Driving New Designs

Getting more (and improved) "woof"

Editor's Note: The "humble" cone driver continues to evolve in a growing number of directions. Here's a look at interesting developments and philosophies explained by several companies.

JBL: DIFFERENTIAL DRIVE

Differential Drive (patent pending) makes use of a pair of in-line voice coils in separate magnetic gaps instead of a single voice coil-gap combination. This permits a more effective use of available space, and allows more efficient removal of heat from the motor structure.

Specifically, the voice coils are reverse wound and immersed in magnetic fields of opposite polarity. This reduces magnetic leakage flux and focuses more magnetic energy in the gaps where it is needed.

Both ferrite and neodymium-iron-boron (NIB) magnets can be used, depending on the relative importance of weight in a given system design. When coupled with the light weight and high energy density of NIB magnets, Differential Drive transducers can be constructed that are only about one-third the weight of traditional designs of comparable performance.

Differential Drive provides many design options. The size, impedance, and spacing of the two voice coils can be independently adjusted relative to each other to attain a desired set of electromechanical performance features. Independently of these, the overall size and mass of a system can be adjusted as required.

The two voice coils may be driven in electrical series or parallel, depending on the system design impedance. Typical applications call for a nominal 8-ohm driver, with two 4-ohm coils operating in electrical series.

Push-pull operation. In an analogy to Class-AB operation of a power amplifier, the motion a Differential Drive system reduces even-order distortion components, due to the exact symmetry of the motor structure along its operating axis.

ADAMSON: KEVLAR CONE MATERIAL

Many years ago, we determined that resin/aramid fiber composites could pose superior properties for driver cones, and this drove development of a solution employing Kevlar.

Our goals over the decade in the development of Kevlar for this purpose include light weight, high stiffness-to-mass ratio (particularly in relation to paper cones), optimum balance of internal loss versus specific stiffness, low cone fatigue (for a far longer lifespan), and extreme water resistance.

The Kevlar "quest" is combined with use of rare earth magnets, specifically Neodymium, for reduced magnet size and mass. The addition of a proprietary PLC controlled capacitor

discharge magnetizer in our production faculty enables the charging of a new 6-inch dual coil, 21-inch woofer soon to be released. (This magnet requires a jolt of 20,000 amperes at 1,300 volts to energize it!)

Finite Element Analysis (FEA) software is used to examine a number of factors in driver design. For example, we can push the cone's break-up modes towards higher frequencies, and can also use this type of sophisticated software to model and optimize the geometry of the motor to get a more linear flux density distribution in the air gap.

D & B AUDIOTECHNIK: LINEARITY

Linearity refers to two different properties of a transducer system. One is called the frequency response. A linear frequency response means all frequencies are reproduced with the same gain. If the transducer does not do this exactly right, it can be corrected by using equalization techniques (analog or digital).

The other characteristic where linearity applies is commonly called non-linear or harmonic distortion. It describes the accuracy of the system response in the time domain depending on the driver displacement.

A lack of linearity will reduce the overall output of the system in the desired frequency range (while at the same time energy outside of the operating range is produced). Also, the response of a transducer will get more and more asymmetric with increasing voltage applied to the driver. This is due to the fact that non-linear behavior is created on the mechanical side of the transducer.

Unfortunately the motor and membrane geometry of almost any transducer is asymmetric by its nature (except perhaps some electrostatic designs with dipolar radiation patterns). The result is an additional limit to the maximum output of the driver because the membrane center position will be offset at high levels to either the cabinet inside or outside (a DC displacement) cutting the full

excursion swing of the cone. This will lead to a deteriorated sound or, with today's high power amplifiers, damage to the driver.

Designs such as the one used for the d & b audiotechnik Q-SUB woofer is operated at peak-to-peak excursions of more than 1 inch. One way to achieve sufficient linearity for this is to apply an over designed motor structure that is then not driven to its displacement limits. This needs extremely long and heavy voice coils and/or thick pole plates leading to a heavy driver with low efficiency.

The more sophisticated way is to create a comparatively compact high efficiency motor structure where maximum linearity is achieved by thoroughly "balancing" the driver.

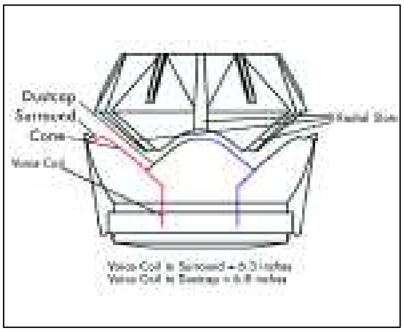
What does "balancing" mean? The critical non-linearity is created by three main elements: the force factor of the motor structure (N/A), the compliance of the suspension (N/mm) and the inductance of the voice coil in the air gap (mH). Unfortunately these parameters vary with the coil/cone displacement creating the distortion.

A newly developed, DSP-based method allows modeling of the driver with all its non-linear components while optimizing the simulation parameters to fit dynamic measurement data taken from the real driver, thus determining the modification of the parameters against the displacement. Using this data, the causes of the distortion effects can easily be identified and the mechanical design can be improved systematically.

Further, to achieve a maximum stability of the system, the remaining minor non-linearity effects can be tuned specifically so that their effects compensate for each other instead of adding up and prohibiting any DC displacement of the driver.

EAW: RADIAL PHASE PLUG

The distance from a cone transducer's voice coil to its dustcap is shorter than the distance from the voice coil to either the cone or edge surround. Therefore, the energy radiating from the dustcap will lead the energy from the rest of the transducer.



Traditional phase plug designs have isolated this energy and routed it through a longer path instead of integrating the energy from the cone or