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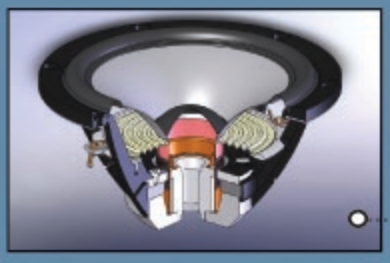

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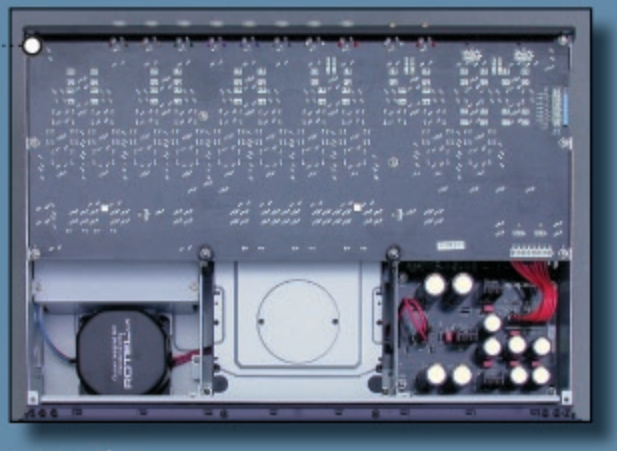

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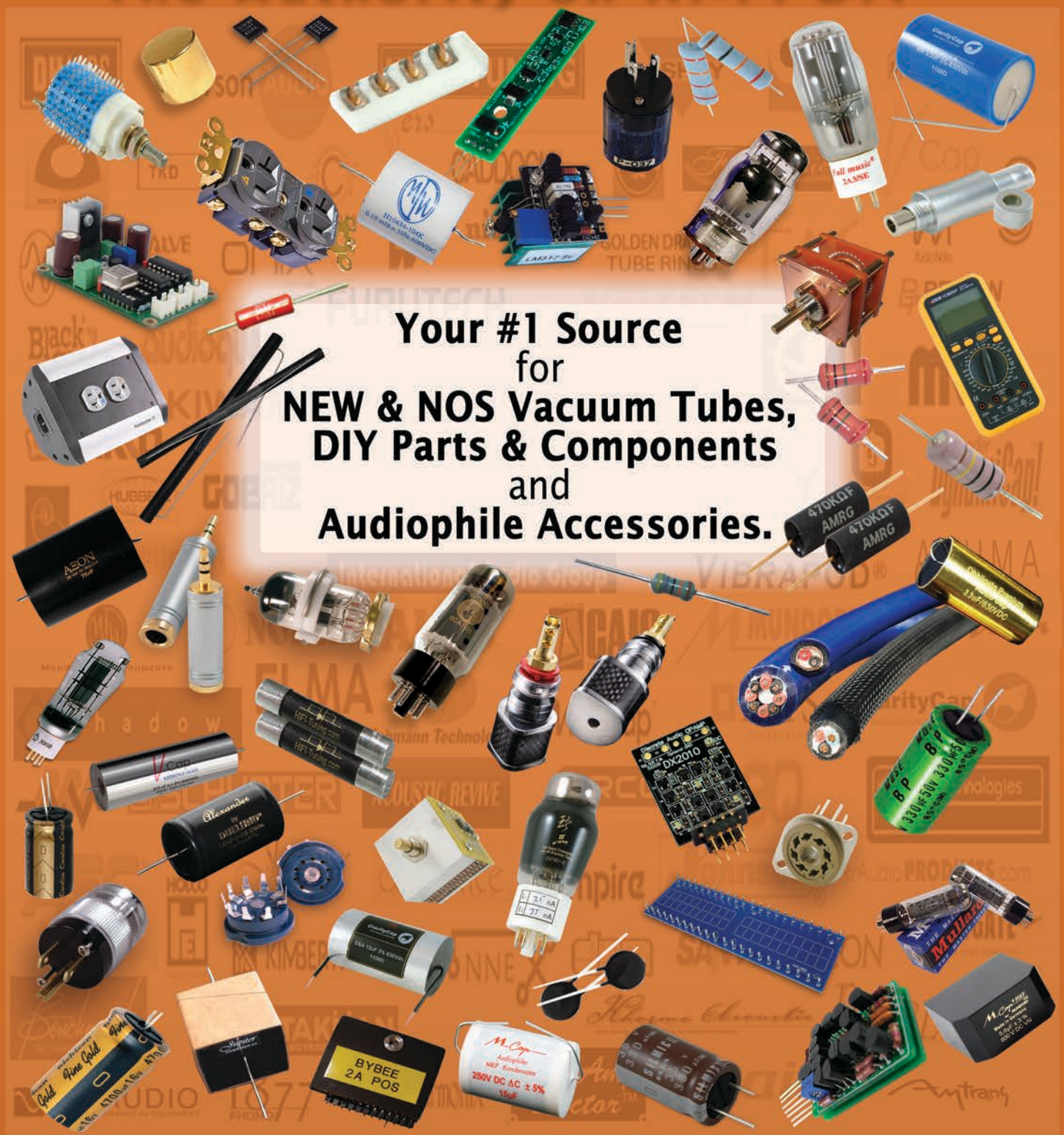

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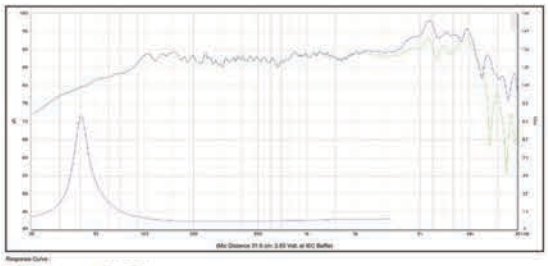
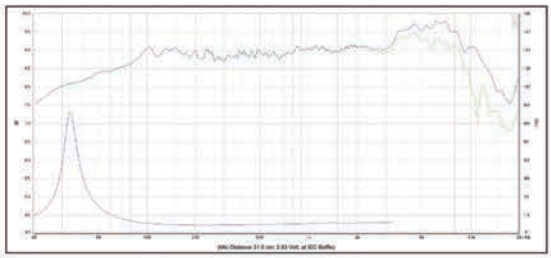


Specs :

Nominal Impedance	8 Ω	Free air resonance, Fs	41 Hz
DC resistance, Re	5.7 Ω	Sensitivity (2.83 V/1m)	87 dB
Voice coil inductance, Le	0.14 mH	Mechanical Q-factor, Qms	5.5
Effective piston area, Sd	88 cm²	Electrical Q-factor, Qes	0.4
Voice coil diameter	30.5 mm	Total Q-factor, Qts	0.37
Voice coil height	15 mm	Moving mass incl.air, md	9 g
Air gap height	5 mm	Force factor, Bl	5.7 Tm
Linear coil travel (p-p)	10 mm	Equivalent volume, Vas	18.7 liters
Magnetic flux density	1.0 T	Compliance, Cms	1.7 mm/N
Magnet weight	0.54 kg	Mechanical loss, Rm	0.4 kg/s
Net weight	1.47 kg	Rated power handling	50 watt

The parameter are measured on drive units that are broken in

THE SPECS



Specs :

Nominal Impedance	8 Ω	Free air resonance, Fs	34 Hz
DC resistance, Re	5.7 Ω	Sensitivity (2.83 V/1m)	88 dB
Voice coil inductance, Le	0.15 mH	Mechanical Q-factor, Qms	5.5
Effective piston area, Sd	118 cm²	Electrical Q-factor, Qes	0.4
Voice coil diameter	35.5 mm	Total Q-factor, Qts	0.35
Voice coil height	16 mm	Moving mass incl.air, md	11.8 g
Air gap height	5 mm	Force factor, Bl	6.2 Tm
Linear coil travel (p-p)	11 mm	Equivalent volume, Vas	37.5 liters
Magnetic flux density	1.0 T	Compliance, Cms	1.89 mm/N
Magnet weight	0.54 kg	Mechanical loss, Rm	0.5 kg/s
Net weight	1.56 kg	Rated power handling	60 watt

The parameter are measured on drive units that are broken in

Specs :

Nominal Impedance	6 Ω	Free air resonance, Fs	20 Hz
DC resistance, Re	4.5 Ω	Sensitivity (2.83 V/1m)	86 dB
Voice coil inductance, Le	3.0 mH	Mechanical Q-factor, Qms	4.5
Effective piston area, Sd	312 cm²	Electrical Q-factor, Qes	0.31
Voice coil diameter	75.6 mm	Total Q-factor, Qts	0.29
Voice coil height	28.5 mm	Moving mass incl.air, md	132 g
Air gap height	6 mm	Force factor, Bl	15.4 Tm
Linear coil travel (p-p)	22 mm	Equivalent volume, Vas	66 liters
Magnetic flux density	0.63 T	Compliance, Cms	0.48 mm/N
Magnet weight	2.1 kg	Mechanical loss, Rm	3.7 kg/s
Net weight	5.38 kg	Rated power handling	200 watt

The parameter are measured on drive units that are broken in

10" SB29SWNRX-S75-6
Drivers

Specs :

Nominal Impedance	6 Ω	Free air resonance, Fs	19 Hz
DC resistance, Re	4.5 Ω	Sensitivity (2.83 V/1m)	88 dB
Voice coil inductance, Le	3.0 mH	Mechanical Q-factor, Qms	5.0
Effective piston area, Sd	506 cm²	Electrical Q-factor, Qes	0.34
Voice coil diameter	75.6 mm	Total Q-factor, Qts	0.32
Voice coil height	28.5 mm	Moving mass incl.air, md	154 g
Air gap height	6 mm	Force factor, Bl	15.4 Tm
Linear coil travel (p-p)	22 mm	Equivalent volume, Vas	164 liters
Magnetic flux density	0.63 T	Compliance, Cms	0.46 mm/N
Magnet weight	2.1 kg	Mechanical loss, Rm	3.7 kg/s
Net weight	5.85 kg	Rated power handling	200 watt

The parameter are measured on drive units that are broken in

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Drivers

SB26STAC-C000-4
Drivers

- Cast aluminium faceplate
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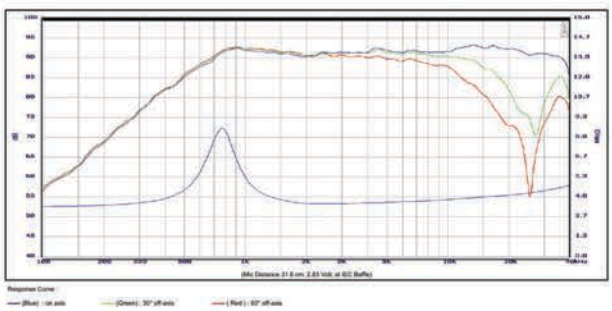
- Flow optimized vented pole piece for optimum coupling to rear chamber
- Fine weave soft fabric dome for smooth frequency response
- Saturation controlled motor system for low distortion
- CCAW voice coil for low moving mass
- Long life silver lead wires
- Low resonance frequency



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The Growing AX Community

One of the perks of editing *audioXpress* is that I have access to dozens of the amazing books Audio Amateur has published over the years. Our collection of audio-related books and back issues is remarkable in its breadth and scope. Any true audiophile at heart could easily spend months reading through the stacks.

A few days ago, I enjoyed flipping through Stephen Spicer's fascinating book *Firsts in High Fidelity* (Audio Amateur 2000), which chronicles the history of H. J. Leak & Co. Ltd. I was immediately impressed by the book's format. Spicer provides more than a standard historical synopsis of the innovative hi-fi company. He also presents classic Leak circuit diagrams and insightful anecdotes from former staffers. But what I consider to be the book's most intriguing sections are the various "profiles" of Leak employees and industry innovators, personalities, and luminaries. They wonderfully highlight the lives, skills, and talents of people who contributed to the overall development of the audio industry.

So, how does the topic of "profiles" relate to this month's issue? Well, our staff believes profiles are insightful, engaging reads. Thus, we've begun profiling members of the *audioXpress* community, which is an ever-growing, international group of audio enthusiasts. Although our community's members have diverse backgrounds and skill sets, the tie that binds them all is an intense passion for audio technology (both vintage and contemporary). Below is the first of what will be many member profiles in upcoming issues.

Thank you for reading. Enjoy!

Regards,

C. J. Abate
editor@audioxpress.com

John Petzold

MEMBER PROFILE

Member Name: John Petzold

Location: Houston, TX, USA

Occupation: Process Instrument Technician (Retired)

Member Status: John is a charter subscriber to *Audio Amateur* and *Speaker Builder*. He has collected all the past issues of *audioXpress* and has had a subscription since 2005.

Affiliations: The Houston Audio Society

Interests: John collects and repairs vintage audio equipment. He is interested in analog and two-channel only.

Dream System: Citation II Amplifier

Most Recent Purchase: On an online auction site, John found a Heathkit w-6a to match his existing Heath-6m amplifier. These are currently the amplifiers in his main listening system. John said: "I am retired, so I have plenty of time to find, repair, and enjoy listening to vintage tube audio."

By Mike Klasco and Steve Tatarunis (United States)

Spiders and Surrounds (Part 1)

Design, Fabrication, and Performance

An introduction to the early and modern spider

To begin, let's talk about the function of the speaker's suspension. The typical speaker cone is suspended at two points: at its outer edge and at the apex. These compliant suspension parts are called the surround and the spider (or damper), respectively. The suspension system provides restoring force and contributes to the loudspeaker's mechanical "Q." This month we explore the spider and next month the surround will get its moment in the spotlight.

SPIDERS 101

The spider provides compliance (flexibility), a significant amount of the restoring force (returns the cone and voice coil to their rest position), along with concetric centering of the voice coil. The spider also helps filter out unwanted matter from getting into the voicecoil gap.

How much restoring force should the spider supply to the cone? This is dependent on the overall speaker system design. At one extreme is the "free-air" enclosure, such as the open back guitar amp or rear deck automotive speakers using the trunk as a back volume. Here, the spider is the speaker's only hope of controlling cone excursion. Especially if the trunk lid is open! Conversely, in a very small-volume enclosure, like the acoustic suspension closed box or the JL- and Alpine-style tight autosound boxes, the air compliance is so tight, the spider's stiffness is only a tiny contributing factor—really serving the purpose of centering the coil in the gap.

At higher excursions, the diameter and the depth of corrugations of the spider become a much greater factor than they do at small excursions. In the case of longer excursion woofers, the spider may also function as a snubber or mechanical limiter. Some speaker designers have used soft felt and other bumpers under the spider to provide a smoother (and quieter) bottoming between the spider and the back of the basket. In any case, over excursion is more sustainable when the spider bottoms out on the frame rather than the voice coil bobbin hitting the back plate.

The reason that the "spider" is called as such is due to its original appearance (see **Figure 1**). These were fabricated from Bakelite (one of the first plastics) which used phenolic as the resin. In the late '70s Sony tried glass epoxy spiders that were similar, but had a somewhat different "finger" pattern and low distortion was claimed. A few years later, EV introduced their EVX1800 subwoofer using a pair of glass epoxy spiders located above each other inside the voice coil bobbin. The spiders had some fatal flaws, including resonance and fracturing due to stresses. A less ambitious but more stable subwoofer soon followed, the EVX180 and with minor improvements made along the way, is still in production. The EVX180 uses a high-grade fabric in very strong weaves in an otherwise conventional spider and works just fine. There is a lesson in this somewhere.

A search through the patents shows many ingenious spider alternatives—accordion bellows, pantograph boxes, cantilever fingers, esoteric fibers, etc.—but the speaker industry has been conditioned to source spiders for pocket change and the fancy stuff does not come cheap.

CURRENT COMMON PRACTICE

The spider is the Achilles' heel of the speaker. It is one of the most critical components of a speaker, yet it is also the most unstable. Here we will review its design, fabrication, and performance, and also take a look at an alternate and more modern solution that is being commercialized.

Some of the design and material elements of spiders include the fibers, weave, resin impregnation, and corrugation profile. Spiders are typically fabricated from woven cotton impregnated with phenolic resin. Spiders and cones are the two main variables in speaker consistency and are acknowledged as a problem by the speaker and automotive OEM industry. Flex life of even the best phenolic impregnated fabric is not unlimited, and more significantly, Cms (compliance) and other parameters shift over time and use.

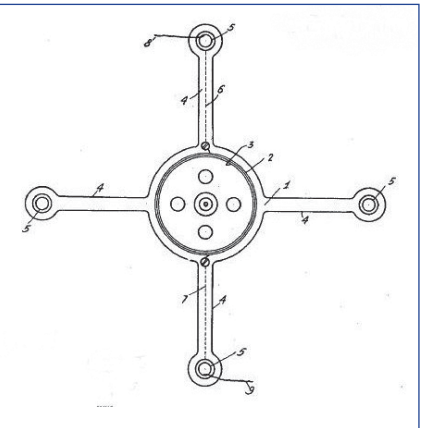

Figure 1: Early spider design

Photo 1: The modern-day spider

Cotton fabric spiders do not fare well under continuous high excursion operation, eventually tend to disintegrate, and are vulnerable to taking a compression set (sagging). Consider these variables which can affect performance: moisture content of the fibers during the resin impregnation process affects phenolic absorption of the cotton, moisture after the speaker is in the field is a performance variable, and shifts in the spider compliance over time due to cotton fiber and resin breakdown is another variable.

