Smart Class D Amplifier Delivers Louder, Richer Sound From Micro Speakers

Maxim Integrated Products' MAX98390 smart amplifier with integrated Dynamic Speaker Management (DSM) algorithm efficiently delivers louder, clearer, richer sound at the lowest quiescent power in the market, according to the vendor. The boosted, digital Class D DSM smart amplifier unleashes a system's full audio potential by safely driving higher power levels (up to 5.1 W) into tiny speakers typically rated for much lower power between 1 and 3 W (Fig. 1).

The miniaturization of consumer devices requires speakers to fit within smaller form factors, which has led to more applications moving towards the use of micro speakers. As speakers shrink, loudness or sound pressure level (SPL) decreases while the resonant frequency increases, leading to less bass. Driving the speakers harder to increase loudness and bass response can easily damage the micro speakers through overheating and over excursion.

The MAX98390 solves this challenge by using integrated IV (current and voltage) sense and Maxim's DSM algorithm to drive speakers to their maximum specified limits, while protecting against over-excursion and overtemperature events. DSM's thermal protection empowers designers to safely push their speakers well beyond their specified power rating enabling the speakers to produce their maximum loudness. At the same time, DSM's excursion protection enables designers to drive speakers to their specified excursion limits, producing sound up to two octaves below the resonant frequency limit (Fig. 2).

The MAX98390 implements technology that Maxim has been selling to cell phone and tablet manufacturers for years. However, in those applications, the DSM algorithm was implemented externally in DSP processing in the host application. In the cell phone and tablet applications, the need for DSP programming is not considered an obstacle. However, for the broader application market for products with micro speakers, this is not the case.

So, to offer DSM to the broader marketplace, Maxim implemented the DSM algorithm in a fixed-function DSP on the MAX98390. This step required major development effort. According to Greg Mow, business manager for Mobile Audio Solutions at Maxim Integrated, it took Maxim's engineers five years to finalize this function. Being able to offer a smart amplifier with DSM that requires no programming gives the MAX98390 an advantage over competing solutions which require use of a general-purpose DSP.

The second challenge in bringing this technology to a wider market is that DSM requires the speaker and enclosure to be characterized, which can be a very complex and time-consuming process that usually requires direct support from the amplifier supplier. To properly protect a speaker, the amplifier algorithms must know the characteristics of the speaker, such as resonant frequency within its enclosure, excursion limit and voice coil thermal limit. In the past, Maxim did this characterization of speakers for its cell phone and tablet customers.

However, this approach is not practical in offering DSM to a broader market as the speaker characterization process is time-consuming. This challenge is further exacerbated as most projects start prototyping with multiple speakers per project, requiring several weeks of supplier support or requiring special equipment and expertise. To address this issue, Maxim developed its DSM Sound Studio GUI, which allows customers to quickly and easily characterize multiple speakers.

To cater to the miniaturization of devices and shrinking batteries, according to the company, the MAX98390 offers an industry-leading peak efficiency at 86%. This is said to be further improved with DSM's Perceptual Power Reduction (PPR) feature, which can yield up to an additional 25% power savings (with no loss in audio fidelity, see Fig. 3), and a low quiescent power consumption of ~24 mW. According to Mow, the MAX98390's I_Q is one half of competing smart amplifiers that have I-V sense and work with a general-purpose DSP.

The amplifier also provides on-chip dc resistance (Rdc) testing, which can be used by the customer on its production line for quality assurance to ensure a speaker is within its expected impedance tolerance. By catching abnormal Rdc values, the customer can identify products with broken speakers before shipping them to the customer. This capability can also be deployed in the field by the end customer to verify a product's speaker is functional. Moreover, when end products fail and are returned, the host processor can poll the DSM amplifier to identify potential breakage of speakers for easier RMA analysis and product repair.

"The MAX98390 smart amplifier was designed to boost audio quality in the smallest form-factor

to make it nimble enough to go into any device," said Mow. "From providing the most balanced and loudest sound to offering the market's highest efficiency and ease of design, the MAX98390 enables our customers to deliver a best-in-class, immersive sound experience."

The MAX98390 is available at Maxim's website for $1.95 and also available from authorized distributors. The MAX98390EVSYS# evaluation kit is available for $200.

