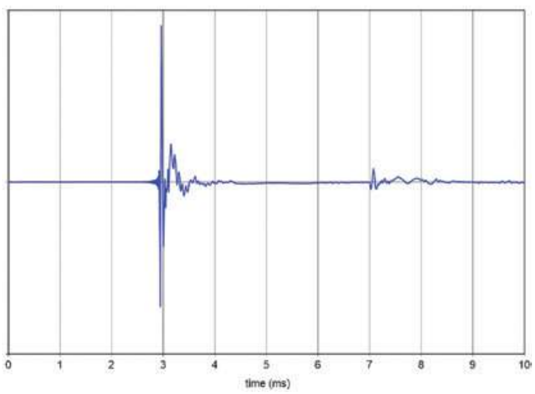

Figure 1. Example of a loudspeaker impulse response measured in a reverberant room. As the microphone was positioned 1m from the loudspeaker, there is a 'time of flight' delay of 2.9ms before the loudspeaker response begins. The first reflection arrives at 7.0ms, allowing a quasi-anechoic time window of 4.1ms