Proprietary treatments can compensate for some of these issues. Tearing, stretch-

ing, and cracking of the fibers near the neck glue joint due to glue wicking by the fibers is one of the failure modes of over-stressed spiders. CA (superglue) and epoxy adhesives, due to cured hardness, can sometimes create a knife edge when combined with a particular spider's geometry.

PROCESSING

Once the fabric is purchased, it is treated with a thermosetting resin, usually phenolic resin. Other additives are used to increase thread strength and improve forming in the tool using machines similar to the ones used at facility run by Loudspker Components Corporation in Nogales, Mexico (see **Photo 2**).

There are many vendors of phenolic resin and each offer endless formulations. The phenolic resin is supplied in either a liquid or powder form. The powder is mixed with solvents (methyl alcohol or acetone). The fabric is usually machine run dipped into the resin, and then dried. The effect of moisture on the fiber can be reduced somewhat by heat drying and also by increasing the phenolic impregnation. Workers are performing the process (see **Photo 3**) at a facility run by Loudspeaker Components Corporation.

FIBERS AND FABRICS

The life and stability of cotton as spider material leaves much to be desired. Speaker parameters shift even after a short "burn in" due to the cotton fibers breaking down. Poly cotton (first tried by RDM) has gained acceptance as a more stable fiber. Most promising are aramids, a cousin of the nylon family. Aramids are considered to have superior consistency with absorption of phenolics, better stability of mechanical characteristics, and quite a few other advantages. The first aramid fibers to be used for spiders were TeijinConex, from Teijin. This is a Japanese company who supplies TeijinConex fibers, fabrics, and blends of cotton. There are blending and twisting issues, and the effect on warping—shrinkage and flexing nonlineairities at high excursion—when fibers of different characteristics are mixed.

One solution is the use of intimate blends. Intimate blends twist different types of fibers together into a yarn, which is then used for weaving a fabric. Another aramid is DuPont's Nomex brand aramid fiber. DuPont spun lace Nomex has been used for speaker bobbins and collars for decades.

For audiophile speakers, aramid dampers have superior internal damping (tan delta) and are "quieter." That is, they are lower Q materials, resulting in lower self-noise interference with the sound radiation of the cone, especially in the upper midrange and higher frequencies.

For high-power speakers aramid fibers can tolerate high temperatures, close to 200° C, so they are going to have a better chance of surviving being bonded to a thermally conductive bobbin like aluminum than cotton or poly-cotton.

WEAVE

Aside from the fibers themselves, the weave contributes to mechanical and acoustical performance. For example, if the weave is too tight, then the air trapped in the chamber cavity formed between the spider and the back of the basket frame becomes a nonlinear air suspension element. This contributes to less than maximally flat bass response, higher air modulation noise, buckling of the spider at high excursion, as well as blowing out any ferrofluid of the gap (if ferrofluid is used). Venting of this chamber is accomplished using holes in the spider, cone neck, basket frame, or in the spider spacer.

Photo 2: Automated spider manufacturing at Loudspeaker Components Corporation's facility in Nogales, Mexico

Photo 3: Manual production of spiders at Loudspeaker Components Corporation's facility in Nogales, Mexico

LESS IS MORE, MORE IS LESS

What about getting rid of the spider altogether? If you have ever tried using ferrofluids in a cone midrange, you noticed that it is more resistant to voice coil rubs. This is due to the "liquid bearing" effect of ferrofluids. If the box internal volume (more specifically the air spring) is just right, and if the design of the driver is optimized, along with appropriate magnetic and viscous properties of the magnetic fluids, then you can eliminate the spider. NEAR (now part of the Bogen brand) has used this technique in their woofers for years. Aside from saving a bit of moving mass, the distortion drops a bit too. Assembly jigging is critical, and this approach is a lot of work.

DOUBLE SPIDERS

The opposite direction to NEAR's ap-

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proach was first used by Gauss on their woofers. Gauss used double spiders to enhance voice coil centering, especially at large excursions. The hope was to be able to use a really tight gap. Fostex used double spiders in their coax near field studio monitors, and in an AES preprint, pointed out the usefulness of measuring low-frequency distortion and orienting the direction each spider so as to counteract asymmetric characteristics in the surround and magnetic field in the gap.

An earlier double spider approach is used in Cerwin Vega's Stroker subwoofers and places the second spider in front of the cone. Community also has a similar scheme, and has used ferrofluid for an extra boost of voice coil centering.

PROFILE

When selecting a spider, aside from fiber and weave selection, you have the mechanical dimensions.

• The roll outside diameter must fit into your basket frame.

• The voice coil ID trim determines how snug a fit you will have between the voice coil bobbin (or collar) and the spider ID. The neck of the spider may be inverted or not inverted. The ID of the spider may have a tubular collar formed into the part or may be trimmed to a butt joint (the collar helps increase joint strength)

• Corrugation height helps determine maximum excursion.

• Corrugation profile—spider roll dimensions, progressive or linear roll size, contribute to spider linearity.

Another important consideration is to bump or not to bump (see **Figures 2** and **3**)? An easy way to increase distortion and reduce product life is to use a spider with a bump or cup. A large bump introduces asymmetrical compliance into the spider which shows up as an increase in harmonic distortion. With high excursion, these cups are known to fail. Why do engineers use

Figure 2: Flat spider

Figure 3: Bump spider

bumped spiders? Because for expediency, this configuration spaces the plateau of the spider off the basket frame, resulting in additional backward clearance.

How to avoid this compromise? One way is to use a bumped (often called an "offset basket"). A bumped or a double-bumped basket provides the needed clearance between the basket and the spider. Most basket vendors now offer bumped and double-bumped baskets. A double-bumped basket requires a secondary operation and you are going to pay for this. Another solution is a spider spacer beneath the OD of the spider.

By now you must be spidered out. Next month we will review all aspects of speaker surrounds. *aX*

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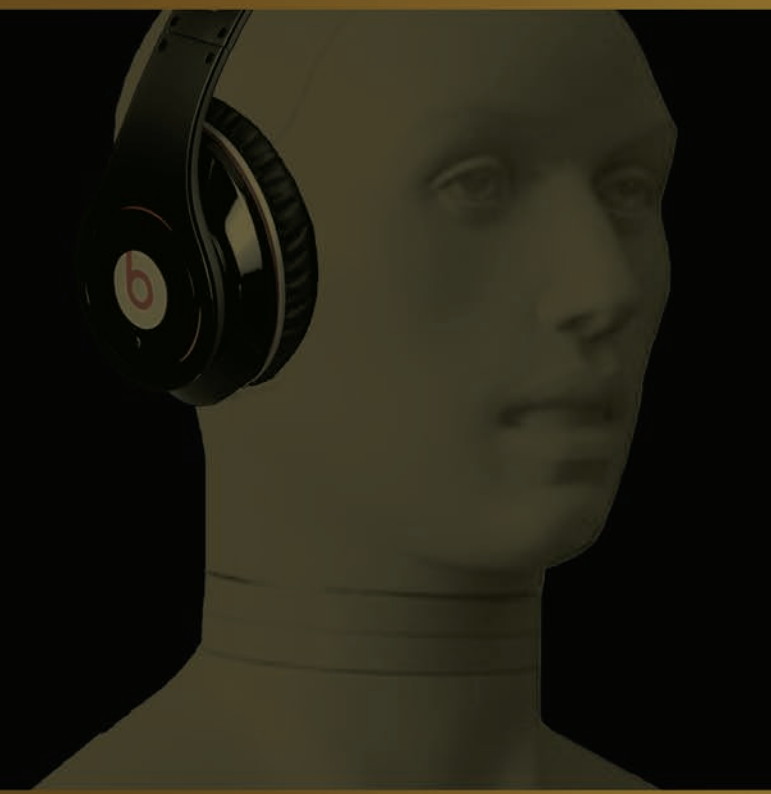

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By Nelson Pass (United States)

JBL L300 Modification

An audio enthusiast rekindles his desire for the JBL L300 loudspeakers and completes a renovation

Photo 1: JBL L300 Summit loudspeakers

Since I first encountered them in the mid 1970s, I have always admired the JBL L300 Summit loudspeakers. I have always thought these were some of the most attractive loudspeakers ever made, and I recalled that they sounded as good as they looked. I couldn't afford them when they were new. But here we are 35 years later, and you can get used ones for roughly the same price. Inflation being what it is, I find I can afford them now (see **Photo 1**).

GOTTA HAVE 'EM!

I have a neighbor, Jerry, who owns a pair of L300's he acquired in the early '80s. He was using them for the back channels in his media room. You might ask, "What speakers would relegate L300's to the back channels?" A custom pair of Augspurger monitors using dual TAD 1601 woofers, bi-amped with TAD 4001 compression drivers and horns. Very nice.

Jerry's L300's had spent a lot of time exposed to Los Angeles sunshine and smog. The result being that the woofer surrounds had decomposed, as had the grill cloth material, and the wood had become dried and bleached. Nevertheless, they rekindled my original lust for these pieces, and I decided to get a pair. Kent English found them for sale in San Francisco at the corner of Haight and Ashbury. They were in excellent shape. The wood looked good and the woofer cones had new foam surrounds. Jake played me a few cuts to confirm proper operation, and yes, they were as I remembered them, warts and all.

I hauled them home and over the course of several weeks the efficient bass reflex boxes and horns provided a nice manly contrast to my full-range cones in open baffles. On the positive, the sound is very dynamic and lively, with punchy bass and good articulation coming from the mid-range and top-end horns. Very rock and roll.

Another plus is that they are easier to drive than I had been led to believe. They seem to work well with low-power amplifiers and with amplifiers without high damping factors. Toward this end, they are good candidates for tube amplification.

And they come with level controls, allowing adjustment of midrange and tweeter levels so you can tweak them to taste.

I suppose it's too much to ask for perfection from speakers introduced at the beginning of the Disco era. The faults are two: the bass bump at 50 Hz is a bit resonant, and the crossover network between the woofer and midrange brings out too much of the "horn sound" in the system. Perhaps it's just that tastes have evolved over 36 years, or perhaps it's just me, but after a while these traits began to wear on me, and I began thinking about some adjustments.

By the way, George Brooke did a nice write up on renovating his L300's, and you can check that out in the September 2001 issue of *audioXpress*. His piece is not marred by the inclusion of an Aleph 5 power amplifier, and I am informed he is considering another article featuring the JBL 4343.

NEW WOOFER SURROUNDS

Meanwhile, Jerry climbed on board to renovate his pair of L300s. In his case, we needed to repair the surrounds on his woofers, so we went to Orange County Sound (www.speakerrepair.com) and ordered up some re-edge kits #11-035-W-JBL for $30. For those who view this sort of task with trepidation, these folks also offer a service to do it for you. We opted for the DIY kit, on the logic that the worst that could happen is that we would end up sending them to Orange County anyway.

The kit turned out to be perfect. We trimmed off the decayed foam surrounds with a sharp hobby knife, scraping the old adhesive from the cone and the cast basket. The new foam edges and the gaskets fit perfectly, and we first glued the cones to the surrounds and then came back the next day to fit these to the rim of the baskets. Fortunately, Orange County Sound provides a generous quantity of the glue, and by following the instructions it came out perfectly.

THE ORIGINAL CROSSOVER

I opened up the speakers and removed the crossover network to the outside, running wires through the bass port to the drivers. Then, I made a series of measurements documenting its characteristics, plotting the voltages to the drivers, the impedance seen by the amplifier and the acoustic response. I also measured the raw impedances of each driver so that I could better simulate their interaction with a crossover network.

Figure 1 shows the original crossover schematic as provided by JBL. **Figure 2** illustrates a plot of the voltages fed to the drivers vs. frequency. Here you see the curve of both speakers, and we infer that the crossover points are about 1 kHz between woofer and midrange, and about 7 kHz between midrange and tweeter.

Figure 3 is a plot of the acoustic output of the speaker at one meter. The dip you see here at 400 Hz is a floor-bounce artifact, but the dip at 1700 Hz is the response of the speaker. **Figure 4** is an impedance plot seen by the amplifier.

ANOTHER TAKE ON THE CROSSOVER

After I measured the stock crossover,

I began to assemble a new one from scratch, wiring prospective components on a piece of plywood sitting on top of the speaker. I set up the system so that I could easily listen and also measure electrical and acoustic response.

This started a process that lasted several months. Some of you might imagine that we can just plug the measured numbers into the computer and it will spit out a perfect crossover network. Certainly, it will spit out something, but it is unusual for the results to be the best possible sound. At best, the simulations will give you a good start.

Of course, we already had a good starting point by virtue of the original design. Also there are a couple of other alternative designs on the web, testaments to the respect the L300 gets in polite audio society.

The revision procedure involves trying something, measuring, and then listening a lot. With a soldering iron and lots of parts handy, the first two parts only take a few minutes. The last part is occasionally quick (when it sounds awful). If it sounds good or better, then it is necessary to spend more time with it, running through a series of familiar recordings, sometimes for days, deciding on whether the change stays or not.

And then you reiterate the process until you are happy with the sound and every change you make sounds worse. I usually use CDs for this as it can be very hard on my precious vinyl. In the early 1970s at ESS, we kept boxes of Oscar Peterson, Joan Baez, and the soundtrack from *Shaft*, not to mention spare cartridges, and we tended to burn through them.

As I said earlier, there were two performance issues. The first was the resonant bass bump at about 50 Hz, which turned out to be easy enough to deal with—small amount of dacron in the port. This reduced the bump by about 3 dB at the 50-Hz point, tightening and smoothing the sound. You can conveniently adjust this to taste from the outside.

The character of the woofer to midrange transition was more difficult. Looking at the curves and schematic, I made a guess that the original design had to contend with the prospect of being driven to very high-power levels. This is a potential problem concerning both the distortion and reliability of the midrange compression driver, as this horn does not provide much loading below 1 kHz. The crossover network addresses this with a relatively high-crossover point at 1 kHz, with a fairly sharp slope. A similar approach is used in the crossover characteristic between the midrange and the horn tweeter, with the high-pass filter having three poles.

My reasoning was that given the expectation of more modest power levels we could relax these constraints, lowering the crossover point and using filters with a lower "Q." Toward that end, I began constructing variations of the original filter set to examine whether going in that direction improved the sound.

After a while, I settled into a woofer low-pass network that was nearly identical to the original, except with a slightly lower frequency. I used heavy-gauge air core coils over iron core, and larger value polypropylene capacitors, both presumably better than the original parts.

Initially, I worked with variations around the original in-phase wiring of the midrange, but I found it difficult to construct a filter that was flat at 1 kHz and also sounded as good as I wanted. I think the difficulty revolved around the distance time delay of the

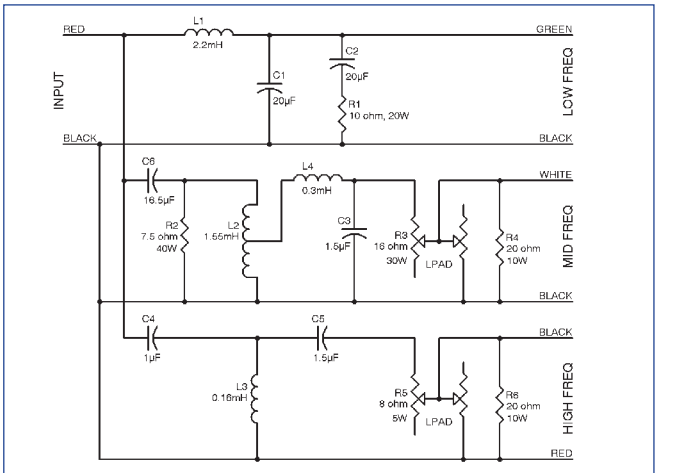

Figure 1: The original crossover network

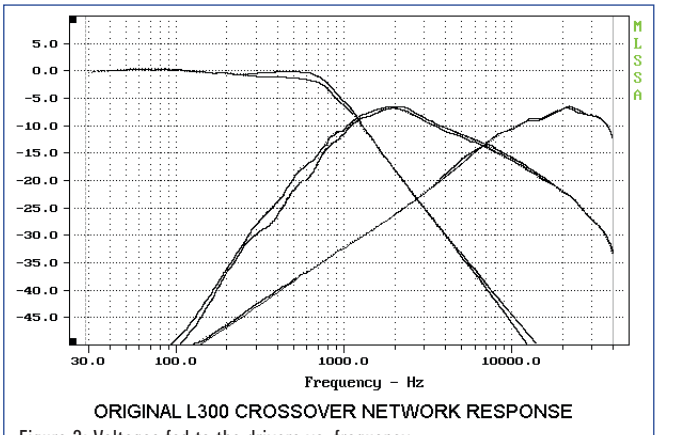

Figure 2: Voltages fed to the drivers vs. frequency

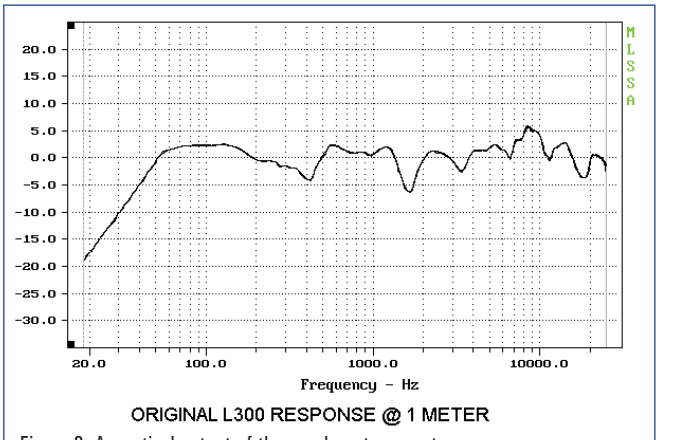

Figure 3: Acoustical output of the speaker at one meter

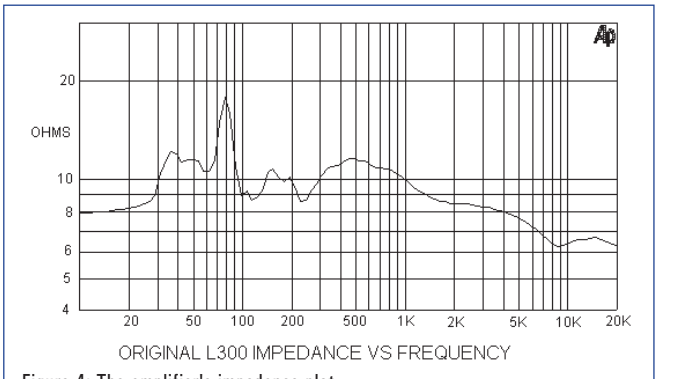

Figure 4: The amplifier's impedance plot

midrange, which can be clearly seen in a MLSSA pulse. (That is to say, there are two of them: one from the woofer and tweeter and another from the midrange.) Finally, I began working with the midrange phase flipped.