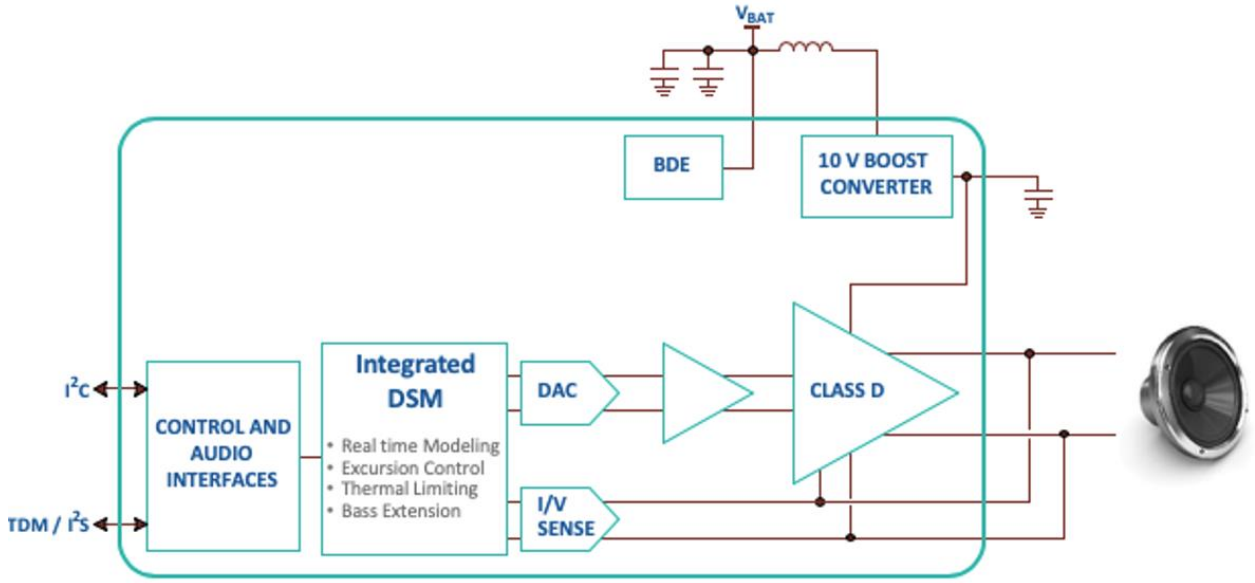

Fig. 1. The MAX98390 smart class D amplifier uses integrated IV (current and voltage) sense and Maxim's DSM algorithm to drive speakers to their maximum specified limits, while protecting against over-excursion and overtemperature events. Competing solutions require a general-purpose DSP, which requires programming, versus the fixed-function DSP that has been brought on chip in the MAX98390.

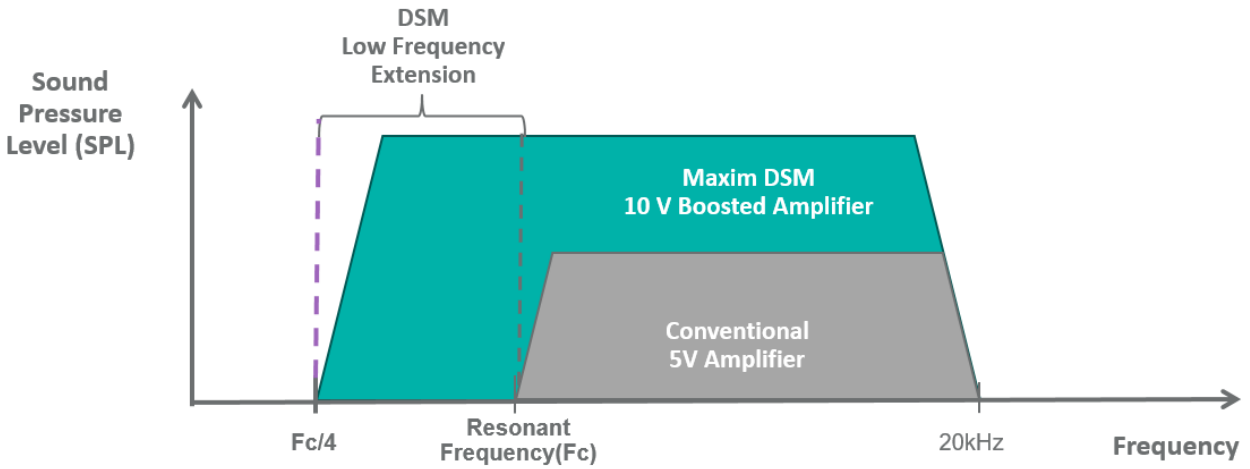

Fig. 2.The Dynamic Speaker Management (DSM) algorithm in the MAX98390 smart amplifier enables micro speakers to deliver 2.5X the loudness and deeper bass than with a conventional amplifier. By providing thermal and excursion protection, DSM makes it possible to ignore the micro speakers' power rating while safely driving them to their true thermal and excursion limits. According to Mow, DSM enables speakers that are nominally rated at 1 to 3 W to be driven safely to 5 W.

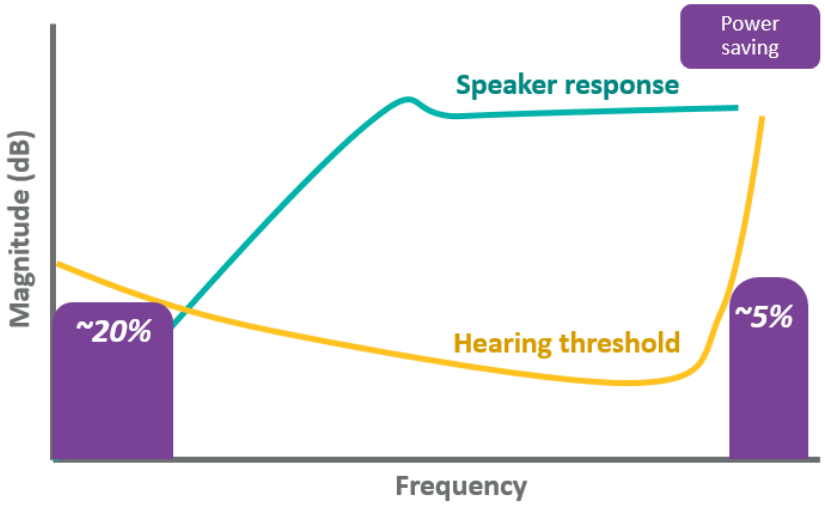

Fig. 3. Perceptual Power Reduction (PPR) provides up to 25% power savings versus use of a high pass filter, without affecting the audio quality. PPR is a dynamic and adaptive form of filtering that adjusts to the volume level and the speaker's response at that specific level. It uses the speaker's SPL response acquired via DSM coupled with the human hearing threshold.