Low Impedance Voice Coils for Improved Loudspeaker Efficiency

In modern audio systems utilizing switch-mode amplifiers the total efficiency is dominated by the rather poor efficiency of the loudspeaker. For decades voice coils have been designed so that nominal resistances of 4 to 8 Ohms is obtained, despite modern audio amplifiers, using switch-mode technology, can be designed to much lower loads. A thorough analysis of the loudspeaker efficiency is presented and its relation to the voice coil fill factor is described. A new parameter, the drivers mass ratio, is introduced and it indicates how much a fill factor optimization will improve a driver’s efficiency. Different voice coil winding layouts are described and their fill factors analyzed. It is found that by lowering the nominal resistance of a voice coil, using rectangular wire, one can increase the fill factor. Three voice coils are designed for a standard 10” woofer and corresponding frequency responses are estimated. For this woofer it is shown that the sensitivity can be improved approximately 1 dB, corresponding to a 30% efficiency improvement, just by increasing the fill factor using a low impedance voice coil with rectangular wire.

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