This is where I had to choose between faults. There is simply not an ideal complementary match between the character of these two drivers. After some more experimenting, I worked up my best compromise—a midrange high-pass network, which is different in the details and response curve, but delivers most of the warmth, intimacy and articulation I was looking for. This is where the instruments have a "float in the air quality" that takes the performance out of the box and into your room.

Very often you get something like this simply by trying everything, and in the end, depending on your ears to tell you when it's right. I continued playing with variations for several weeks, but kept coming back to this circuit (see **Figure 5**).

All the coils are heavy gauge air core, the capacitors are polypropylene and the resistors are 10 W. Where you see parallel resistors is where I wanted 20 W. You can get these from Parts Express or Madisound. Clarity Caps and Mills resistors were chosen because they were on hand. All the parts were glued down with silicone adhesive and wired point-to-point.

High precision is not essential in this network—5% is plenty good enough. No fancy wire was used in the speaker, just the regular stuff from National Cable, but with separate lines from the crossover elements to the input terminals to minimize interaction.

Also when considering where to glue the coils on the plywood board, keep them some distance apart so they don't talk to each other. The 12" × 16" piece of wood has plenty of space and still fits on the bottom of the enclosure fine.

I replaced the input terminals with big fat gold ones and kept the L-pads in the circuit (mostly to keep the controls on the front panel).

You can replace the originals with these parts from Parts Express:

- Tweeter: #260-250 8 Ω 15-W Lpad
- Midrange: #260-265 8 Ω 100-W Lpad

Make a point of getting the 1"-long shafts, as the boards that holds these inside the enclosure recesses them, and you want to have the original knobs sit flush with the front baffle.

Many people look askance at L-pads. This is understandable, and the wipers are certain to get noisy over the years. Some people think they just sound lousy anyway, but I did, in fact, use them satisfactorily. If you want to do better, here is an alternative network using resistors tapped to discrete levels (see **Figure 6**).

This network was tested, and the performance differences between it and the L pad were minimal, so you can use it without compromise. Just attach the driver's wire to tap points from Low to High as you like. The resistors can be 3 W or more, and once again, 5% is plenty of precision. The sound didn't suffer for using wire-wound types, but if you want to pay more for noninductive resistors you should feel free.

Refer to **Figure 7** for the response curve of this crossover network. Comparison between this and the original shows that the roll-off characteristic for the drivers is similar, but less sharp. The

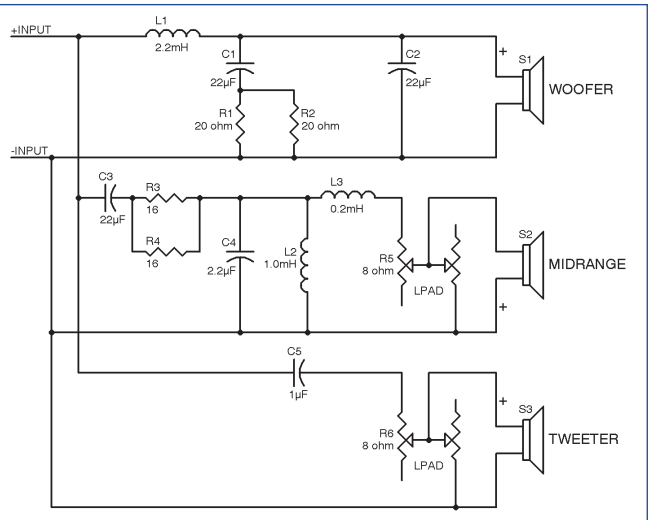

Figure 5: The modified circuitry for the L300 Crossover

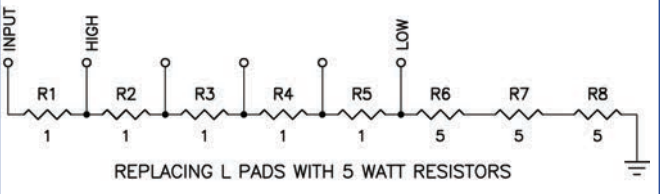

Figure 6: An alternative network using 5-W resistors

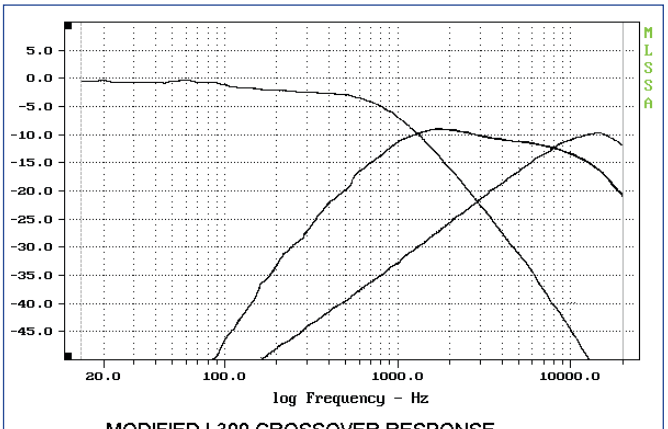

Figure 7: The response curve of the modified crossover network

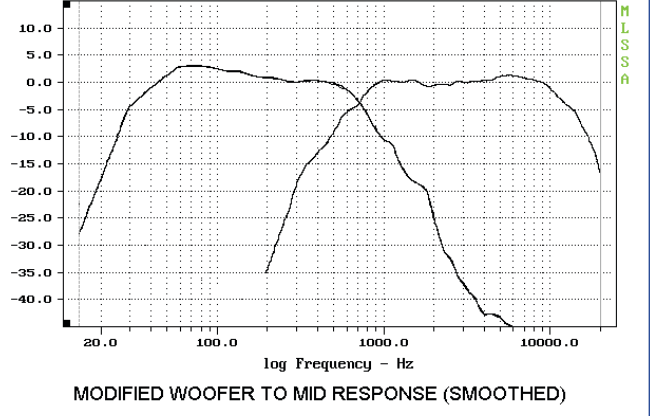

Figure 8: The smoothed near-field curve of the woofer to mid-range response

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8 - 12 - 14 - 16 AWG

Wax Coil
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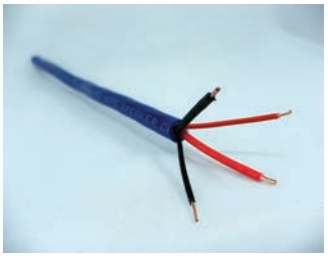

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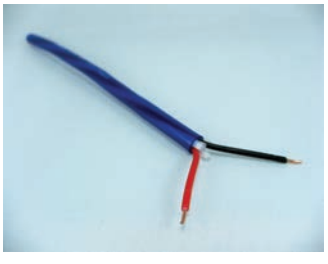

Jantzen Solid Core 6N OFC
6N 2x17AWG (2x1.0 mm2)

www.jantzen-audio.com

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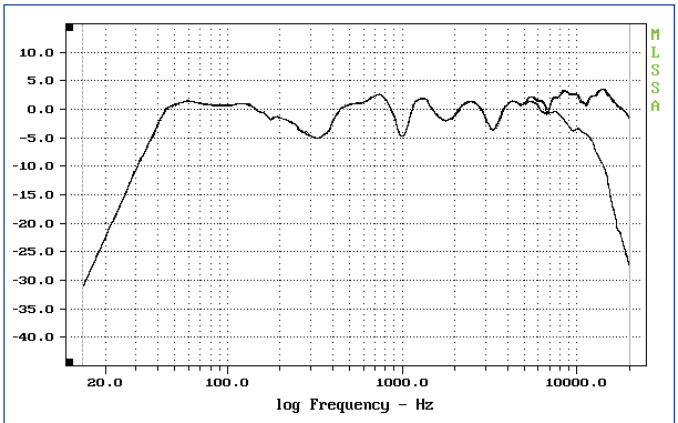
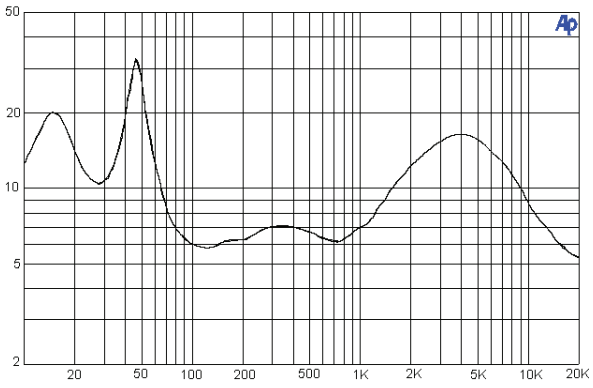


MODIFIED L300 RESPONSE @ 1 METER W/ AND W/O TWEETER

Figure 9: The acoustic response of the speaker at one meter



MODIFIED L300 IMPEDANCE

Figure 10: The input impedance of the modified speaker

crossover frequency between the woofer and the midrange has been moved down slightly, and the tweeter is now crossed slightly higher, but with a single pole (one capacitor) instead of the original three-pole network.

Figure 8 shows a smoothed near-field curve of the woofer to midrange response. The above curve has been smoothed to highlight the acoustic center of the crossover point, which is about 700 Hz. Of course, the real curve is bumpier than this, reflecting the resonant points of the horn midrange and some interference between the drivers. For the acoustic response of the speaker at 1 m refer to **Figure 9**.

Here you can see more of the vagaries of the actual response. At 300 Hz, we observe some interference off the floor (not such a problem at greater distances from the speaker) and the bumps and dips of the crossover point itself. What can I say? I can make it flatter, but I can't make it sound better. Also, here you can see the addition of the tweeter to the system where the curve bifurcates above 6 kHz. **Figure 10** shows the input impedance of the modified speaker.

IDEAL FOR DIY EFFORTS

This isn't the first time I have tried to improve a JBL loudspeaker. Some years ago I played with a pair of L100s (love that grill), but I have to say that I could not regard that as a success. Most likely, I simply didn't put enough time and effort into them. I did learn that it is not a trivial task to improve on original JBL design. If it can be done at all, it requires a lot of persistance and patience—just the kind of approach Thomas Edison would have used.

The speaker is very forgiving of amplifiers. I was able to drive them well with 600-W mono-blocks with high damping factors and also with little 5-W amplifiers having damping factors of three or four. Both extremes worked well, even if the sound was not quite identical.

I am very happy with the results. The end product doesn't appear to be an improvement based on response curves alone, but they do sound really great. I think I've managed to respect the JBL legacy while tweaking the sound to reflect the tastes of the 21st century. They still have that lively character of the originals, but the bass thumps are a little tighter and the horns a little more subtle and sweet, inviting you to spend hour after hour going through your entire record collection, which is what we're here for.

And, of course, I kept the original crossovers. *aX*

By David J. Weinberg (United States)

CEDIA 2011

The Integrated Home

A review of CEDIA 2011

The Custom Electronic Design and Installation Association (CEDIA; www.CEDIA.org) held the 2011 expo in the new Indianapolis convention center. There was general agreement that it afforded a much better experience than the Atlanta convention facility.

While there is much to appreciate and learn at the CEDIA Expo, I reserve my one major complaint for the end of this report.

There were approximately 450 exhibitors (approximately 80 first-time). Attendance was claimed to be 17,600 (approximately 25% first-time), down from last year's 20,700 and 2009's 22,000. Press attendance also seemed light.

More than 100 CEDIA University courses and approximately 150 manufacturers' product training sessions filled out the schedule.

This year's theme was "Every Overlapping Technology of the Integrated Home," testifying to CEDIA's expanded scope from a strong central focus on home theater into all facets of home technology, including wired/wireless local and remote (Internet-based) health monitoring, security, and whole-home monitoring/control.

Compared with recent CEDIA Expos, there was more emphasis on networking (especially wireless) and home-system monitoring/control, plus whole-home content distribution, with many Android and iOS system-control apps. Even so, there were few exhibits related to home lighting and energy management. Many presentations and products played up the retrofit, expansion and upgrade potential vs. new construction, recognizing the real estate market reality.

Loudspeaker driver costs have been increasing due to China (which supplies about 97% of the world's rare earths) having declared neodymium, used in magnets, to be a national resource and restricting its export, with the price doubling due to raised taxes and other costs over the first third of 2011. Other sources confirm the extent of the price increase.

Invisible speakers have become more conspicuous in various manufacturers' lines.

The 3-D hype level was muted compared with recent shows. Based on a September 8, 2011 CEDIA press release, in late 2011 CEDIA will release the market research report, "Size and Scope of the Residential Electronic Systems Market in the U.S.," which will feature data on the characteristics of companies working in that industry, listing their number (approximately 11,000 custom retailers and AV installers/integrators), the size of the workforce, the economic impact of the industry, plus current opportunities and threats. The average 2010 gross revenue for survey respondents was $1.6 million.

EXHIBITORS

These exhibits are summarized because of interesting devices and to highlight the breadth of product areas that come under the umbrella of custom installation. However, not all custom installers are experts in all facets of home theater, automation, monitoring, and control. The consumer needs to do his homework when selecting a contractor.

CEDIA's Future Technology Pavilion included a 20' × 9' wall-sized display comprising six Digital Projection 1920 × 1080 projectors (two rows of three projectors) and six Fusion processors, controlled from a PC with an NVidia graphics card. The system splits the source image(s) into feeds for each processor/projector, overlapping and mating the images into a single wall image, or enabling display of several images at once. The projectors and processors generated lots of heat in the enclosed back room; especially quiet air conditioning would be required in non-convention floor installations. The pavilion incorporated Crestron controls and invisible speakers, and used the Trinnov sound-correction system.

DISPLAYS

Da-Lite (www.Da-Lite.com) again featured the JKP Affinity series screen material in their demo theater, showing a screen free from grain and sparkles, and thus capable of revealing the best and worst from any projector at any current resolution. The demo also proved that a low-gain screen can deliver a high-quality image in a room with some lights on, as long as those lights don't shine directly on the screen. Panasonic, which can select any screen material they want for their show-floor projector demo room chose the JKP Affinity screen material; even with a quick viewing, the clarity of the image was obvious.

JVC (www.JVC.com) announced four D-ILA front projectors: the Reference series DLA-RS65U ($12,000 srp) and DLA-RS55U ($8,000 srp), plus the Precision series DLA-X90R ($12,000 srp) and DLA-X70R ($8,000 srp), a primary difference within each series being a claimed native contrast ratio of 120 k or 80 k. The DLA-RS65U and DLA-X90R are built using hand-selected parts. All four projectors feature three 0.7" 1920 × 1080 D-ILA devices, a 2- to -3-D converter, a 220-W UHP lamp for 1200 ANSI lumens output, and incorporate JVC's 4K e-Shift technology (developed with NHK) to upconvert and scale HD content to 3840 × 2160. The difference between the Reference series and Precision series is how they are distributed. JVC built a small theater on the show floor for its consumer 4K D-ILA projector demo, which used the DLA-RS65U and a 10'-diagonal Stewart Reflections Active 170 3-D screen. I sat toward the right in the first row, about 7' from the screen. The screen material is not smooth enough for high-resolution images; I saw sparkles and video noise caused by the screen. I was told that for the demo setup their projector calibration was intentionally compromised—the color was adjusted to look moderately right when viewed through 3-D glasses, while also approximating correct color without the glasses (2-D images); neither was accurate, but I give them credit for trying. The blacks were good, but not as black as the masking around the screen. Compared with the 2-D

images, the 3-D images were substantially darker with color shift and less color saturation. Overall, the image of Times Square, NYC, appeared soft.

