# New Ways to Formulate Speakers

This article looks at new companies, products, and inventions that are pushing speaker design to new levels. From innovative speaker designs and new transducer topologies to feed-forward protection circuits, this is an overview of innovation happening right in front of us.

By
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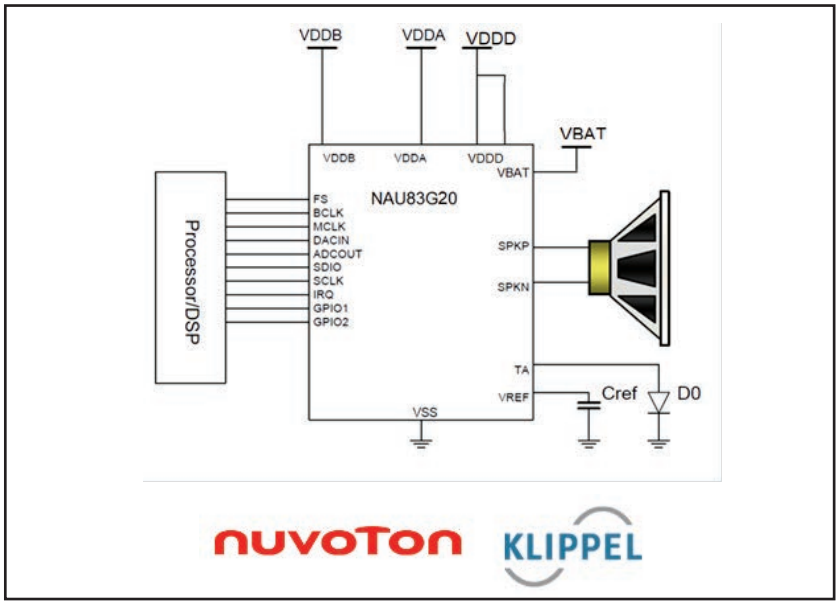
Perhaps both the easiest and also the most difficult topic to cover in audio is what's new with speakers. There are those who feel the existing products are just fine, Thiele-Small (T-S) parameters cover the engineering, a proper wooden speaker box should only have two wires going to the amplifier—and you have it all covered. But others feel that a speaker design should feature new diaphragm and enclosure materials, be designed with FEA simulation software, be laser scanned, and intimately interface with the latest DSP processing.




Klippel Controlled Sound (KCS) technology, integrated in a Nuvoton audio amplifier chip, creates a versatile solution to improve speaker performance and sound quality by compensating for nonlinear speaker responses.

The industry has seen a massive shift over the last decade with widespread adoption of mass-market audio systems, from smart speakers to soundbars. An honest assessment is that the sound quality of most home audio is not much more than a multi-channel table radio with a cheap remote woofer. Aside from pricing in a race to the bottom, visual rather than acoustic aesthetics now requires sleeker more compact industrial designs. In reviewing these innovations, I realized every single one results in a more shallow and compact solution.

The development that I see having the most impact on speaker designs this year is not even a transducer but a processing technique that will change how most of us design not just integrated speaker systems, but the drivers themselves. This is Dr. Wolfgang Klippel's Klippel Controlled Sound (KCS) in chip form from Nuvoton, which we mentioned previously here in *audioXpress* (see Resources). For my recent speaker projects, this is just what I needed. Essentially a dynamic pre-distortion circuit that is calibrated to the speaker and enclosure.

You might consider smart-amps the caterpillar and KCS as the butterfly, emerging as the complete form. A smart-amp, typically designed with the smartphone as its intended home, is predominately a feed-forward protection circuit specifically tuned for the limits of the speaker, both displacement and

thermal. I have consulted for a couple of leading smart-amp chip vendors over the years and we consistently ended up rediscovering Dr. Klippel's patents.

The challenge was to increase the maximum acoustic output without creating new failure modes by inadvertently crossing the line with fatigue failure issues by dancing at the edge (which might annoy Apple, Samsung, etc.) or worse, driving to the edge on ring tones and speakerphone functions might inadvertently stumble into long-term speaker failure modes. It has been a few years now and NXP, Maxim, Texas Instruments, Cirrus Logic, Infineon, and Qualcomm have all succeeded with their smart-amps, all of which are a couple of watts—more than enough for smartphones considering battery drain and what the microspeaker can handle. At this point speakers can play as loud as possible without rattling buzzing, or failing—allowing everyone in the smart-amp business to sleep soundly.

But what else could speaker system designers want? I have always pressed the product managers at the smart-amp companies to consider a version of this dynamic protection processing in a form that could be used from soundbars to subwoofers to concert sound systems. For functionality, aside from saving the speakers from damage, how about we drop distortion, and for applications where there is full duplex with acoustic echo cancelers, along with painless barge-in, provide a significant margin before echoes.

