Bowers & Wilkins

CM Series Technical paper

Summary

The Bowers & Wilkins CM Series has grown from the CM1, launched in 2006. Over time the range has grown to become one of the most extensive in the Bowers & Wilkins portfolio and in the same period the technologies used on certain models within the range has advanced significantly. The new CM Series has allowed us to rationalise these technologies across every product in the range, thus bringing the entire series up to date. This document covers the main technologies implemented in the new CM Series and provides explanations on the theories behind them.

Decoupled Double Dome tweeter

At Bowers & Wilkins we believe that the best tweeters use the stiffest and lightest assemblies because we want our drive unit diaphragms to remain pistonic for as long as possible. However the problem with all structures is that the higher in frequency they are driven the harder is it for them to remain stable. At a given frequency the structure will lose its integrity and start to bend and flex. At this point the structure is said to be in 'break-up'. As a general rule of thumb the higher in frequency we can push this break-up frequency the cleaner the high-frequency performance of the loudspeaker becomes.

In our premium 800 Series Diamond we achieve this by creating a tweeter dome from a very thin layer of diamond. This produces the stiffest structure we can possibly make and pushes the break-up frequency to 70kHz, a significant improvement on our conventional aluminium tweeter, which has a break-up frequency of 30kHz. However this advanced technology has a high associated cost so, despite its ability, it is not appropriate for use in every application. Our solution is the Double Dome tweeter.

By using advanced Finite Element Analysis (FEA) techniques we can show that at break up the conventional aluminium tweeter is weakest at the edge of the dome, where the voice coil is connected to the dome. This can be seen in the image below.

The Double Dome design comprises a 35-micron aluminium diaphragm reinforced with a 50-micron ring profile bonded to the rear surface of the dome. This stiffens the structure in its weakest area and pushes the break-up frequency of the structure up to 38kHz. At the same time, this approach minimises the amount of mass being added to the assembly.

Across the entire CM Series, every tweeter is fully decoupled from the loudspeaker cabinet, achieved by housing the high-frequency assembly in a soft gel-like material so that it effectively floats free of the baffle. This isolates any of the energy generated by the tweeter from the cabinet, therefore reducing any unwanted sound generated by the cabinet itself and also stopping any of the low and mid-frequency energy (generated by the larger drive units in the enclosure) from affecting the tweeter's output.

