

Powersoft provides a range of two motors and six M-System diaphragms models for very low-end subwoofer (40") and low-frequency applications (30" and 22").

Powersoft also noted other possible fields of application in materials stress testing, vibrational active damping control, mechanical to electrical conversion, and even mechanical energy harvesting.

The M-Force Drive

According to the paper presented at AES Berlin, the "motor structure" uses forces generated by current and magnetic field interaction, the same as on a conventional moving coil actuator. "However the stationary reference has been moved from the magnet and yoke assembly to the exciting coils, which become the "heavy" part of the system," Lastrucci details.

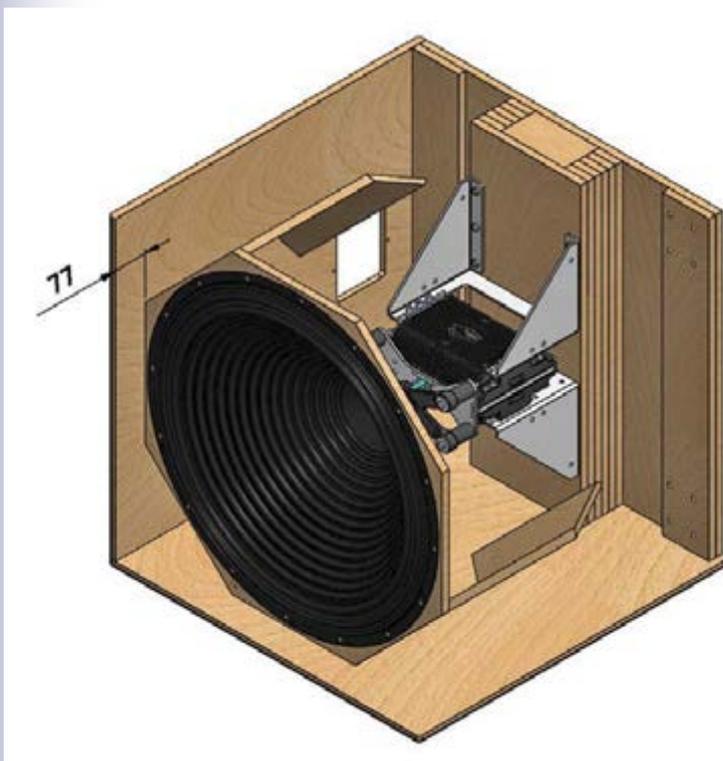
Powersoft has written three complementary papers, which can be accessed from the AES website (www.aes.org). As for the new system, it is "based on two parallel bars of NdFeB magnets, facing to a common plane but with opposed magnetic field orientation. Two coils are placed facing the bars of magnet in a way to create a sandwich structure that holds the magnet within the coils."

"The coils are wound using a ribbon of solid conductor, forming a winding of rectangular shape. The magnetic field generated by the magnets is forced to cross the conductor of the coils, producing, once the coils are subjected to current, a relative force between the coils and the magnet bars. This force linearly depends on the intensity of the field generated by the magnets and the current flowing into the coils."

The paper also describes how the symmetrical design is surrounded by an outer ferromagnetic shell "to allow easy circulation of the steady field generated by the magnet bars and to create a defined path for the variable flux produced by the current flowing in the coils," and "a frame of composite material" to "provide a mechanical connection to the radiating part of the complete acoustical transducer."

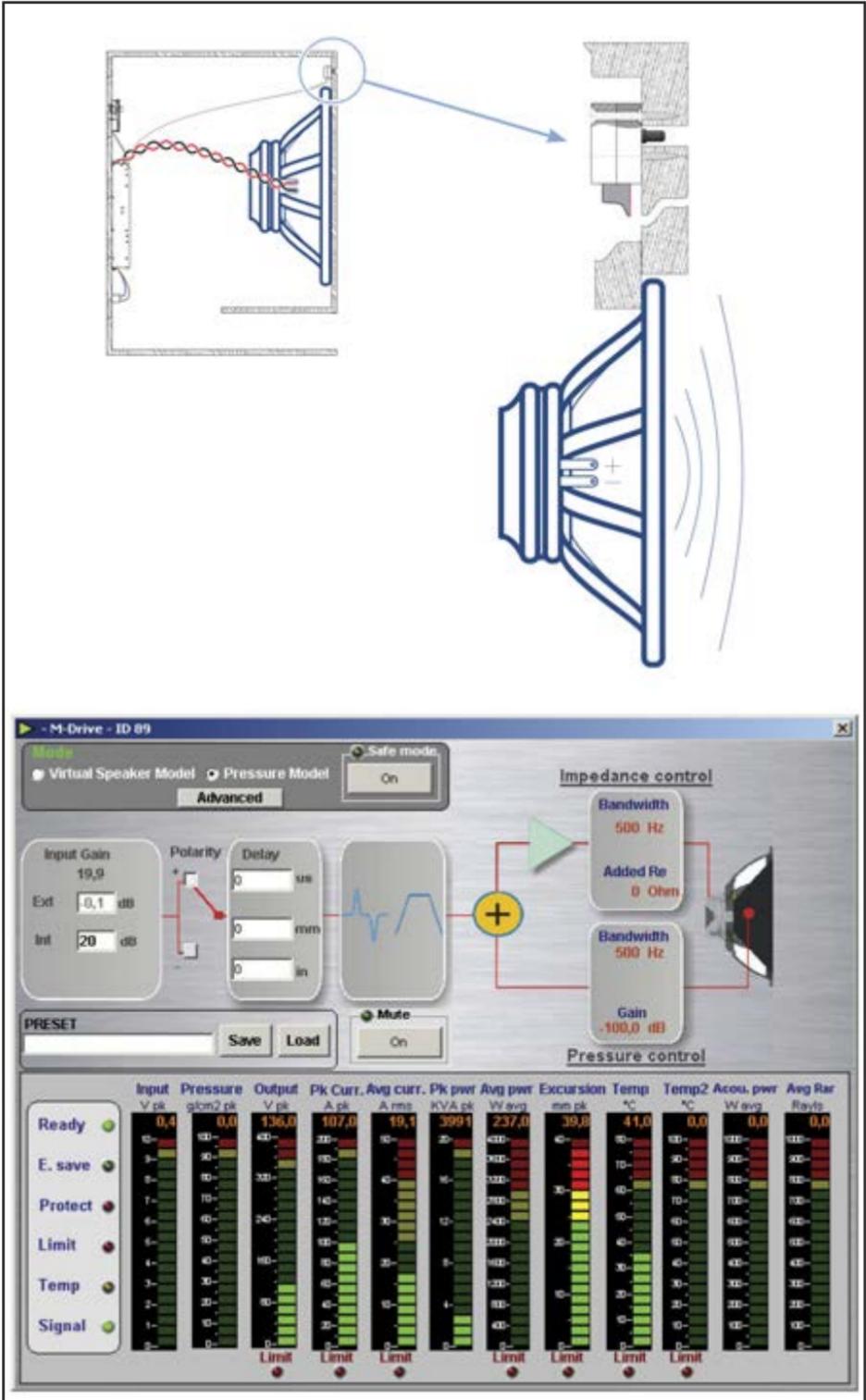
Lastrucci says "this can be considered a real push-pull device, where both magnet bars and coils work completely symmetrical in respect to the axial displacement and each portion of the conductors provide either push or pull action on each magnet bar in a complementary fashion to the other specular portion of the motor," while the most evident feature is the absence of conductors in the moving portion of the motor.

