Inside the CM10, part one: All-new tweeter technology

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CM10 is the new flagship loudspeaker of the CM Series. Senior Product Manager Mike Gough explains why the tweeter-on-top technology together with a new tweeter design, a decoupled FST™ midrange and three bass drivers give a breath-taking performance that represents a new high for the CM series.

PM1, with its carbon braced aluminium dome tweeter, has shown how raising the frequency of first breakup improves tweeter performance in the audible range below 20kHz. Carbon bracing has proved its worth when the price point precludes diamond dome technology and similar performance was required of the CM10.

But adding a carbon brace to the standard aluminium dome adds mass and this, of course, reduces sensitivity. Not a problem with the 84dB sensitivity of the diminutive PM1, but the brief here was to achieve a system sensitivity of 90dB, so another way of raising the first breakup frequency was needed that did not add unduly to the moving mass.

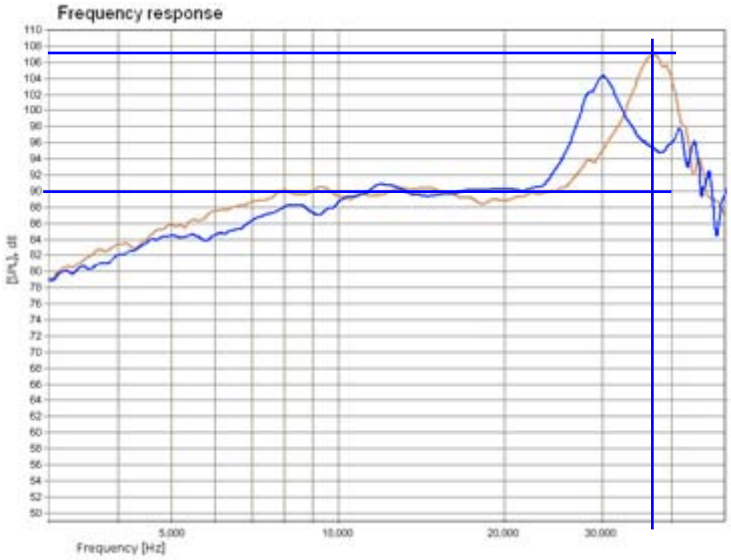

Figure 1 – Tweeter on-axis responses. Blue – CM9 Orange – CM10

The eventual solution was found in a dual layer construction. The main aluminium dome thickness is first reduced from 50µm to 35µm. By itself, this reduction in thickness would actually result in a lower breakup frequency, but added to the back of this thinner dome is a ring of aluminium, 50µm thick, around the periphery. This ring is profiled to match the shape of the dome and increases total diaphragm stiffness. The breakup frequency is raised from 30kHz to 38kHz (figure 1), with only a small increase in total moving mass and the full sensitivity is recovered by adding a single, reverse-polarised magnet to the back plate.

It should be remembered that it is not the ultrasonic frequency of breakup per se that improves sound quality; it is that diaphragm behaviour just below 20kHz, where we can hear, is more piston-like as a result of raising this frequency. The higher initial breakup frequency of the CM10 tweeter is immediately obvious, but the on-axis response of the CM9 tweeter is flatter than that of the CM10 tweeter between 10kHz and 20kHz and this may at first be thought of as better. However, in a previous paper on the 800D, where the performance of the even stiffer diamond dome tweeter was considered, it was noted that the response of a theoretically perfect dome (ie one with infinite stiffness) drooped above 15kHz. As the frequency increases, the wavelength decreases and eventually approaches the height of the dome with the result that the radiation from the centre of the dome begins to get out of phase with that from the rim. The fact of the matter is that the flat response is only so because the breakup resonance is supporting it and the slightly drooping response actually sounds better because the CM10 dome is better behaved up to 20kHz.

A new location

It is well known that the diameter of the drive unit affects dispersion. The dispersion depends on the diameter of the driver compared to the wavelength of the sound being produced and, for any given frequency, dispersion will be wider from a smaller diameter unit. That's one of the reasons the frequency range is divided between drivers of different size. It is also fairly well known that stereo imaging is improved if the system dispersion is as constant with frequency as possible. What is less widely known is that the size of the housing in which the driver is mounted also affects dispersion and the off-axis response is generally smoother if the dimensions of the driver's housing are as close as possible to the diaphragm

diameter.