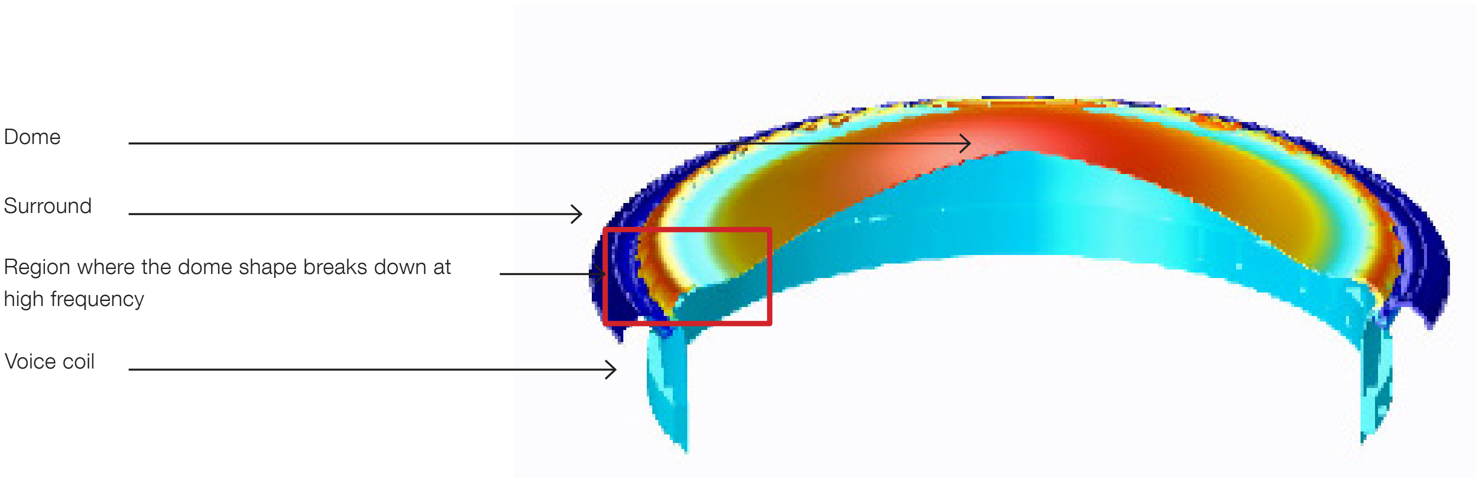


Figure 1 - Current CM Series 25mm aluminium dome

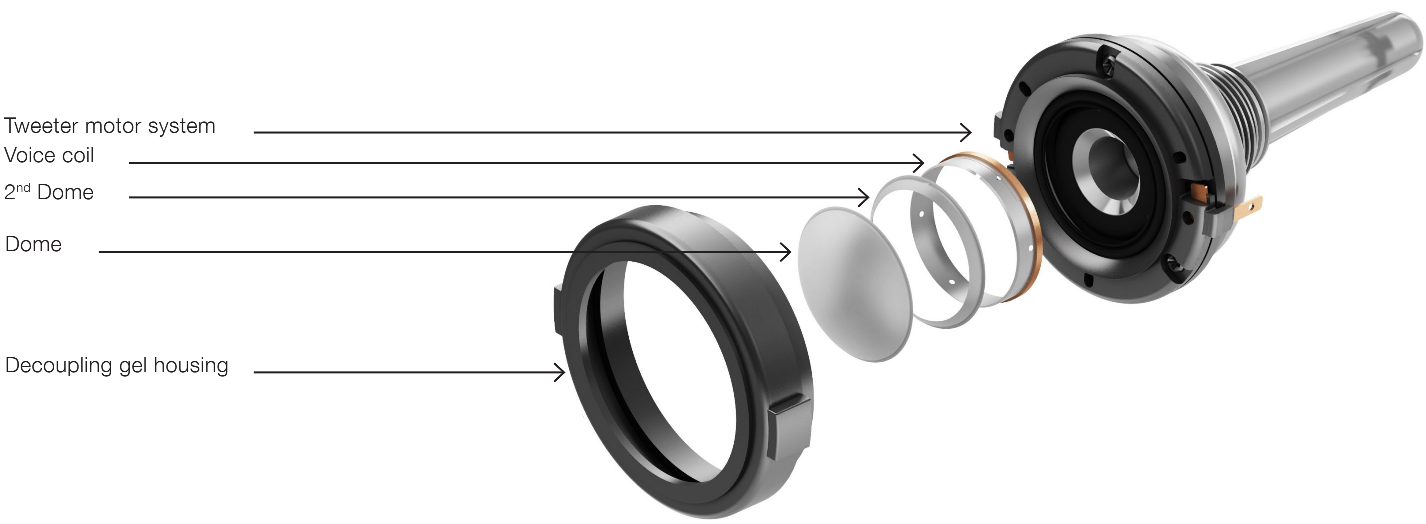


Figure 2 – Exploded view of tweeter assembly

Tweeter On Top

Within the new CM Series there are two premium products utilising tweeter-on-top technology. This proven Bowers & Wilkins technology reduces the effect of cabinet diffraction.

When a tweeter is mounted on to a cabinet baffle the acoustic wave generated by the tweeter travels out in all directions from the dome. When this wave-front hits the edge of the cabinet a second wave-front is generated at this edge because of the change in the acoustic environment. This secondary wave travels out in a circular direction from the edge of the cabinet and some of this energy is reflected back towards the tweeter. This second wave will interfere with the output from the tweeter and cause uneven tweeter response at the listening position. This effect is known as cabinet diffraction. The tweeter-on-top technology deals with this by placing the tweeter in a smooth enclosure with no edges to create cabinet diffraction. The effect of this interference can be seen in the measurements below (Fig.3).