"The forces are provided by the interaction of the field that is generated by the steady coils and the field generated by the magnets that are not energized by any connection," allowing for a "free and very reliable operation even with extreme acceleration and displacement" and thermal stability.



This Powersoft subwoofer reference design features M-Force.

To optimize such a system, and specifically its peak force to mass ratio, over a linear displacement of 30-mm peak to peak, Powersoft applied all the technology from its M-Drive amplifier module with on-board DSP to achieve actively synthesized values from -10Ω to $+10 \Omega$ resistance and -2 mH to $+2 \text{ mH}$ inductance. To create global



The differential pressure control (DPC) measures the difference in pressure between the front and the rear sides of the radiating diaphragm and uses this information to alter the transducer's behavior, according to the actual boundary conditions.



The Avalon Hollywood club now has a new improved audio system, featuring “the world’s largest subwoofer club installation ever” with new subwoofers powered by Powersoft’s new M-Force technology and 40” cones.

feedback in the system, Powersoft used a differential pressure sensor to detect the overall pressure acting on the radiating surface of the radiating diaphragm. The DPC measures the difference in pressure between the front and the rear sides of the radiating diaphragm and uses this information to alter the transducer’s behavior, according to the actual boundary conditions. Via software, it’s even possible to weigh and customize the feedback between the electrical and the acoustic domains.

“This method allows the definition of a

predictable behavior in the electrical–mechanical–acoustical signal chain, and allows reduction in the sensitivity of the system performance against aging and boundary condition,” says Lastrucci.

All the main parameters of the transducers are supervised. The voltage, the current, the power, the pressure, the displacement, and the forces are maintained within the safety conditions and limited within a global amplifier and transducer combination. Power management uses a combination of energy recycling output stage and PFC integrated into the power supply.

The M-System in Practice

A new paper, presented in 2014 at the 137th AES Convention in Los Angeles, CA, titled “Subwoofer Design with Moving Magnet Linear Motor” and co-authored by Di Cola (Audio Labs Systems), Lastrucci, and Lorenzo Lombardi (Powersoft), takes the new electro-dynamic transducer described in Lastrucci’s previous paper and details specific proposals in subwoofer design using this technology. Among the designs, we find a high output, high Q vented box design tuned at 30 Hz, a small-size compact vented design tuned at 34 Hz and a hybrid short transmission line. The paper details actual measurements from those units and provides advice on system optimization using the available tools.

Powersoft also released a series of documents that includes “Loudspeaker Project Examples” for subwoofer designs based on M-Force. The company has also been expanding the information it provides to manufacturers, including information for two M-Force models, one for extremely low frequency applications with $(BI)^2/Re = 2215 (T \cdot m)^2/\Omega$ and maximum acceleration of 3800 m/s^2 ; and another with $(BI)^2/Re = 3000 (T \cdot m)^2/\Omega$ and maximum acceleration of 4800 m/s^2 . Details of different diaphragm designs are also provided in Powersoft’s literature.

Since its launch, AV specialists and integrators including ATK Audiotek, Maryland Sound International (MSI), and others have used Powersoft’s M-Force and M-Drive solutions in a variety of high-profile applications.

Meanwhile, the first commercial implementation examples have also become public. One of those involves the world’s largest subwoofer club installation, in a collaborative project with Eastern Acoustic Works (EAW) at the Avalon club, a Hollywood, CA, historic venue.

John Lyons, Avalon Hollywood’s owner and audio expert is known for the design and the installation of audio systems at some of the world’s leading nightclubs, restaurants, and lounges across the