Samsung's (www.Samsung.com) 3-D LCD HDTVs that incorporate RealD's RDZ technology will have the active shutter built into the display, so the viewer can wear the same passive 3-D glasses used in RealD 3-D-equipped movie theaters. Samsung claims that this will enable delivery of 1920 × 1080 image resolution to each eye. However, it remains unclear how that image will be created. Will there be a new, wider-bandwidth method of delivering image data to the home, or will the display upconvert the half-resolution 3-D image data in most consumer 3-D delivery formats?

Sharp Electronics (www.SharpUSA.com) has brought back Pioneer's Elite brand with the 60" ($6,000 srp) and 70" ($8,500 srp) LED-backlit LCD HDTVs. Like Sharp's AQUOS line, these displays incorporate the added yellow subpixel (RGB+Y). As displayed on the outside wall of their booth, the blacks appeared quite dark, although not as black as the display's frame, and I needed to be at least 4' from the panel to not see the pixel structure. The display's location prevented me from making any useful judgment about its performance. However, industry consultant Pete Putman has pointed out that there have been problems with local-area LED backlighting (such as that used in these panels and many others), such as halos and fringing around objects on dark backgrounds, even on high-cost professional LCD monitors. This is a flaw I noticed several years ago on a Toshiba monitor exhibited in a dark room on the show floor.

Sony (www.Sony.com) introduced the VPL-VW1000ES 4K SXRD home theater projector ($25,000 srp), claiming 2000 ANSI lumens output from its 330-W UHP lamp. Naturally it includes a dynamic iris (manual iris control is accessible through the projector's menus), so contrast ratio numbers are dynamic, not static. Sony representatives would not state the projector's native contrast ratio. The projector performs upscaling, although how well was not obvious from my front-row viewpoint, 8' from the 120" diagonal (104"-wide) screen. Detail improvement from 1920 × 1080 to 4K was not dramatic, although the Stewart Ultramatte 150 screen was not smooth enough to reveal all of the projector's possible capabilities and flaws—sparkles and grain in the image that likely were due to the screen. I heard from others viewing this demo who were "underwhelmed." The projector appeared to be properly calibrated. The projector has an integrated IR transmitter to drive Sony's TDG-PJ1 active-shutter 3-D glasses ($130 srp). Sony also demonstrated their HMZ-T1 personal 3-D viewer headset ($800 srp) with two 1280 × 720 OLED panels delivering a virtual image of 12.5' diagonal as viewed at a 12' distance, stereo or virtual-5.1-channel sound, which is connected by a 3.5 m cable to the processor unit that has an HDMI input; the headset weighs 14 oz.

AUDIO PROCESSING AND LOUDSPEAKERS

Atlantic Technology (AT; www.AtlanticTechnology.com) revealed the PowerBar 235 (probably around $600 srp, due for release in January 2012), a two-channel soundbar (42" × 5.25" × 5.75") that requires no separate woofer module and can generate virtual surround. Near each end is a 4" woofer and its H-PAS cabinetry (with a claimed 47 Hz –3 dB low-end cutoff) that crosses over in the 3.5 to 5 kHz region to a ¾" tweeter. Within the soundbar are two 40-W Trident switch-mode amps. As is hinted in the model number, it can be configured for two-channel stereo, or to generate a virtual three or five channels from up to five channels of line-level input. It has three sound-quality controls: bass, treble, and intelligibility (a shelf boost over approximately 500 Hz to 1000 Hz, plus DSP providing minimal compression; designed to be fairly subtle). When I heard it in AT's sound room (sitting one seat off center, about 6' from the speaker), I was assured all adjustments were set to flat. With their source material (with which I was not familiar), my perception was that the overall sound was relatively natural; the midrange was slightly forward, but not bothersome; the bass was decent. It generated a bigger sound than I expect from a soundbar. When set to two-channel mode for a selection of male vocal, piano and saxophone, the low-end of the male voice sounded a little boosted. In surround mode, movie sound (an excerpt from *The Day After*) was acceptable—dialog was clear, the effects sounded okay, but I'm not sure about the top end, as the sound of the cracking ice shelf didn't sound right. For a soundbar, this one is decent.

GoldenEar Technology (www.GoldenEar.com) has added Triton offsprings: the Aon series bookshelf-sized monitors that sound similar to the Triton floor-standing models. The Aon 3 ($500 srp) and smaller Aon 2 ($400 srp) use the same tweeter as the Triton, plus a woofer, with a passive radiator on each side. Listening from one seat right of center, about 6' from the speakers, which were about 11' apart and slightly toed in, the sound was quite natural and the ambiance in the recordings came through clearly. The spectral balance sounded similar from on-axis to about 40°-off axis (I wasn't able to check beyond that point). Bass is not overwhelming, but acceptable for bookshelf speakers. Male chorus and brass were free from an edginess I usually hear. The same was true of a female solo with mixed chorus, woodwinds, strings, harp, and organ. A jazz club recording delivered real-sounding audience applause and crowd noise. On a Broadway musical recording with jazz band, the upper register of the male vocals had a slight edge (possibly a bad microphone choice, or poorly close-miked), but the instruments sounded okay except for the trumpet, which also sounded close-miked. Even at moderately high levels, a piano sounded clean. Mussorgsky's Pictures at an Exhibition showed that these speakers generated more-than adequately deep bass for bookshelf speakers. The orchestra sounded quite good with clear musical detail during both pianissimo and forte passages. At no time did I sense a boosted or depressed frequency range, except for deep bass. The Aon's sound is sufficiently natural, clear, and full-bodied that few listeners will want to crank the volume. They are eminently listenable. Sandy Gross has raised good kids. All parents should do so well.

Harman (www.Harman.com) has developed an algorithm for simulating surround that in some ways seems to go beyond the long-time staple of Lexicon processors: David Griesinger's Logic7. Created under the guidance of Gil Soulodre, Harman calls it Quantum Logic 3-D surround technology (QL3D), which is designed to create surround sound from mono, stereo, and multichannel sources. Their demo room, in a tractor-trailer, had all-JBL speakers in their 7.1-channel system, with four subwoofers (fed from a single subwoofer output) in the corners. The left- and right-front speakers were toed in. There were three front-height speakers (above the left, center, and right)

and two surround-height speakers. I sat in the left of three large chairs in the front row. QL3D synthesizes surround signals beginning with a process they call signal decomposition, which deconstructs the front soundstage into relatively narrow angular "spatial" slices (picture the left-speaker to right-speaker arc viewed from the prime listener's seat, and slice it like you would a pie), then isolates the sound from each slice into a separate datastream (such as identifying and pulling out the soloist's voice, partially because it's usually in a single slice. They said there was some tracking if the identified source moved laterally). The DSP separates the "dry" source from its related reflections/reverberation and, using their Aesthetic Engine, places the various sounds where the algorithm chooses, also trying to select appropriate sounds for the height speakers. They claim "perfect reconstruction" of a two-channel source signal if the extracted streams are recombined. The extraction and signal analysis was called the "brains" of the system, with the aesthetic engine (where to put the extracted streams) being the "heart and art." On a QL3D-processed stereo recording of Frank Sinatra, when they played only the extracted voice I heard artifacts that sounded like inadequate sampling, with a little of his band mixed in; during the extracted band playback, there was some of Sinatra's voice in the stream. Jennifer Warnes' Famous Blue Raincoat (an album I know well): The extracted source was dry, but not anechoic; the reverb-only extraction sounded pretty good. Miles Davis' Kind of Blue: With QL3D turned on, the instruments (bass and horn) wandered as the music moved up and down the musical scale. Several excerpts mixed by noted sound engineer Nathaniel Kunkel, who approved what QL3D did to his mixes: Shawn Colvin's "Don't You think I Feel It Too" (from Live '88; voice and acoustic guitar): With QL3D on, I heard a spatial/temporal disconnect between the source and the reverberation, with only ambiance in the height channels; David Crosby and Graham Nash's "Lay Me Down" (from Crosby Nash): The QL3D effect was pleasant, spreading out the voices and instruments, reducing the clutter of the stereo soundstage. One excerpt I did not hear was "Handy Man" from James Taylor's JT; Kunkel did the 5.1-channel album mix, and told me that on it his mother sang backup and his father played drums. Led Zeppelin's "Whole Lotta Love" from Led Zeppelin II: The "round-the-room" effect was strong, but sometimes the center-rear sound disappeared. An excerpt from one of the Matrix movies (5.1-channel source): While they claimed that QL3D processing of a 5.1-channel soundtrack delivers a stronger sense of height and front-back space plus diagonally moving effects, the music in the soundtrack sounded like it was relegated primarily to the rear channels, and the center of the room sounded empty.

SpeakerCraft's (www.SpeakerCraft.com) Seamless Invisible Series speakers can be "plastered" into the wall and painted, thus becoming truly invisible. They stated that this series can also be mounted in exterior walls, although there was no comment regarding the advisability of weatherproofing. The BoomTomb in-ground subwoofer delivers deep bass in your back yard, with only a short tube above ground radiating sound. I found it interesting that Nirv (www.MyNirv.com) was not given more play at this year's CEDIA Expo; it is an interesting and apparently nicely conceived home-wide audio/video control and distribution system that continues to be part of the company's product line. SpeakerCraft is proud of having raised their prices only 6% over the past three years, while food prices have increased 21%.

PERIPHERALS, ACCESSORIES, AND INTERCONNECTION PRODUCTS

Accell (www.AccellCables.com) announced three new products: the UltraAV 5 × 1 HDMI audio/video switch/repeater (certified HDMI/HDCP-compliant, with automatic/manual switching and a remote; $90 srp), a growing need as we install more sources than the display and surround processor can handle; AVGrip Pro locking high-speed HDMI 1' cables (useful behind equipment stacks and racks; $15 srp); and the UltraCat high-speed HDMI extender transmitter/receiver set (certified HDMI/HDCP-compliant; $500 srp/set) using HDBaseT technology over a single Cat5e/6 cable.

Belkin (www.Belkin.com) exhibited their ScreenCast F7D4515 ($250 srp) AV4 AV-to-HDTV wireless transmitter system that operates in the 5 GHz spectrum, is compliant with the WHDI standard, and transmits 1080p30 video and up to 5.1-channel sound over distances up to 100'. However, I could not determine whether the audio or

the video are data-reduced, but strongly suspect that the data rates are no higher than those from cable and satellite service providers. Belkin also showed the new F7D4555 Universal Wireless HDTV Adapter ($80 srp) with selectable 2.4 GHz or 5 GHz band operation, which is designed "specifically for smart TV applications, [to] turn any Internet-ready HDTV into a WiFi-enabled HDTV and make getting connected to services like Netflix, Pandora, and Hulu Plus easy."

Hangman (www.HangmanProducts.com) has developed an innovative line of hardware solutions including cable management systems, furniture anti-tip kits, soundbar hangers, and the Simple Mount TV Hanger to securely suspend an HDTV panel like a heavy painting (closer to the wall than most other mounts.)

Jensen Transformers (www.Jensen-Transformers.com) continues to offer RF, video and audio products that solve grounding problems without violating the National Fire Protection Association (NFPA; www.NFPA.org) codes and standards, including the National Electric Code (NEC). There are many informative white papers and Jensen-product schematics on their website. Bill Whitlock, Jensen president, was a member of the AES working group that generated AES48-2005 (reaffirmed 2010) "AES standard on interconnections—Grounding and EMC practices—Shields of connectors in audio equipment containing active circuitry." This is the website where you can learn the facts about grounding and electronic noise generation and elimination.

Monster Cable had their test bench showing the eye-pattern performance of HDMI cables. However, this is deceptive, as there are 19 conductors in an HDMI cable. The eye pattern only looks at two of them—a video signal pair—and ignores the signal amplitude and phase integrity on the other 17 wires. To ensure an HDMI cable will perform as desired, a single test is required: bit error rate—if the bits fed to the HDMI transmitter and through the cable at the required bitrate come out of the HDMI receiver at the other end without errors, the cable will work; this test takes into account inter- and intra-pair timing and bit-waveform distortion.

The Multimedia over Coax Alliance (www.MoCAlliance.org) continues enhancing and marketing its standardized specifications for using existing and newly installed coaxial cable for multimedia distribution throughout the home, emphasizing the benefit for retrofitting houses that have coax already in place.

NextGen (www.NextGen.US) announced $80 3-D active-shutter glasses that are rechargeable via USB and are claimed to work with all major brands of 3-D displays. They also showed the Super-Slim TV wall mount ($25 to $32 srp depending on display size; 17" to 37" displays up to 110 lbs) that hangs a panel display as easily as a painting, and puts it closer to the wall than all but recessed mounts.

Rainbow Fish Fiber Optic (www.RainbowFishCorp.com) announced their lossless HDMI fiberoptic extender in lengths up to 1000'. The source end gets its power from the HDMI connection. The far end has both an HDMI connector and a USB connector, the latter for power, since physics has not come up with a cost effective way to send power through a glass fiber. This is the most intelligent solution I have come across for long HDMI cable runs.

For those who (like me) watch far too much television, TiVo's (www.TiVo.com) Premiere Elite DVR ($500, plus the cost for TiVo service; anticipated late 2011 release) is the ticket. It offers four tuners (record up to four programs simultaneously), 2TB storage (claimed to hold up to 300 hours of HD programs), multistream-CableCARD slot, USB 2.0 port for external eSATA storage, access to online services such as Netflix, Pandora, Hulu Plus, Amazon, and YouTube (contracts with specific services required), control from a keyboard as well as via an iPad/iPhone app, compatible with Crestron/Control4/RTI systems, MoCA support, supports HDMI-compliant splitters with up to 16 HDMI ports, and streams music and photos from the home network. The only negative is the monthly service fee for their electronic program guide.

SYSTEM CONTROL

Aprilaire ("fresh ideas for indoor air;" www.Aprilaire.com) announced their model 8800 universal communicating thermostat, which can be integrated into a home-control system, enabling monitoring and control of indoor and outdoor temperature, and humidity at a variety of sites throughout the estate.

Clare Controls (www.ClareControls.com) announced a configurable home automation system that is managed from the Cloud and runs on a Mac (including iPads, iPhones, and iPod Touches). Dealers/installers can configure, deploy, service, and monitor these systems from a Cloud-based portal, minimizing service calls for reprogramming. In addition, the customer is given access to Clare's extensive library to create and customize their user interface.

Crestron (www.Crestron.com) has implemented an object-oriented, drag-and-drop iPad-like interface on HD touch panels for their house control systems. It runs on their Core 3 OS. All images and icons are built using vector graphics, enabling simple resizing for different screens and screen layouts. They run many of their control and audio/video data signals across CAT5e twisted-pairs cable, a growing trend in home-system wiring. Crestron is offering a trade-in credit on any brand of analog video distribution system toward purchase and installation of a Crestron digital video distribution system, at least some of which transfer uncompressed HD video and audio.

Navnet (www.NavNetInc.com) claims to offer a "no-programming home automation" system that comes to the installer with many features preconfigured, merely needing to be enabled. Various manufacturers' system functions can be added and activated via pulldown menus. NavNet systems include security, HVAC control, electricity use monitoring, and other capabilities. Their system is designed to minimize programming and installation time, reducing cost. I was not able to determine the extent of manufacturers' systems readily available for inclusion, nor how to add control and monitoring of those product lines not in their database.

Powerline Control Systems (www.PCSLighting.com) has been developing, manufacturing, and selling commercial and residential powerline-communicating lighting control systems for almost two decades. Their product line includes controllers/dimmers for LED and CFL (cold fluorescent lamps), fluorescent, halogen, and incandescent bulbs.

PRESENTATIONS

I was able to attend some of the courses, but CEDIA offered others I also bring to your attention. The information on these courses comes from a combination of my notes and the handouts presented

to course attendees. There is much more to each course than presented here.

ESD029 was Michael Heiss' "**17th Annual New Technologies Update**" during which he relates tales about the technologies that drive the custom installation industry, the current status of key technology areas, and where he sees them going over the next 12 to 24 months.

• Today's custom installer industry is migrating toward being content-centric, not technology-centric (we're here to facilitate consumers playing their content), with recognition that the Cloud is quickly becoming a widely accepted storage and access point for content of all types (focus on the Cloud, "as it is going to rain content") and that multiple products deliver quite similar functionalities and services. (There are many ways to access content, but there is no one overwhelming choice for service or hardware platform. Google's purchase of Motorola Mobility notwithstanding.) There is also the choice of a service vs. a set-top box. However, it will be some time before the Cloud replaces discs, especially for higher-quality HD content. (There are substantial questions about Cloud-storage reliability, plus concerns about Cloud-stored data privacy, security, and accessibility.)