With the CM9, we already have a narrow cabinet, barely wider than the bass and midrange drivers, and so the only option left to improve the dispersion is in the high frequencies, where we can employ the tweeter-on-top configuration.

The graphs in figure 2 compare the on and off axis responses of the CM9 and CM10 tweeters between 1kHz and 50kHz, in situ but without crossover. They need some explanation, as the aural effects of the measurements are not immediately obvious.

Figure 2a – Response of CM9 tweeter without crossover at 0º, 30º & 45º horizontally off axis

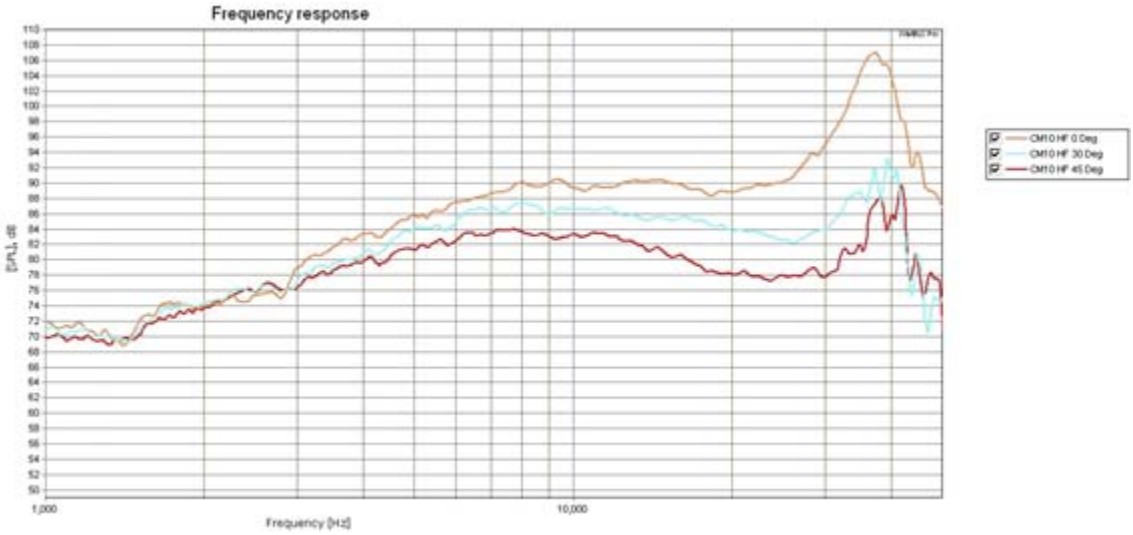

Figure 2b – Response of CM10 tweeter without crossover at 0º, 30º & 45º horizontally off axis

When comparing the difference between the on- and off-axis responses of the two tweeters, there is little change between 10kHz and 20kHz. This is to be expected, because the off-axis performance is defined by the dimensions of the diaphragm itself. Below 10kHz, however, there is a distinct difference and this is imposed by the different mounting methods. With the tweeter-on-top arrangement of the CM10, the response reduces smoothly off axis. Compare the off-axis of the baffle-mounted CM9 tweeter where all three traces are close together and the 45º level actually exceeds the 30º level around 5kHz. This excess of off-axis energy within a relatively narrow frequency band tends to highlight the position of the speaker itself and reduces that difficult to describe “out of the box” effect where the aural image seems almost dissociated with the speaker cabinet and is more stable with changes in listener position.

Vibration isolation

In all 800 Series Diamond speakers, not only is the tweeter in its own housing on top of the main cabinet, but vibration isolation is used. This is a powerful technique that reduces vibrations generated by diaphragm motion in the driver being transmitted to the structure. Reducing structural vibration in turn reduces coloration and allows the finer detail in the signal to be transmitted to the listener without masking. As in the 800 Series, not only is the tweeter unit decoupled from its own housing, the housing itself is decoupled from the main cabinet. The decoupling material is a gel-like substance with very low Shore hardness.