Another intriguing aspect is what Dr. Klippel has defined as "green speaker design." Given the materials' budget, you can design an underhung voice coil with a huge magnetic structure and achieve high linearity—at a cost in weight. Or you can draw up a less extravagant design and use dynamic pre-distortion to keep your driver on its best linear behavior.

This is what Klippel's KCS promises, and as I found with my recent projects, it actually delivers. I cannot talk about the current product development that so impressed me (it won't be shipping until well after this is published) but let's just say I am a believer. KCS changes what a system designer can demand from smart speakers, Bluetooth speakers, soundbars, conferencing or huddle room voice lift, and even concert sound speakers.

Aside from this initial "excursion" into speaker processing, the rest of our focus remains on the electro-dynamic domain.

## A New Coaxial Design

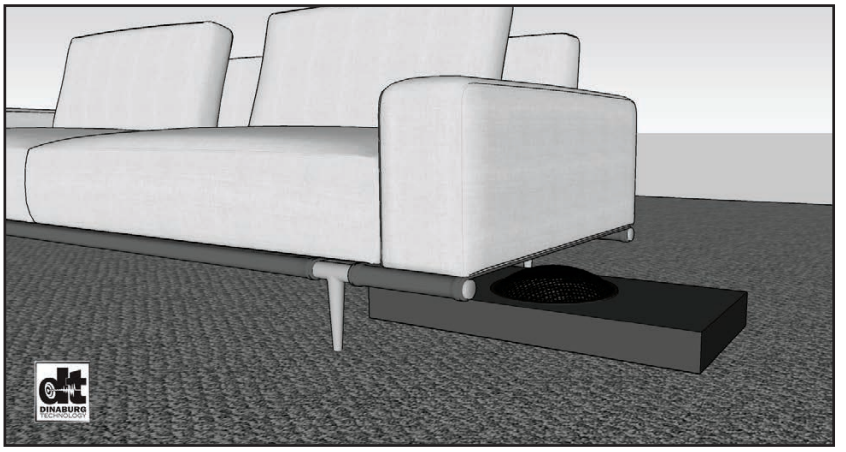
Dinaburg Technology has developed a speaker constructed concentrically with a peripheral passive ring radiator. This flat ring is compliantly held in place by surrounds on both the inner and outer periphery. There are a number of positive aspects with the ring configuration beyond the obvious benefits of a conventional vent-substitute design.

Dinaburg Technology was issued its first US patent (10,812,912 B2) for an enhanced electro-dynamic loudspeaker design that consists of an active speaker constructed concentrically with a stabilizing ring radiator. This passive ring is compliantly held in place by surrounds on both the inner and outer periphery.

The design techniques enable lower distortion, extended frequency range, higher efficiency, and wider and more consistent beamwidth (dispersion). The invention has wide applications and can be used for near-field studio monitors, autosound, ceiling speakers, in-walls, and more uniquely to under-couch subwoofers.

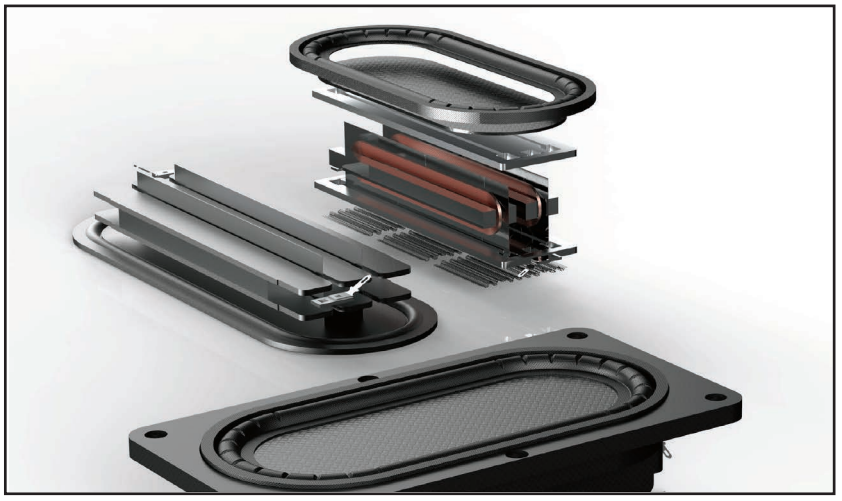
Bass reflex, as provided by T-S simulations and supported by the acceptance of the audio engineering community, confers a combination of reduced cone excursion for a given acoustic output (in the range of the vent or passive radiator turning), higher sensitivity in this range, and/or extended low-end response.