• Questions the installer must ask: Which device for which service? (Some content is only available from certain services and on specific hardware, and it's changing. For example, Netflix is scheduled to lose access to Starz content in early 2012.) Is there a difference in quality among the choices? (Heiss hasn't seen substantial quality differences. Vudu offers more HD video than Netflix, and delivers higher resolution multichannel audio.) What is the impact of the options for home wired/wireless infrastructure? (Wired delivers more consistent higher-quality performance than wireless.) There are various Cloud-based data storage services. There is the question of where to publish user-generated content (UGC).

• A unified standard for 3-D glasses is under development from an ad hoc alliance of manufacturers.

• In an August 8, 2011 FCC Enforcement Advisory #2011-09 (Public Notice DA 11-1373; www.FCC.gov/document/fcc-enforcement-advisorycablecards), cable companies are required to provide multistream CableCARDs to consumers upon request, in lieu of requiring consumers to rent the cable company's set-top box. It also requires "cable operators to provide accurate information about retail set-top boxes and ensure that consumers are treated similarly, whether they choose to buy a retail device or rent a device from their cable provider." The advisory continues that cable operators must: "Provide accurate information about the capability of retail CableCARD-compatible devices. Cable operators must not mislead their customers regarding the ability of retail CableCARD-compatible devices to tune switched digital channels. See 47 C.F.R. 76.1205(c); they must discount packaged services for subscribers who do not rent devices" [in other words, reduce the package cost to not include the box rental]; they also must price CableCARDs the same for everyone on the cable system and not impose CableCARD service fees, plus "permit self-installation of CableCARDs" [not require a service call], ensure a cable provider's installer has the correct number of CableCARDs for the installation, and "ensure access to all linear channels". (The cable company must also provide a switched-video adapter, if required for the installation.) Consumers encountering problems can e-mail the Enforcement Bureau at CableCARDEnf@FCC.gov or call 202.418.1160.

• Heiss emphasized that with the growing number of in-home wired and wireless devices, WiFi, and cellphone connectivity, the consumer still needs broadband, using an enterprise-grade infrastructure. Inexpensive consumer-retail networking hardware won't provide consistent performance or reliability. A knowledgeable professional installer is necessary. [The gap between consumer and enterprise-grade networking equipment is wide and growing. Enterprise networking products' performance, stability, ease of configuration/management, and reliability all lead to reduced service calls and much higher quality of service.]

• Over-the-top (OTT) refers to devices that don't have to connect through a computer or set-top box to reach the Internet for content. However, HD availability is spotty; there are speed, quality of service, and network-contention issues; not all content providers can be accessed from all devices; and other limitations.

• IPTV (separate from OTT) is "a service requiring a proprietary set-top or other device that is not 'open'", such as FiOS and AT&T's U-Verse.

• Widgets (point to a website that runs Cloud content) and apps (streams/downloads content and runs it locally) are increasing in numbers.

• DTV stations are increasing the variety of uses for their subchannels.

• 3D is evolving, but there is an ongoing format battle—passive (substantial image quality compromises, starting with resolution) vs. active (which also has problems, but can—but might not—deliver full resolution to each eye), active-shutter glasses or the shutter in the display (with different passive glasses) and more.

ESD091: "**Future Technologies—The Inside Scoop from Silicon Valley**" is presented at each CEDIA Expo by Rich Green, who takes this opportunity to prognosticate about the custom installation marketplace five years ahead. Green sees a continuing trend among all industries "to overestimate short-term change and underestimate long-term change." He thinks that home networks will have "everything connected," with the local "network" expanding beyond the home to include relatives and friends. Information appliances and computing will be ubiquitous (all devices interconnected; entertainment everywhere on every device) with devices like smartphones being the master controllers (with voice control becoming prevalent). He believes media will move to the Cloud (there have been post-CEDIA announcements by movie studios and other companies that raise a question about that prediction), immersive entertainment and virtual reality will increase, and home health care (the "Gray Market," tele-health, companion robots with emotion, tele-visiting, tele-socializing, even tele-roleplaying) will be widely adopted. Green predicts an increased focus on family life and a close-to-home trend (telecommuting being a part of it) including kids moving back in—"interdependence is replacing independence." Home, network, and personal data security are growing concerns with an expanding market for solutions. Retrofitting will be a huge market.

Michael Heiss and Rich Green presented their ESD097: "**CEDIA Half-Time Show**" relatively early during the expo, to give their take on what to see or avoid. In part, they spoke of what they did not see

that had been expected, and what they found exciting or disappointing. They emphasized that custom installers should use the show to learn about products and procedures that enable them to do their job better—how the show can help installers increase their business and deliver a better product (system, experience) to their customers. After all, "custom installers are in the business of selling magic." They encouraged installers to look for ways to deliver services that yield recurring revenue, such as home security and health monitoring.

• The Wireless Power Consortium (www.WirelessPowerConsortium.com) has generated the Qi (pronounced "chee") standard for wireless charging that has begun to result in consumer products. The CEDIA Future Technology Pavilion (FTP) used this technology to charge cellphones and similar devices (with either a sleeve or special battery module), to boil water in a pan, and run an 800-W blender. At the pavilion I learned that the tuned inductive power source was embedded in the kitchen countertop (marked to identify its location). The blender had a module attached to its base that transferred the induced current when placed over the power source.

• The digital home health portion of the FTP showed security system devices that monitor the resident and alert caregivers when the system detects or is informed that help is needed.

• Solar systems, plus energy management and conservation, is a growing business. The FTP had an Eaton (www.Eaton.com) electric-car charging station (no car—they couldn't get it onto the show floor) and a circuit-breaker panel with a ZigBee-compliant (www.ZigBee.org) wireless monitoring and management system with a web-browser graphic interface. Heiss's concept statement was "to implement systems that measure it, control it, and manage it" (whatever "it" you choose).

• There are a growing number of IP-addressable power devices (including switches, outlets, sockets) facilitating more web-based system monitoring and control. Manufacturers are broadening their lines, diversifying into non-core product areas, making it easier for custom installers to purchase from fewer companies. This also makes it possible for the installer to offer a broader range of energy management systems and services.

• JVC's (www.JVC.com) so-called 4K projector ($12,000 srp) is a 1920 × 1080 D-ILA projector using what they call e-shift, which is apparently similar to "wobulation," which half-shifts pixels and interpolates data to generate simulated 4K images. JVC's demo source material was special uncompressed very high quality video, thus there was no way to fairly compare it with other displays that did not receive the same content.

• Autostereoscopic 3-D displays were NOT at CEDIA Expo, including Toshiba's (http://US.Toshiba.com) 55" panel that was shown at IFA (www.IFA-Berlin.com) in Germany a couple of weeks prior.

• Digital Projection (DPI; www.DigitalProjection.com) showed a projector with a native 2.35:1 aspect ratio. It used TI's 2560 × 1600 chip, but used only 2560 × 1080 to get the width.

• Silicon Image (www.SiliconImage.com) owns SiBEAM, (from their May 16, 2011 press release) "A developer of 60 GHz multi-gigabit/s wireless communication technology for consumer electronics and personal computer applications, and a founding member of the WirelessHD Consortium" (aka WiHD; www.WirelessHD.org). SiBEAM technology supports wireless transmission of uncompressed HD video over a relatively short distance, usually within a room. [This and similar technologies are often implemented in products that replace a long HDMI cable.] Epson (www.Epson.com) has two projectors with SiBEAM technology built in. The Wireless Gigabit Alliance (www.WirelessGigabitAlliance.org; [from the website] their specification "supplements and extends the 802.11 Medium Access Control layer") and the Wireless Home Digital Interface (WHDI; www.WHDI.org) do essentially the same thing.

• One of Stewart Filmscreen's (www.StewartFilmscreen.com) offerings is a curved version of their 5-D screen material. (A relatively high-gain screen is generally used for 3-D projection because of the high light loss due to 3-D technology implementations. A "high-gain" screen results in "high directivity;" therefore wide flat high-gain screens exhibit hotspotting. A properly curved high-directivity screen can substantially reduce hotspotting and widen the acceptable viewing area.)

• No-bezel displays (the image reaches the four edges of the display) are beginning to reach the market, but were not being exhibited at the CEDIA Expo. So far these have a 21 × 9 aspect ratio (wider than the 16 × 9 HDTV aspect ratio). I can conceive of no valid reason for a 21 × 9 (2.33:1) aspect-ratio display. I agree that it will eliminate letter-boxing, but it will require pillar-boxing for almost every movie and all TV shows.

• There is a luxury two-channel audio market that is mostly overseas—South America, Europe, Asia—but is relatively small in the United States.

• SpeakerCraft (www.SpeakerCraft.com), Sonance (www.Sonance.com) and several other companies are highlighting landscape speakers (speakers that can survive outdoors and effectively disappear into the terrain).

• Heiss believes that Cloud access will overtake in-home distributed audio servers because the Cloud delivers access to sources without wires and local servers.

• Homes now have so many wireless and networked devices—computers, music/video servers, iPod Touches, smartphones, tablets, HDTVs, Blu-ray players, home monitoring/control systems, security systems, home theaters, car entertainment systems, etc.—that consumer-grade networking hardware and software is not adequate. Nothing less than an enterprise-grade distributed, managed, seamless, no-dropout network will provide reliable connectivity and customer experience. This is not something your neighbor's 14-year-old can do, and you can't buy it from your local or Internet retailer. It requires a professional network installer with the appropriate knowledge and experience. After all, distributed audio and video is still networking, with near-real-time delivery requirements and special file formats. With so many wired/wireless HDMI-connected devices, in-home EDID and HDCP key management is necessary.

• Luxul (www.Luxul.com) wireless access points, antennas and other wireless network products can help provide seamless network access throughout a large home and grounds, but installers should also run wires to potential wireless access point locations in case there are coverage problems.

• Companies like ihiji (www.ihiji.com), Nuage Nine (www.NuageNine.com), and Certified Cyber Solutions (www.CertifiedCyberSolutions.com) offer services that remotely monitor home network health and report status, changes and problems to the dealer/installer, facilitating a call to the customer to determine if they might need assistance (a potential revenue source, without the installer having to perform the

monitoring).
• Clare Controls (www.ClareControls.com) sells home automation systems that can be managed from the Cloud.

Heiss moderated the ESD005: "**HDMI Hot Seat**" panel consisting of Michael Braithwaite (chief strategy officer, ClearOne; www.ClearOne.com), Micha Risling (v.p. of Marketing & Business Development, Valens Semiconductor; www.Valens-Semi.com), Mark Stockfisch (v.p./CTO, Quantum Data; www.QuantumData.com), and Jim Chase (director of Technology, HDMI Licensing; www.HDMI.org):
• Introducing each panel member, Heiss pointed out that "no one from the HDCP world would show up, again." Chase explained that there were seven founders of HDMI, greater than 1100 adopters, and greater than two billion products sold to date with an HDMI connection (not including cables.) Risling spoke about Valens' introduction of HDBaseT that enables the five types of communication signals (5Play: uncompressed HD video, audio, 100BaseT Ethernet, power less than 100 W, and control signals) to be carried across a single LAN Cat-5e/6 cable.
• Heiss brought the discussion to Intel-developed HDCP's [High-bandwidth Digital Content Protection] two flavors: v1.4 (on most new products; not to be confused with HDMIv1.4a) and v2.1 (developed for streaming content). He has found that it can be very difficult to determine which HDCP version is implemented in a given product; sometimes even the manufacturer isn't sure. HDCPv1.4 supports a depth of seven devices (such as a source, five repeaters, and the display in series) and a total of 128 nodes. HDCPv2.1 supports a depth of three devices with stronger key-limited encryption and less than 127 sync'd devices. Manufacturers can limit the number of sync'd devices, such as cable boxes supporting no more than one display, forcing the consumer to rent more set-top boxes (STBs). Information regarding the limited number of sync'd devices allowable when splitting the HDMI output is not provided on equipment data sheets. While the HDCP specification allows four seconds for complete connection authentication (end-to-end through all sequential links), which seems like forever in computer time, the processing delays and multiple forward-backward communications to establish that authentication can take too long, especially if there are bit errors that require retransmission. HDMI Licensing's website (www.HDMI.org) contains a list of HDMI adopters. Intel's Digital Content Protection website (www.Digital-CP.com) hosts a list of HDCP-compliant products, but neither they nor HDMI Licensing guarantee that any two products will work when connected together. The only way to be sure is to test.

ESD033: "**Apple, Google & the Cloud—Content Delivery in the 21st-Century Home**" was a panel moderated by Julie Jacobson (CEPro editor-at-large; www.CEPro.com), with Michael de Nigris (CEO and cofounder, Autonomic Controls; www.Autonomic-Controls.com), Gordon van Zuiden (owner, CyberManor; www.CyberManor.com), Joe Whitaker (senior development director, The SoHo Shop; www.TheSoHoShop.com), and Zach Holcomb (Holcomb Audio Visual Technologies; www.HolcombAVT.com):
• Holcomb spoke about dropping his cableTV service, instead using a Mac mini (to watch Hulu, Netflix, and other digital sources), to which he added a TV tuner and antenna (for over the air reception) and an Apple TV (with AirPlay technology, for content access and distribution), plus a connected Blu-ray player (with a different Netflix interface). Holcomb found his costs dropped from $72/mo to $28/mo with 1.5 Mbps DSL. He now has DVR capability and still receives all the content he wants. Holcomb thinks Google TV is a "great idea [that includes a] web browser and media player controlled by a wireless keyboard and mouse," although it delivers limited content. His bottom line is that "overall, we have accepted the lower picture/audio quality for the convenience of paying less per month" (former total annual cost about $1,200; now he pays about $550). He does miss some live sporting events and simple channel surfing.
• Whitaker talked of optimizing the home network, starting with service-provider broadband speeds (SD requires 1Mbps; 1280 × 720 p60 HD requires 2.25 Mbps; 1920 × 1080 p60 HD needs 4.5 Mbps [These depend on whether the service provider uses MPEG2, MPEG4 or some other encoding system and the degree of data reduction applied. For reference, uncompressed HD video at 1920 × 1080 i30 re-

quires 1.485 Gbps.]). His position is that "small-business routers are the base level for systems supporting streaming and control systems" plus gigabit switches and a plan for expansion. He suggested IPSwitch's WhatsUpGold Flow Monitor (www.WhatsUpgold.com) or SolarWinds' Orion NTA (www.SolarWinds.com/products/network-traffic-analyzer/info.aspx) for network traffic analysis.

• Gordon van Zuiden looked at integrating Cloud content with home control, with its complexities of so many services, user interfaces, plus ever-changing content licensing requirements and procedures.

• Michael de Nigris' "Cloudy Skies" expressed his belief that "the days of physical media are numbered," and content acquisition is the custom installer's burden, as "there are dozens of service providers, countless technologies, and it's changing every day." The consumer's confusion provides the custom installer his opportunity. His presentation covered some of the risks (providers going out of business, purchased media vs. service, the question of who legally owns the consumer's data and purchased content, etc.) and possibilities for Cloud streaming and Cloud storage. Other topics included the bitrate forecast in general and for movies.

EST304: "**Power Quality and Conditioning**" acknowledges the noise, surge, and transient problems electronics are subjected to from the power lines and discusses how to help prevent equipment degradation and failure. The course defines the various power-related terms (such as surge and transient), rightly points to the International Electrotechnical Commission (IEC) and NEC regulations as they relate to personal safety [and insurance risk], and discusses different technologies aimed at reducing the potential impact on equipment performance and damage. It has a section on balanced power [a concept I don't consider valid for properly designed equipment. Line-level signal transfer is where a balanced connection is beneficial; see the Audio Engineering Society's AES48-2005(r2010) "AES standard on interconnections—Grounding and EMC practices—Shields of connectors in audio equipment containing active circuitry."]. The course suggests that an Underwriters Laboratories label is testimony to the quality of the equipment, whereas my understanding is that the UL label only ensures it isn't likely to blow up, cause fires, or put users at physical risk.

ESD034: "**Designing and Installing Photovoltaic Power Systems**" was presented by Ken Erdmann (cofounder and President, Erdmann Custom Electronics; Chairman, CEDIA Executive Committee).

EST012: "**Telepresence and Video Conferencing Systems**" explains the benefits, players (the big three are Skype—www.Skype.com, Polycom—www.Polycom.com, and Cisco—www.Cisco.com) and technology of video conferencing, plus the enhanced naturalness of communications from telepresence, where the non-local participants are displayed as though seated across the conference table. The course warns about bad acoustics/audio and discusses techniques and technologies to help ensure intelligible communications. Included are ideas about colors and lighting, such as avoiding an individual being in sunlight through an open Venetian blind or being in front of a too-bright background. The last section covers network concepts and technology.