The measurements below (Fig.4) show the directivity of a CM5 S2 and CM6 S2. The only difference between these tweeters on these systems is that the CM5 S2 has a baffle-mounted tweeter and the CM6 S2 uses a tweeter on top. In the CM5 S2 response you can clearly see lobing in the response at 5kHz and 10kHz caused by cabinet diffractions which are not present in the CM6 S2.

tweeter output
secondary wave

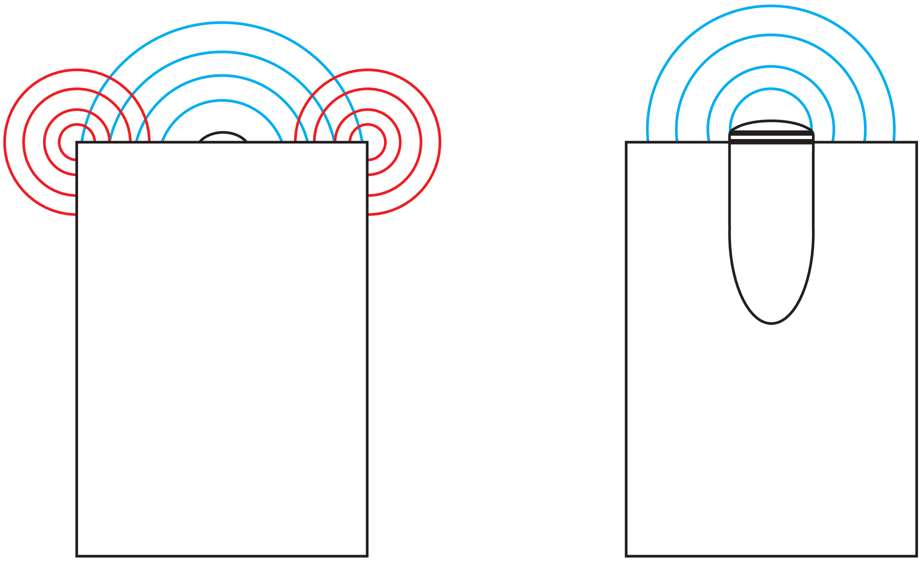


Figure 3 – Tweeter on top - The effect of this interference

CM6 S2
CM5 S2

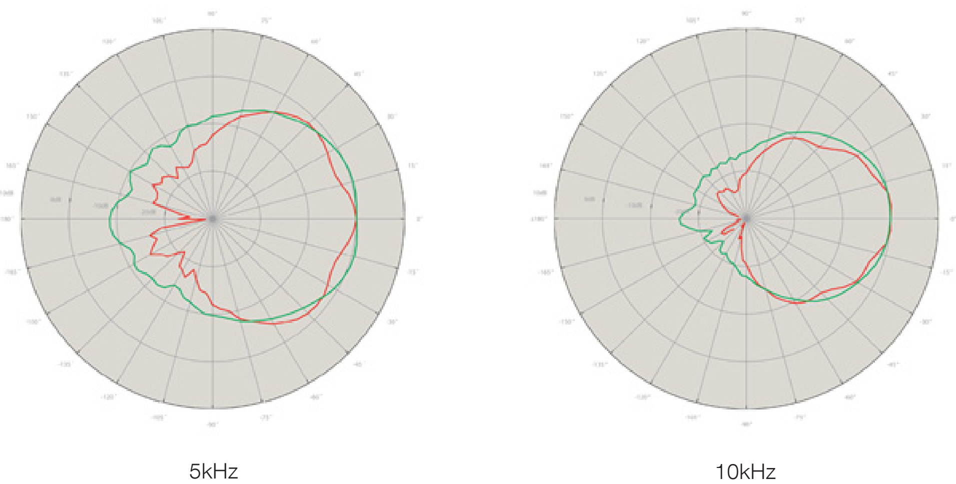


Figure 4 – 'Baffle-mounted tweeter v tweeter-on-top – dispersion compared

Cabinet construction

With all loudspeaker design we want the drive units to radiate the acoustic output and remove the contribution from any other parts of the system to the reproduced sound. This can be challenging as loudspeaker drive units can generate a large amount of energy that can excite the cabinet structure. With cabinet design you can reduce the amount of sound the cabinet radiates by making it heavier and stiffer. To determine how much sound a given cabinet will radiate you can measure the velocity on the surface and this is directly proportional to the sound pressure that is generated.

Below are two measurement of the velocity on the baffle of a 683 and CM9 S2 at 350Hz: the stronger the colour and the more displacement the higher the velocity. Although the 683 is a high performance loudspeaker it can be seen that around the drive unit apertures there is a reasonably high velocity. In comparison the thicker and stiffer baffle of the CM9 significantly reduces the cabinet velocity in these areas resulting in a significantly quieter cabinet.