The passive radiator's diaphragm (compared to a simple vent) blocks midrange sound energy that is

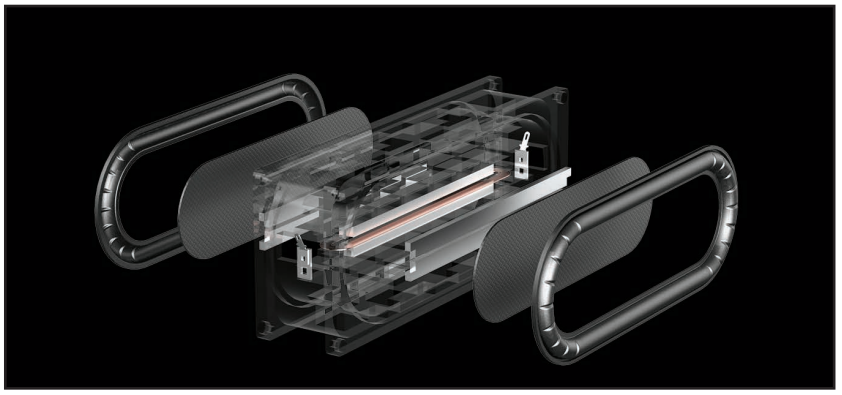


A Dinaburg 8" flat diaphragm active subwoofer in a 10" frame with an integrated ring radiator in an enclosure height of about 3" offers a practical under-couch subwoofer.

otherwise emitted from a port, and the passive ring configuration also provides for tighter constructive coupling to the active speaker (and to the room) compared to an open bass reflex port or a non-concentric passive radiator, which might have to be located on a different side of the enclosure.



One of the biggest challenges that low-profile speaker technologies have faced in the past, and still face today, is the reproduction of low frequencies. Resonado Labs solved this problem by engineering FCS technology to have a modular motor. By having multiple voice coil and magnet arrays under one diaphragm, the company can design powerful subwoofers that are able to maintain a thin structure yet have a large diaphragm necessary for low-frequency reproduction. FCS DualCore technology represents the FCS speaker driver structure comprised of dual voice coils bonded to one diaphragm.



FCS Bidirectional is the latest addition to the FCS suite. The patented design allows for two diaphragms to be attached and driven by a single voice coil, a concept that offers extremely wide acoustic coverage and is especially well suited for dipole-type loudspeaker systems.

## About the Author

**Mike Klasco** is the president of Menlo Scientific, a consulting firm for the loudspeaker industry, located in Richmond, CA. He is a graduate from New York University, with post graduate work in signal processing, and he holds multiple patents licensed or assigned. For the past 35 years, Mike has worked on countless R&D projects for large and small companies. Mike specializes in materials and fabrication techniques to enhance audio performance.

From the measured data, it can be seen that the Dinaburg topology results in more output than what would be predicted by the more basic speaker box modeling simulations. Actually, these simulations assume the on-axis response in the range of where the passive ring provides a larger effective radiating area and tighter coupling of the bass to the room. This is in the bottom end response with the added benefit of avoiding beaming in the midrange that would have resulted from an active speaker of the same overall size as the outer diameter of the ring radiator. On the other end, the passive ring radiator maintains the speaker's pattern control down to a bit lower inflection point than the active driver has if just mounted on a baffle, (in all cases from seal, vented or with non-concentric passive).

The Dinaburg approach enables reduced depth with increased and extended bass response with higher sensitivity. The aspect ratio is that of a small active speaker but the radiating pumping power is that of a larger and deeper speaker. Additionally, a self-contained module is achieved with the combined frame/back chamber.

A couple of applications come to mind. Let's consider a standard 8" ceiling speaker "high-hat" housing but with a 4" active driver with a coax mounted tweeter and passive ring radiator. This design would offer wider coverage yet retain pattern control throughout the lower voice range, enabling wider spacing of the ceiling speakers, reducing both equipment costs as well as providing faster system installation. There are similar benefits for autosound in car doors or scaled-down drivers mounted into the front seat headrests facing the rear occupants.

One Dinaburg application that I am enthused about are shallow under-couch subs. Soundbars have dominated the audio-video market as they have the ideal form-factor to fit flat-screen televisions—except for the bulky sub. Design teams have wished for a practical under-couch subwoofer. A Dinaburg 8" flat diaphragm active subwoofer in a 12" frame with an integrated ring radiator is the same depth as a shallow 8" woofer. With an enclosure height maximum of about 3" and the driver/ring passive facing upward, the impact is immersive as the couch will provide both the bass and tactile bass.

Dinaburg Technology is currently focused on inviting collaboration with brands to offer its design innovations and technical support for a wide range of applications.

## Thinner, Flatter, Better

Another driver technology that has been receiving attention is Resonado's Flat Core Speaker