ESCR039: "**Home Health Technology is Here to Stay … Are You?**" is self-explanatory of this panel discussion and indicative of a relatively new focus in home technology. Moderator Laura Mitchell (v.p. of Marketing, GrandCare Systems; www.GrandCare.com) claimed that "two-thirds of all people who have ever lived to age 65 are alive today; by 2050 there will be one million people over 100 years of age; 90% of Americans believe caregiving is a family responsibility; a recent study showed that the majority of seniors polled feared nursing homes worse than death; and more than 44 million Americans are family caregivers for a spouse, parent, relative, or friend." The panel talked about available and upcoming technology and how to market it to the consumer (custom installer's clients), including the concept of a repeating revenue stream from support services.

ESCR047: "**Home Health Technology Case Study: A How-To Discussion**" was Laura Mitchell's followup to ESCR039.

ESD030: "**Projection Screens**" (presented by Joaquin Rivera, Stewart Filmscreen) goes into all aspects of projected image parameters and screen materials, formats, masking, etc. The outline doesn't specify if it addresses the impact of screen smoothness on perceived sparkles and image noise.

ESD301/302/303: "**Home Theater Audio and Acoustics**" Parts 1, 2, and 3 is Floyd Toole's extensive and thorough tutorial based on his book, *Sound Reproduction: The Acoustics and Psychoacoustics of Loudspeakers in Rooms* (Focal Press; 2008; $40 for the paperback edition at www.Amazon.com).

ESD026: "**Acoustical Isolation and Noise**," delivered by Floyd Toole, addresses specifications, design, and materials for both directions of noise transmission— into and out of the theater, including "what can and cannot be done in real life situations, especially retrofits."

ESD031: "**Room Acoustics: Acoustic Treatments**" was presented by Anthony Grimani (President and Lead Consultant, Performance Media Industries; www.PMILtd.com), who told his custom-installer audience that "acoustics are audible; acoustics are fixable; and fixing acoustics can make you money." Acoustics is "about the speaker/room/listener interface. … Performance goals of a home theater audio system are: clear dialog, precise sound localization, spacious surround, smooth sound movement, even tonal balance, full dynamics, transparency, and every seat a good seat." He recognizes that the goals cannot be perfectly realized, but that the installer should work toward that end. Grimani is a proponent of using absorbent materials (which PMI manufactures and sells) and diffusion panels to ameliorate reflection and reverberation problems (without making the room too dry), pointing out that the panels "should have similar absorption coefficients at all frequencies in their operating range [and that] mounting panels away from walls enhances their low-frequency absorption."

Jeff Gardner presented ESD131: "**Fundamentals of Home Theater Design**," an introductory course describing considerations of acoustics, lighting, HVAC, and home theater technology for dedicated and multipurpose rooms. Gardner's focus was "to deliver a great cinema experience that meets the customer's needs and budget; profit margin is no more than a secondary concern." He emphasized that the technology is a small part of an overall home theater design, with the goal of "duplicating, as closely

as possible, the post-production studio environment where the image and sound were finalized." He identified the challenges of doing that in a home and some of the compromises that the installer will likely have to make. This course is an excellent introduction into all facets of home theater design.

ESD232: "**Home Theater Room Design**," (taught by Sam Cavitt, Media Environment Design; www.MEDesign.TV) is a mid-level course (part of CEDIA University's Electronic System Designer curriculum) claiming to "describe the holistic principles necessary for the integration of room design and system performance," based on the goal of providing "the cinema experience." It steps through finding out what the client needs, wants and can afford, then designing the theater whether in a dedicated room or a multipurpose space, taking into account acoustics and noise sources, lighting, seating, speaker and equipment locations, etc. The course emphasizes physical construction and noise abatement, acoustic treatment, aesthetics, decor, and lighting.

Steve Briggs, who came across in his opening remarks as a two-channel audio tweak-oriented individual, presented ESD151: "**Introduction to Video and Imaging**" (part of "CEDIA University's Electronic System Designer curriculum"), which claims to outline the history of analog and digital television, describe the basic functionality of the eye, explain video terms and concepts, plus describe video processing/controls and interfaces. It is a good basic course, with a few minor technical errors.

ESD332: "**Home Theater Video and Imaging**" is CEDIA's higher level course (also part of their Electronic System Designer curriculum), intended to discuss human vision (overlapping ESD151), plus the characteristics of high-quality home theater images, screen options, optimal viewing positions, ambient lighting and related topics. Among the 227 pages in the handout there were slide errors (for example, "Roy G. Biv" described as red-orange-yellow-blue-green-indigo), and I don't agree that "anamorphic projection [always] causes pincushioning" or "nonuniformity of brightness." Also, the course doesn't point out that perforated screens cause a loss of image detail, and can often cause moire interference with pixelated projection. The course materials should not use the word "brightness" when they mean "white level," since when discussing video "brightness" refers to black level, and the dual use will cause confusion. When discussing the square law for off-the-screen video, the material tries to correlate it with the square law in audio from loudspeakers; however, that only applies to an omnidirectional radiator, not speakers in a home theater room. On some slides, the handout-author's inability to spell is obvious, such as the incorrect "posturized" for the correct "posterized"—both spellings on the same handout page. The discussion of test patterns explains what to look for. Inaccuracies notwithstanding, this is an edifying course that covers a lot of useful information. I got the impression that the presenter wasn't as familiar with the material, especially color vision and color space, as I think he should have been for this audience (possibly his first-time presenting the material without adequate preparation?)

EST311: "**Video Setup and Calibration**" starts by walking through analog video connections and levels before stepping through test patterns and measurements (including the use of a vectorscope and an oscilloscope to view the signals). There is an entire section about the CIE chromaticity diagram and correlated color of white, including its three-dimensionality, which is not often shown or described. The next steps are color gamut and gamma, followed by calibration concepts and procedures. It even shows the spectra of various display light sources, which also is rarely described yet has a substantial impact on the ability of a display to accurately reproduce content. This appears to be a well-designed course.

EST325: "**Audio Setup and Calibration**" aims to deliver sonic clarity, localizability, envelopment, smooth frequency response, sonic dynamics, and sonic seat-to-seat consistency. Calibration is performed in two ways: mechanically (HT design plus the selection and location of speakers and room furnishings) and electronically; both are necessary. When discussing cables, the course emphasizes the basics and avoids esoteric designs and materials. It discusses the traditional measurement tools including the real-time analyzer, but does not include time-windowing FFT measurement systems (such as Rational Acoustics Smaart; www.RationalAcoustics.com) whose measurements might more accurately correlate with what we aurally perceive. Consideration is given to ensuring correct relative and absolute polarity; finding and eliminating sources of hum, buzz, and noise; ensuring the surround processor's crossover to the subwoofer is used [setting the subwoofer's internal crossover to the often-recommended 80 Hz low-pass point will cut off the LFE's top end, which extends by specification to 125 Hz]; checking the processor's bass management performance; etc. That many speakers have poor off-axis frequency response is considered an "insidious form of response distortion" and helps explain "why many speakers improve remarkably by adding side-wall absorption despite the fact that evidence suggests side-wall reflections are important to preserve." The course includes the final calibration step of listening to well-known content and making appropriate adjustments to correct anomalies that did not show up in the measurements.

ESD058: "**Designing HDMI Distribution Systems That Work**" provides a good introduction to the pins and signals on HDMI and other digital connectors (including DisplayPort and DVI). It also covers details of the digital signals carried over these connections including bandwidth, data rate, and color depth, although it emphasizes the HDMI video test eye pattern without tying all of the details together in a total bit error rate test. It also mentions that "many displays continue to overscan when receiving digital video, despite the fact that it is no longer needed" (noting that it can't always be eliminated through display adjustments). The course includes how audio is carried over the HDMI connection, the HDMI authentication sequence, HDCP, and the Advanced Access Content protection system (which defines the HDCP requirement). It delineates potential issues with the HDCP check that can cause video communication failure, HDMI connection troubleshooting, wireless and wired HDMI extender technologies, future-proofing the installation, and common real-world problems. Content notwithstanding, I disagreed with some of the simplistic statements made, believing that a course for this audience needs to be more detailed and precise. Perhaps a different lecturer would be better suited.

Jeff Boccaccio (President, DPL Labs; www.

DPLLabs.com) presented the Ethereal-sponsored (www.EtherealHomeTheater.com) training session "**HDMI Alternative Transmission Methods**" (ATM). He takes strong issue against the use of the word "balun" to describe HDMI extenders, as balun has a specific meaning in the communications industry (especially telephone and broadcasting, where a balun is an impedance-matching device); thus he uses the term alternative transmission methods for all non-HDMI-cable HDMI interconnections. Boccaccio described HDMI as "high-speed digital signaling," an evolutionary extension of the PC-industry's DVI, which worked reliably and consistently even over long distances. He explained that the eye pattern test only shows the waveform delivery of video data on one conductor pair, but nothing about all the timing and shape of the other signals carried on the 19-conductor cable. Boccaccio said that for HDMI to work, it requires end-to-end video integrity, timing accuracy and coordination, communication of the intelligence data, and adequately transmitted supply voltage. He explained the connection sequence between the source and receiver (usually the display, but can be an intermediate device like an AV receiver with HDMI inputs and outputs, where each connection must act as its own source or receiver): 5 Vdc sent out, hot-plug detect code sent back (after a specified 200 ms delay), EDID (extended display identification data) request sent out, display data sent back, HDCP (high-bandwidth digital content protection) sent out, and a data key sent back (the source requests a new key after every 128 video frames—about 4.25 seconds). The 5 Vdc trigger voltage must be greater than or equal to 4.7 Vdc at the receiver or the connection will not work. There are many other potential problems that can beset an HDMI connection, some of which he talked about. However, David A. Rich (and others I have spoken with) pointed out that Boccaccio has repeatedly refused to acknowledge the single test that most directly determines the performance of an HDMI connection: bit error rate (BER) from transmitter input to receiver output. While BER won't identify the cause of the problem, if the BER is below an appropriate level the connection works reliably; if not, the connection fails. This is a relatively easy test, and it's the only test needed to determine HDMI transport reliability, yet HDMI Licensing has not called for its use in certifying products or evaluating their performance.

EST056: "**HDMI Troubleshooting**" is a hands-on course teaching the principles of diagnosing HDMI/HDCP communications problems, giving the students the laboratory experience of applying those concepts and procedures.

ONE MAJOR COMPLAINT

CEDIA has taken on the responsibility to train and certify custom installers, apparently with the idea that a CEDIA certification will help give those system designers and technicians a marketing edge in their pursuit of business and lead to better system performance for paying customers.

As such, I believe they have an obligation to ensure that the information provided to those certified individuals is incontestably correct.

In July 2009, CEDIA's educational division issued the first edition of the *CEDIA Electronic Systems Technical Reference Manual*, which is still being sold, even at this recent CEDIA Expo, to custom installers for at least $90. This 400-page book is clearly designed to teach custom installers much of the technical knowledge required to deliver to their clients a high-quality home theater experience and home automation/security installation. This book is also obviously intended as preparation material for those planning to take CEDIA certification exams.

I thoroughly reviewed this book in February 2010 and failed it, as it included many factual and technical errors, which I delineated point-by-point. I sent a copy of my review to CEDIA, and published it in two magazines: *BASSv32n1* ("CEDIA's Tech Reference Manual Needs Professional Work"; April 2010) and in an issue of *Multi Media Manufacturer* that came out that spring.

I have contacted CEDIA officials and CEDIA-involved individuals on several occasions to offer my assistance and to learn of any progress toward generating a corrected second edition, as well as to find out what CEDIA will do for all those people who are getting incorrect information from their purchased first edition.

I am aware that other professionals, some of whom were involved in preparing various sections of this book, have vigorously and persistently pursued CEDIA officials with lists of errors and suggested corrections.

As recently as at the 2011 CEDIA Expo (18 months after my review), I heard from CEDIA officials that there are plans to generate a second edition, but there are no plans regarding what to do for those who purchased the seriously flawed first edition—not even a comprehensive set of errata.

Apparently all of our efforts to get the book fixed have fallen on blind eyes and deaf ears.

This is unacceptable behavior, especially from an organization that is trying to market itself and its trainees as "professionals" providing quality service.

Flaws in this book mean there are flaws in the certification exams and answers, which means those using the books are likely using erroneous data in providing designs and service to their paying customers.

I continue to strongly recommend against purchasing or using this book. Even though it does contain much useful material, unless readers have the expertise to identify what is right and what is wrong, they and their customers are at risk.

WRAPUP

It was good to be back in Indianapolis for CEDIA. The new convention center is just the right size for the almost 500 exhibits. Walking between the training/course rooms and the show floor doesn't eat up a lot of time because they are near by. The training/course rooms are quiet (very little HVAC or back-corridor noise), with better than average PA sound quality; many of the presenters found no need to use a microphone to be heard clearly throughout the room. There are at least a half dozen hotels connected to the convention center via enclosed skywalks, so weather isn't a major factor. An assortment of restaurants are within short walking distance of the convention center. The Indianapolis airport is relatively small and not too far out of town. And for me, it's only a 1.5-hour flight.

CEDIA will be in Indianapolis again in 2012, September 5–8. There are plans to hold it in Denver each of the following two years, with consideration being given to alternating every couple of years between Indianapolis and Denver. I would rather it never leave Indianapolis, but that won't stop me from attending to keep you informed of my take on the evolution of home technology, and I'll again check to see if CEDIA has accepted its obligation to its members, customers (custom installers) and consumers to correct the many major errors in the *Electronic Systems Technical Reference Manual*. aX

By Charlie Hughes (United States)

Subwoofer Alignment with a Full-Range System

The possiblility of alignimg a subwofer with a full-range loudspeaker system is explored

I have heard the following question asked many times: "How do I align a subwoofer with a full-range loudspeaker system?" I thought it might be interesting to delve into this to see if I could come up with an answer. The task of adding a subwoofer to a loudspeaker system to increase the low-frequency bandwidth should typically entail three primary items:

- The relative bandwidth of the subwoofer and the full-range system (crossover)
- The relative output level of the subwoofer and the full-range system (gain)
- The relative arrival time of the signal from the subwoofer and the full-range system (delay)

It is this last item that is perhaps the most challenging. This is the one that we will primarily investigate. We will also look at the first item briefly. With these taken care of, the second item should not be much of a problem.

MEASUREMENTS

Loudspeakers, by their nature, are band-pass devices. To simplify the measurements and make it easier to see what's going on with the graphs, I will use high-pass and low-pass filters instead of actual loudspeakers. The results will be the same with one exception: microphone location. Since our examples don't use a microphone (only electrical measurements), it can't be moved to a different location. This can be much more critical for measurements at higher frequencies because the directivity response of a loudspeaker will lead to differences in the measured response of a device at different locations. For devices that are, for the most part, omni-directional in the lower-frequency region, this will not be an issue.

There is another issue, of which one should be aware, concerning microphone placement that could lead to measured differences. That is the potential change in path length from the two devices under test (lower-frequency device and higher-frequency device) to the measurement microphone (or the listener's ear.) At one mic position there may be very good summation. At another location, where the path length difference has changed by one-half wavelength of frequencies in the crossover region, there will be a notch (cancellation) in the summed response. When making field measurements, it is advisable to place the microphone(s) in position(s) that are typical of magnitude and arrival time differences to which most of the intended coverage area will be subjected.