Figure 3 shows not only how the gel is employed in the construction of the tweeter, but also the separate housing, the supplementary magnet and the ubiquitous Nautilus™ tube loading that is exclusive to Bowers & Wilkins.

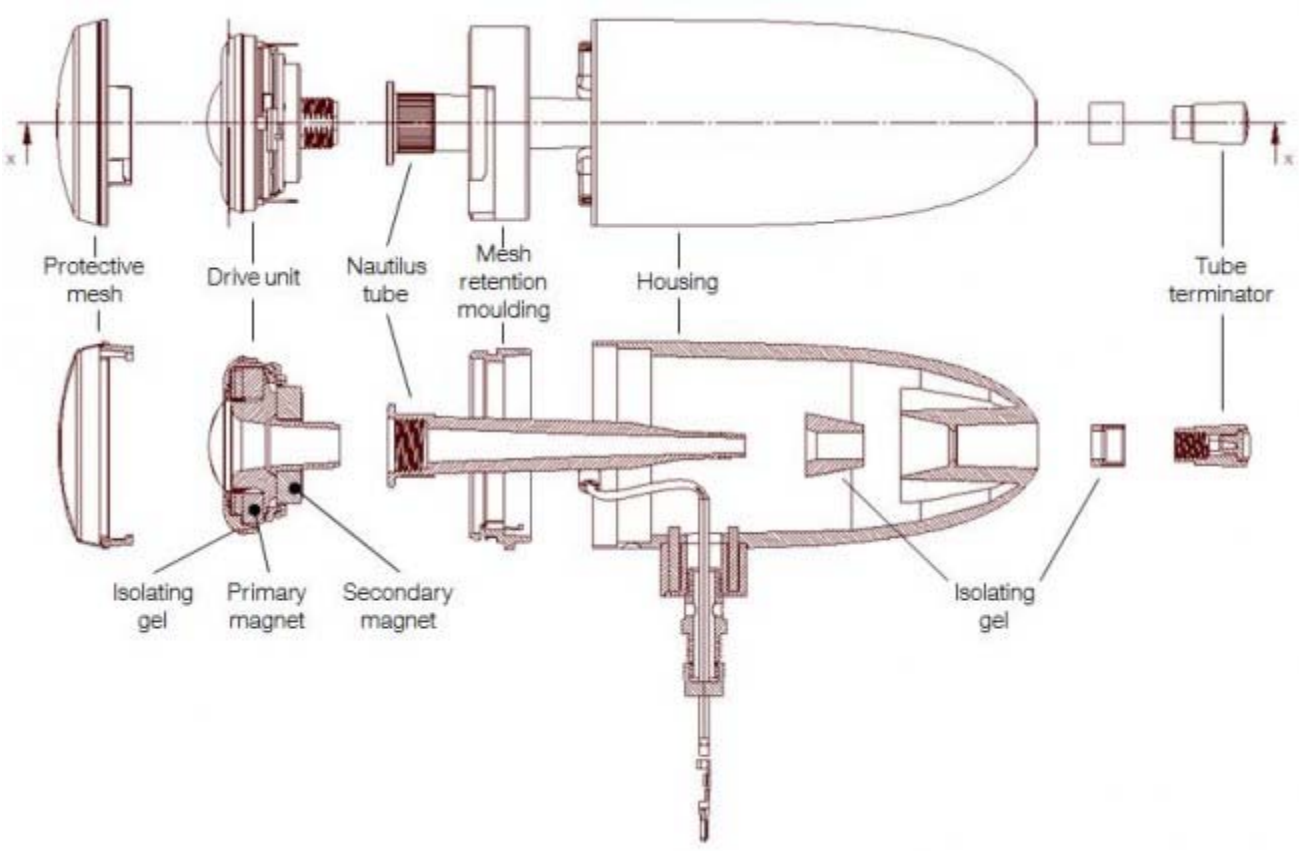

Figure 3 – Exploded illustration of CM10 tweeter construction