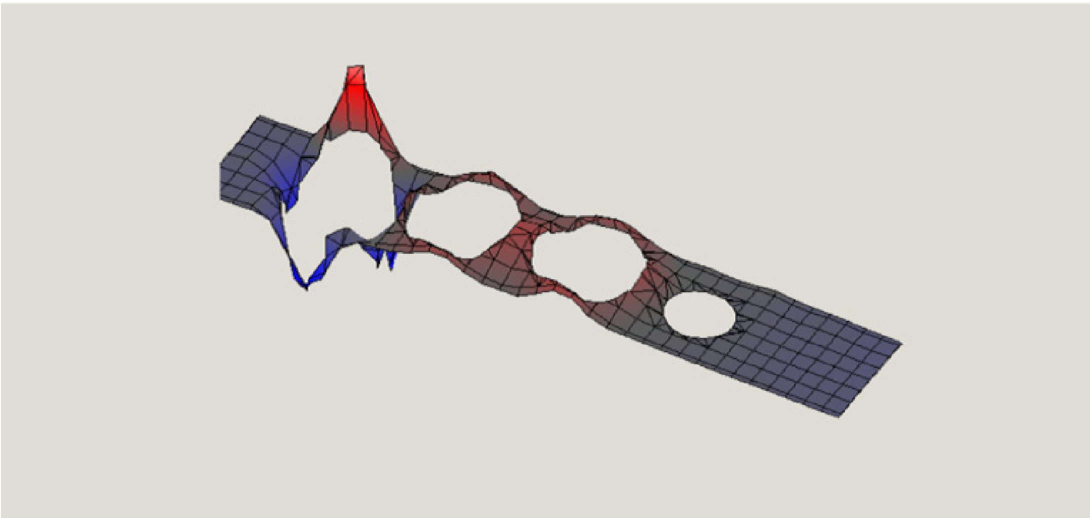


Figure 5 – 683 S2

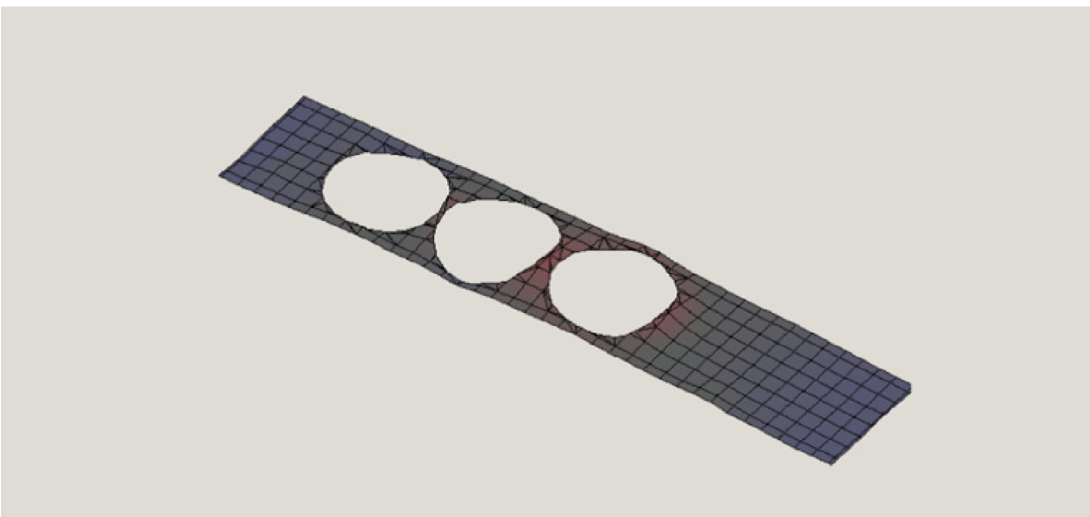
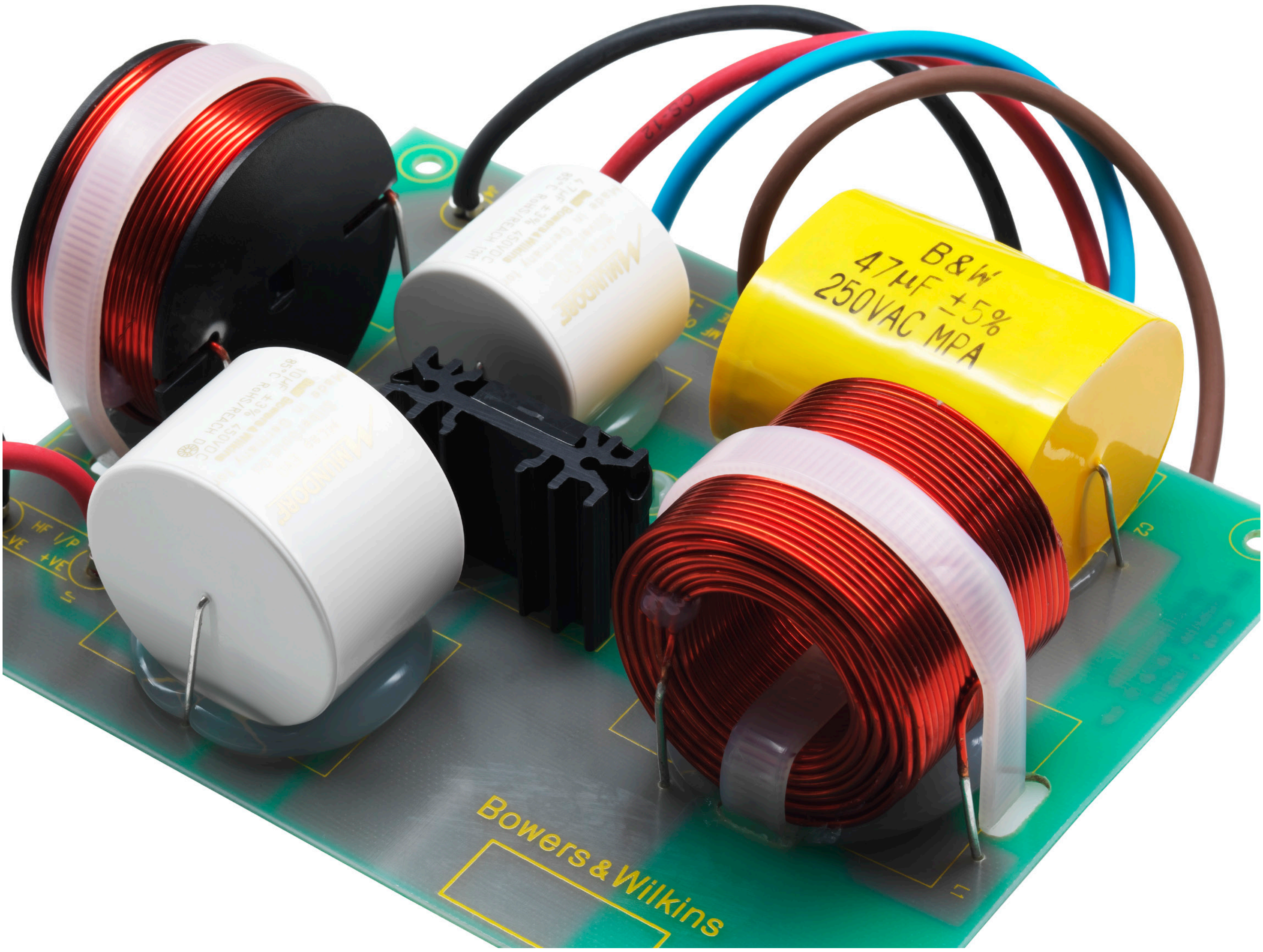


Figure 6 – CM9 S2

Crossover and harness assembly

Loudspeaker crossovers are defined in terms of their order. A low-order crossover is one where the output of a drive unit rolls off very slowly with changes in frequency, while a high-order crossover has a very steep roll off with frequency. Low-order crossovers have the fewest number of components between the terminals and the drive units.

At Bowers & Wilkins we design all our drive units ourselves. Because of this tight control on the design we can ensure that the performance of every drive unit is controlled and consistent and this allows us to use low-order crossovers. Every component in a crossover has some losses associated and therefore the type and quality of the components in the crossover will have a considerable effect on the loudspeakers' performance.
In the new CM Series we use high quality Mundorf MCap® EVO Silver Gold Oil capacitors across the range, and even the internal wiring harness has been updated to audiophile-grade cabling.



Anti-Resonance Plug

In the same way that the tweeter dome reaches a certain frequency and starts to flex, so does the voice coil in the bass/mid drive unit. The Anti-Resonance Plug is a dust cap that is inserted into the top of the voice coil. This provides additional stiffness, pushing the frequency of the voice coil break-up higher in frequency. The material that the Anti-Resonance Plug is made from also adds damping, reducing the output when the voice coil is at resonance. This smooths the high frequency response of the bass/midrange drive units.