HYPOTHETICAL SYSTEM

Let's imagine a hypothetical system that has a full-range cluster that reproduces 60 Hz to 14 kHz adequately. We will add a subwoofer that is physically displaced from the full-range cluster. The subwoofer repro-

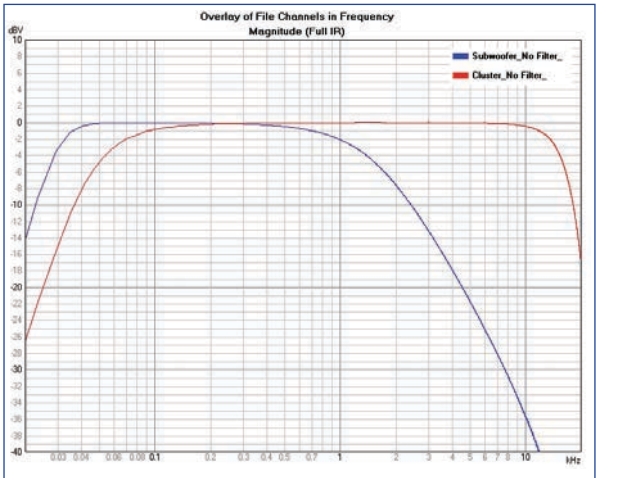


Figure 1: Magnitude response of individual simulated loudspeakers

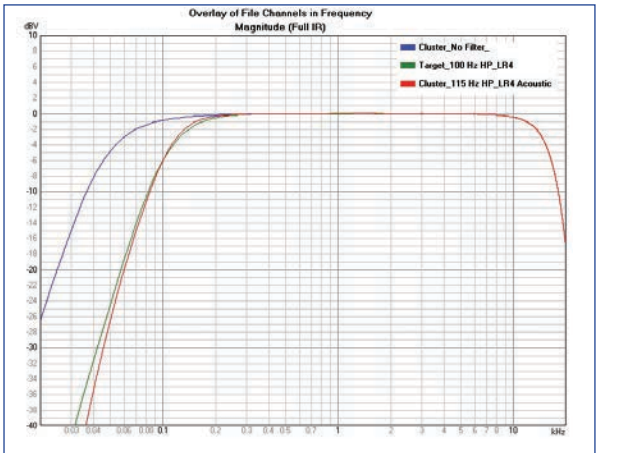


Figure 2: Magnitude response of cluster without HP filter (blue), target Linkwitz-Riley response (green), and cluster with HP filter (red)

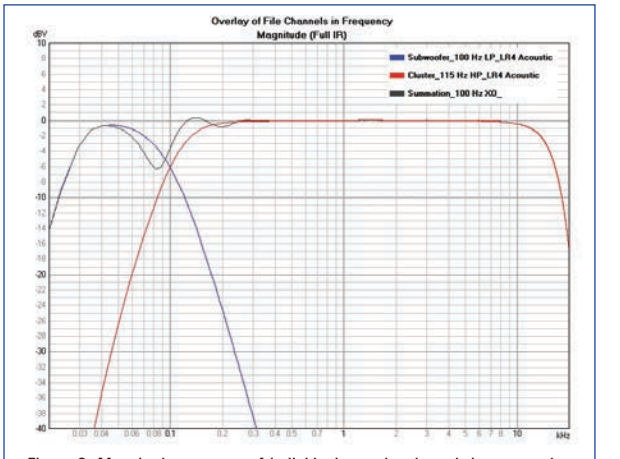


Figure 3: Magnitude response of individual pass bands and the summed response

duces adequately down to 30 Hz. These response curves are shown in **Figure 1**. We want a crossover at 100 Hz with a 4th order Linkwitz-Riley alignment.

We can simply apply a 4th Linkwitz-Riley low-pass filter at 100 Hz to the subwoofer since its response is relatively flat, well above the intended crossover region. This is not the case for the cluster, however. Its output is already beginning to decrease, with decreasing frequency through the intended crossover region. We will need to apply an electrical filter that, when combined with the natural response of the cluster, will yield an acoustical output that matches a 4th-order Linkwitz-Riley filter with an Fc of 100 Hz. **Figure 2** shows the natural output of the cluster and the target Linkwitz-Riley response along with the cluster's output after it has been high-pass filtered. A 3rd- order Butterworth high pass at 115 Hz was used to get this response. A lower Fc and a parametric EQ filter might be used to achieve a more exact match. The response shown will be close enough for our purposes.

When the outputs of the two devices are combined, we get the responses shown in **Figure 3**. The summed magnitude response is not at all what we want. It is clear that something is causing cancellation. We know that the acoustic Linkwitz-Riley response of each device should sum to a flat response. Since it doesn't, this would seem to indicate the problem is a misalignment of the two devices in the time domain. Looking at the Envelope Time Curve (ETC) of the passbands (see **Figure 4**) confirms that they are not synchronized. We need to delay the cluster, but by how much?

If we choose to align the cluster's peak arrival with the peak arrival from the subwoofer, we need to delay the cluster 14.7 ms. Alternatively, we might choose to try to place the arrival of the cluster more towards the leading edge of the subwoofer's ETC. This will require approximate 10 ms of delay for the cluster. The frequency and time domain of both these scenarios are shown in **Figure 5** and **Figure 6**. Neither of the frequency domain curves looks like what one would consider good summation (reasonably flat response). The time domain would seem to indicate that the shorter delay is closer to the ideal response than the longer delay. We could go on guessing at different delay times in an attempt to optimize the response in both domains. Hopefully, there is a better way.

The underlying problem is that we have only low-frequency information output from the subwoofer. Refer to the following equation:

$$\Delta t = \frac{1}{\Delta f}$$

Δt is time resolution and Δf is frequency resolution. We can see that high-frequency resolution (small value of Δf) will yield low-time resolution (large values of Δt). We need higher-frequency output from the subwoofer (corresponding to higher Δf, lower-frequency resolution) to increase the time resolution in order for us to know when to position the cluster. If possible, we can bypass the low-pass filter on the subwoofer to get more high-frequency content in the output signal. This may help in more precisely determining the arrival time of energy from the subwoofer. Let's assume that we can't do this or if we can that it still doesn't give us sufficient time resolution.

What we need is a way to get precise time information without high-frequency content. This is a seemingly impossible task, but only so in the time domain. In the frequency domain, there is a metric available that yields quite precise relative timing information. This is the group delay. The group delay is

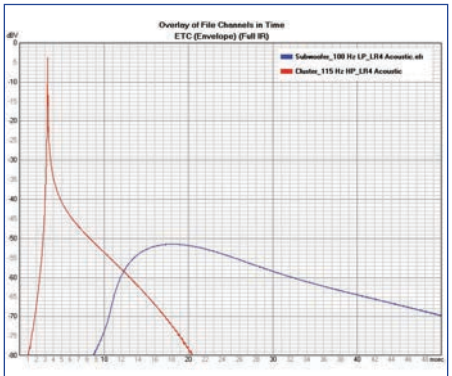


Figure 4: ETC of individual pass bands

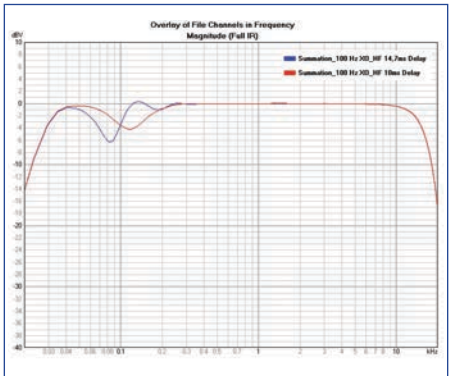


Figure 5: Magnitude response summed response with the cluster delayed 10 ms (red) and 14.7 ms (blue)

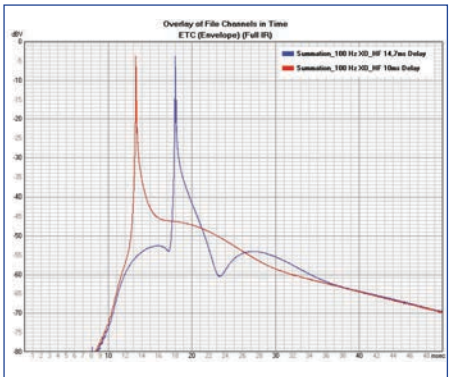


Figure 6: ETC of the summed response with the cluster delayed 10 ms (red) and 14.7 ms (blue)

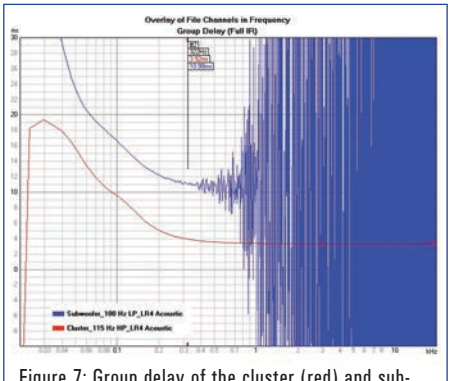


Figure 7: Group delay of the cluster (red) and subwoofer (blue) with crossover filters in place

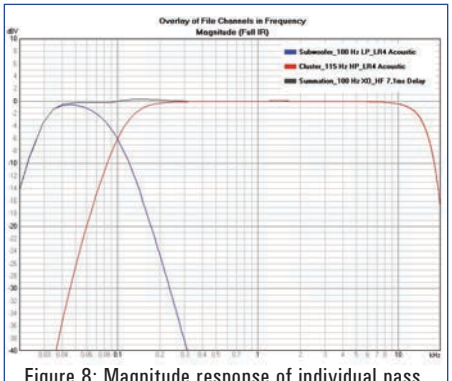


Figure 8: Magnitude response of individual pass bands and the summed response with the cluster delayed 7.1 ms

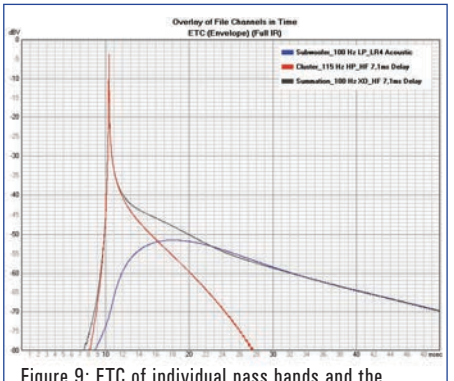


Figure 9: ETC of individual pass bands and the summed response with the cluster delayed 7.1 ms

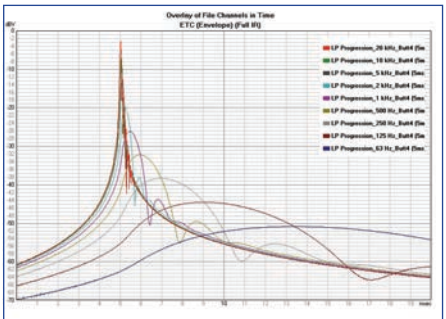


Figure 10: ETC of low-pass filter with different corner frequencies

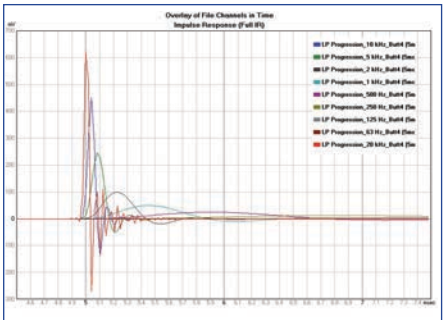


Figure 11: IR of low-pass filter with different corner frequencies

defined mathematically as the negative rate of change of the phase response with respect to frequency.

Figure 3 and **Figure 4** show different

$$\tau g = \frac{-d\phi}{d\omega}$$

views (domains) of the same measurement for the individual passbands. If we look at the group delay of this same data, we can derive some valuable information. The high-frequency limit (plateau) of each curve indicates the arrival time of the signal from that device. From this we see that the cluster arrival time is approximately 3.3 ms. This correlates very well with the ETC in **Figure 4**.

Don't let the appearance of the subwoofer curve in the high-frequency region be bothersome. This is due to the low signal-to-noise ratio of the measurement above 400 Hz. Referring to **Figure 3,** the output of the subwoofer is less than –24 dB at 200 Hz. Our use of a 4th-order filter would indicate a level of less than –48 dB at 400 Hz and decreasing rapidly. It's no wonder there is an SNR problem at higher frequencies.

We can look at the subwoofer curve around 300 Hz to get an indication of the high-frequency limit of its group delay. This turns out to be approximately 11.0 ms. The group delay of the cluster at this frequency is approximately 3.9 ms. This is a bit different than the 3.3 ms at higher frequencies. This is caused by the phase shift of the high-pass filter and the natural high-pass response of the device. The low-pass filter being used on the subwoofer will have similar phase shift, and consequently, similar group delay differences in the high-frequency region if our measurement SNR was good enough to see it.

Taking the difference in 11.0 ms and 3.9 ms we now have a value of 7.1 ms to use as our delay setting for the cluster. This yields the summation, along with the individual passbands, shown in **Figure 8** and **Figure 9**. This is almost the exact response we desire. There is less than 0.5-dB error in the vicinity of 150 Hz. This error is due to the output of the cluster and high-pass filter not exactly matching the Linkwitz-Riley target (see **Figure 2**).

There is one more item that I think might be of interest in helping to see how a low-pass filter response affects "apparent" arrival time. I say apparent because it only appears that the arrival time is changing. **Figure 10** and **Figure 11** show the ETC and IR, respectively, of a 4th-order Butterworth low-pass filter. The only difference in these curves is the corner frequency (–3 dB point) of the filter. The true arrival time for all of these filter curves is 5 ms. A complementary high-pass filter with an arrival time of 5 ms will combine properly with its low-pass counterpart in the graph. If the high pass is delayed so as to place the arrival so that it occurs later than 5 ms, there will be errors in the summation of the filters just as was illustrated in **Figure 5** and **Figure 6**.

USEFUL TECHNIQUES

We have seen how the response of an electrical filter can combine with the response of a loudspeaker to yield the desired response (alignment) from the combined output. We have seen how the low-pass behavior of a device may make it appear that its arrival time is later than it actually is. We also demonstrated how to use group delay to determine the correct delay setting with relatively high precision when the high-frequency output of a device is limited due to its low pass behavior. I hope that you will find use for these techniques. *aX*

By Vance Dickason (United States)

A New Tweeter and a New Woofer

Testing two high-end home audio drivers

Both of the drivers submitted to test bench are for home audio applications, and both are from SB Acoustics. SB submitted their SB26STAC-C000-4, a ferrite motor 1" soft-dome tweeter, plus a new high-end 6.5" midwoofer, the MW16R Satori.

I have covered a number of SB Acoustics tweeters including: the ferrite motor 29-mm ring dome SB29RDC-C000-4 (*Voice Coil* August 2009); it's neodymium 29-mm ring dome version, the SB29RDNC-C000-4, (*Voice Coil* August 2011); and the SB26STCN-C000-4, a 1" neo-motor tweeter (*Voice Coil* September 2011). This month's addition is the ferrite version of the SB26STCN, the 1" SB26STAC-C000-4 (see **Photo 1**). It bears repeating that SB is the initials for Sinar Baja, which is a large OEM driver manufacturer located in Indonesia. However, the driver line is the brainchild of David Stephens, former U.S. representative of DST. Keeping with his Danish driver heritage, David is closely associated with former Vifa/Scan-Speak engineers Ulrik Schmidt and Frank Nielsen, now co-owners of Danesian Audio. Danesian Audio does all the transducer engineering for SB Acoustics.

In terms of features, the SB26STAC employs a 1" (26-mm) diameter, treated cloth-dome diaphragm, a 1" underhung voice coil with 0.6 mm Xmax and wound with CCAW wire, damped vented pole, exhausting into a damped rear chamber, a copper cap (shorting ring) on the vented pole, silver alloy lead wires terminating to gold terminals, and a cast aluminum faceplate. SB also offers a slightly lower cost version with an injection-molded plastic faceplate, the SB26STC.

Testing commenced using the LinearX LMS analyzer to produce the 300-point impedance sweep, illustrated in **Figure 1**. The magnetic fluid damped resonance occurs at a moderately low 731 Hz. With a 2.96-Ω DCR, the minimum impedance for this tweeter is 3.1 Ω at 2.1 kHz.

Following the impedance test, I recess mounted the SB tweeter in an enclosure that had a baffle area of 10" × 8" and measured the on- and off-axis frequency response with a 100-point gated sine wave sweep at 2.83 V/1 m. **Figure 2** shows the on-axis response to be a very flat ±2.05 dB from 1 kHz to 13 kHz, and from 1 kHz to 29 kHz, ±3.1 dB. **Figure 3** depicts the on- and off-axis response of SB26STAC, with the off-axis curves normalized to the on-axis response in **Figure 4**. The two-sample SPL comparison is illustrated in **Figure 5**, indicating the two samples were closely matched, with a small 1 dB variation between 4.5 kHz to 6 kHz.

The next test procedure was to fire up the Listen, Inc. SoundCheck analyzer along with the Listen, Inc.

Photo 1: The SB26STAC-C000-4, a 1" soft-dome tweeter

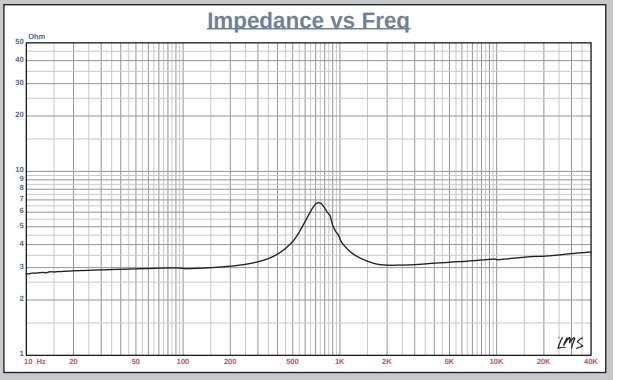


Figure 1: SB Acoustics SB26STAC-C000-4 free-air impedance plot

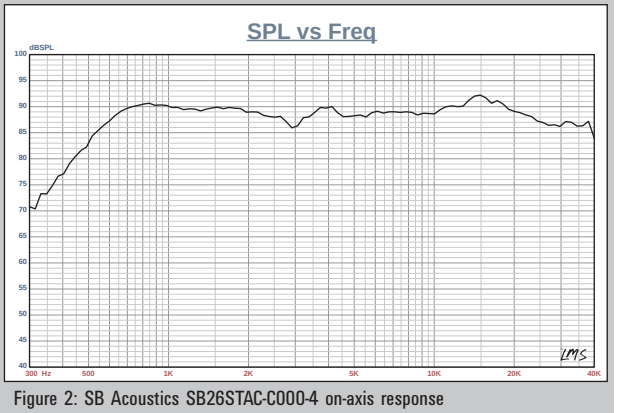


Figure 2: SB Acoustics SB26STAC-C000-4 on-axis response

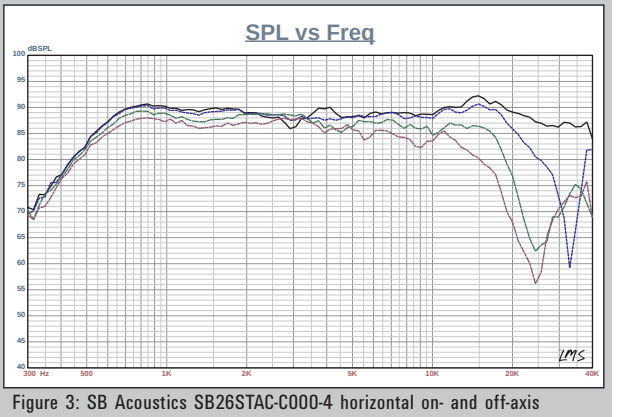


Figure 3: SB Acoustics SB26STAC-C000-4 horizontal on- and off-axis frequency (0° = solid; 15° = dot; 30° = dash; 45° = dash/dot)

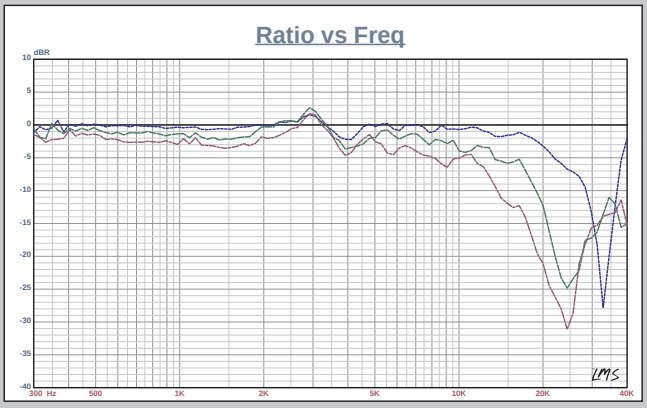


Figure 4: SB Acoustics SB26STAC-C000-4 normalized on- and off-axis frequency response (0° = solid; 15° = dot; 30° = dash; 45° = dash/dot)

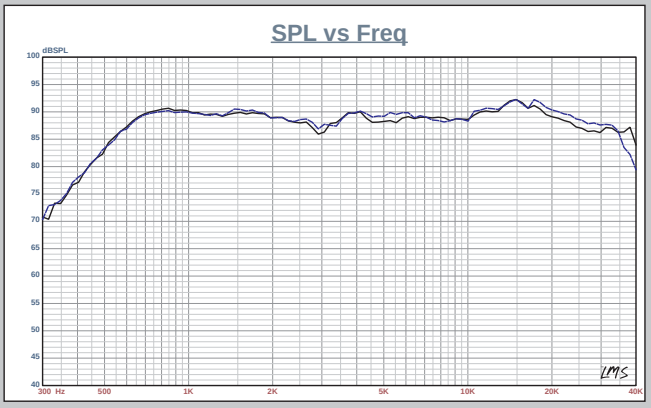


Figure 5: SB Acoustics SB26STAC-C000-4 two-sample SPL comparison

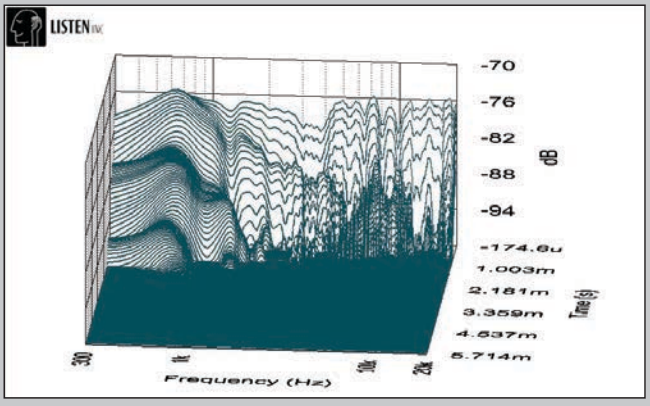


Figure 6: SB Acoustics SB26STAC-C000-4 Soundcheck CSD waterfall plot

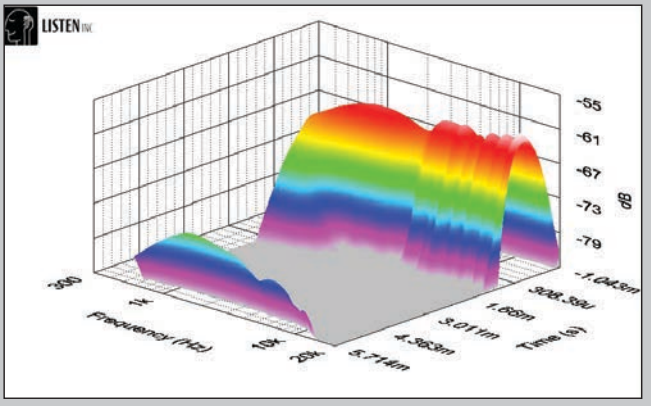


Figure 7: SB Acoustics SB26STAC-C000-4 Sound Check STFT surface intensity plot

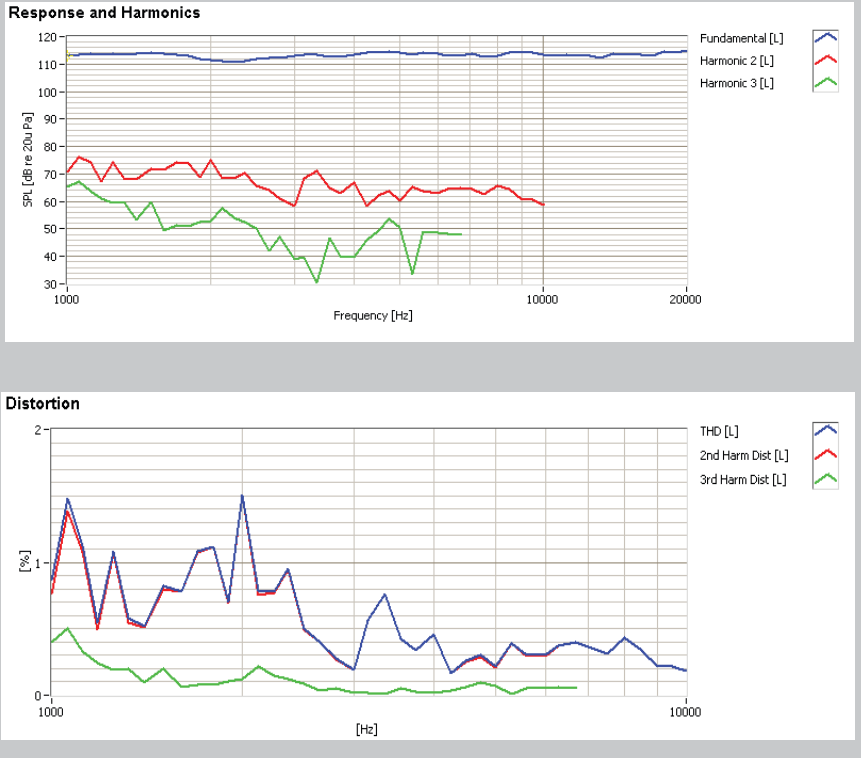


Figure 8: SB Acoustics SB26STAC-C000-4 SoundCheck distortion plots

SCM ¼" microphone (provided courtesy of Listen, Inc.) to measure the impulse response with the tweeter recess mounted on the test baffle. Importing this data into the Listen, Inc. SoundMap software produced the cumulative spectral decay plot (usually referred to as a "waterfall" plot) given in **Figure 6**. **Figure 7** is a Short Time Fourier Transform (STFT) displayed as a surface plot. For the final test procedure, I set the 1 m SPL to 94 dB (4.2 V) using a noise stimulus, and measured the 2nd and 3rd harmonic distortion at 10 cm, depicted in **Figure 8**.

The next SB Acoustics driver is part of what I assume will be a complete new series of ultra-high-end transducers for SB, the Satori line. So far, there are only two drivers in this line, the Satori TW29R (similar to the SB29RDC-C000-4 ring dome) and the subject of this report, the Satori MW16R (see **Photo 2a** and **2b**). In the Zen Buddhist tradition, satori refers to a flash of sudden awareness, or

individual enlightenment, and is considered a "first step" or embarkation toward nirvana. So, to sport such an ambitious moniker, I would expect the driver to be something special, so let's get to it.

In terms of features, the MW16P is built on a very cosmetically attractive six-spoke frame, somewhat resembling two other fairly recent entries into the high-end driver market, the Scan-Speak Illuminator product line and the Vifa NE series. This frame has its own unique features, but like the Scan and Vifa woofers, the frame has a minimal reflective footprint behind the cone to cause reflections and a completely open area beneath the spider mounting shelf. Both are highly desirable attributes. The spider mounting shelf itself is pinned to the frame to limit vibration transfer from the frame to this part of the suspension system. The neodymium motor cup attaches to the bottom of the frame and has a separate cosmetic/heatsink part that looks like the continuation of the frame attached to the peripheral of the motor.

The motor is comprised of neodymium ring magnet and the cup that completes the field and forms the gap area. In addition (see the FEA motor cutaway in **Figure 9**), there is an overhung copper sleeve shorting ring to reduce distortion. The device uses a 1.4" (36 mm) diameter voice coil with a Kapton former wound with round copper wire, and terminated to a pair of gold-plated terminals.

The cone and dust cap material are also very unique and composed of 60% pure Egyptian papyrus parchment fibers, a very expensive, but light and stiff material. This incidentally is available in the black cone seen in the accompanying photo, as well as a natural off-white color if you are going for that Yamaha NS-10 look. Suspension is provided by a NBR surround that uses a special vertical and horizontal attachment process, along with a Dr. Kurt Muller Bimax spider. Bimax is purported to have less twisting tendencies compared to other cloth spider materials and is warm shaped with a durometer resin.

I commenced analysis of the MW16R using the LinearX LMS analyzer (soon to be replaced by a more advanced outboard chassis with USB interface analzyer called the LX500) and VIBox to create both voltage and admittance (current) curves with the driver clamped to a rigid test fixture in free-air at 0.3 V, 1 V, 3 V, 6 V, and 10 V. As has become the protocol for Test Bench testing, I no longer use a single added mass measurement and instead used actual measured mass, but the manufacturer's measured Mmd data. At this point, the 10-V curves were discarded as being too nonlinear for the curve-fitting algorithm to resolve. Next, the remaining eight 550-point stepped sine wave sweeps for each MW16R sample were post-processed and the voltage curves divided by the current curves (admittance curves) to derive impedance curves, phase added by the LMS calculation method, and along with the accompanying voltage curves, imported to the LEAP 5 Enclosure Shop software. Since most Thiele-Small data provided by the majority of OEM manufacturers is generated using either the standard model or the LEAP 4 TSL model, I additionally created a LEAP 4 TSL

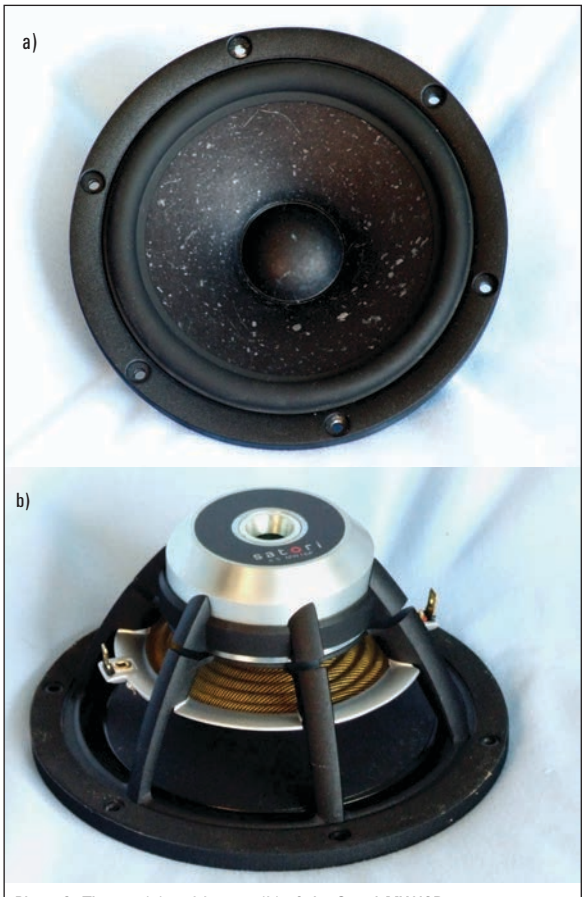


Photo 2: The top (a) and bottom (b) of the Satori MW16R

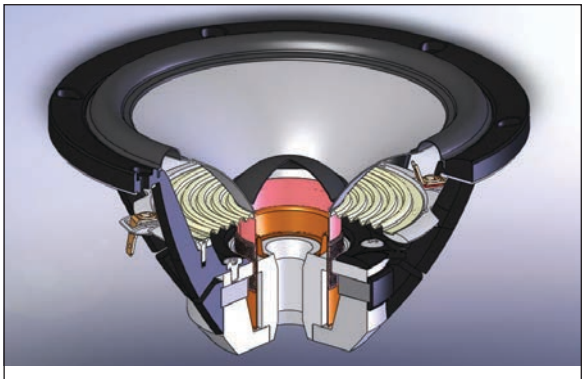


Figure 9: SB Acoustics MW16R motor cutaway drawing

	TSL model		LTD model		Factory
	sample 1	sample 2	sample 1	sample 2	
FS	27.6 Hz	27.6 Hz	27.0 Hz	27.0 Hz	29.0 Hz
REVC	5.99	6.01	5.99	6.01	6.20
Sd	0.0123	0.0123	0.0123	0.0123	0.0119
QMS	5.60	5.33	5.35	5.75	4.50
QES	0.34	0.37	0.38	0.42	0.35
QTS	0.32	0.35	0.35	0.39	0.34
VAS	57.2 ltr	57.1 ltr	60.2 ltr	60.0 ltr	48 ltr
SPL 2.83 V	87.4 dB	87.0 dB	86.8 dB	86.4 dB	87.5 dB
XMAX	6.0 mm	6.0 mm	6.0 mm	6.0 mm	6.0 mm

Table 1: SB Acoustics Satori MW16R midwoofer

parameter set using the 1-V free-air curves. The complete data set, the multiple voltage impedance curves for the LTD model (see **Figure 10** for the 1-V free-air impedance curve) and the 1-V impedance curve for the TSL model were selected in the transducer derivation menu in LEAP 5 and the parameters created for the computer box simulations. **Table 1** compares the LEAP 5 LTD and TSL data and factory parameters for both of Satori MW16R samples.

LEAP TS parameter calculation results for the MW16R were reasonably close to the factory data, however my data definitely showed a lower Vas compared to the factory data. Although the preliminary factory data showed some variation, I followed my usual protocol and proceeded setting up computer enclosure simulations using the LEAP LTD parameters for Sample 1. Two computer box simulations were programmed into LEAP, one sealed and one vented. This resulted in a 0.5 ft^3 sealed enclosure with 50% fiberglass fill material, and a 1.0 ft^3 QB^3 vented enclosure with 15% fiberglass fill material and tuned to 30 Hz.

Figure 11 displays the results for the SB Acoustics Satori woofer in the sealed and vented boxes at 2.83 V and at a voltage level sufficiently high enough to increase cone excursion to Xmax + 15% (6.9 mm for the MW16R). This produced a F^3 frequency of 58 Hz with a box/driver Qtc of 0.69 for the 0.5 ft^3 sealed enclosure and –3 dB = 40 Hz for the 1.0 ft^3 vented simulation. Increasing the voltage input to the simulations until the maximum linear cone excursion was reached resulted in 101.5 dB at 14 V for the sealed enclosure simulation and 103 dB with a 13.5-V input level for the larger vented box (see **Figure 12** and **13** for the 2.83-V group delay curves and the 14/13.5-V excursion curves).

Klippel analysis for the SB Acoustics 6.5" woofer (our analyzer is provided courtesy of Klippel GmbH), performed by Pat Turnmire, Red Rock Acoustics (author of the SpeaD and RevSpeaD software) produced the Bl(X), Kms(X), and Bl and Kms symmetry range plots given in **Figures 14** to **17**. This data is extremely valuable for transducer engineering, so if you don't own a Klippel analyzer and would like to have analysis done on a particular driver project, Red Rock Acoustics can provide Klippel analysis of almost any driver for a nominal fee of $100 per unit. (For contact information, visit the Red Rock Acoustics website at www.redrockacoustics.com.)

The Bl(X) curve for the MW16R (see **Figure 14**) is fairly broad, but obviously with a component of asymmetry, with a forward (coil-out) offset. Looking at the Bl Symmetry plot (see **Figure 15**), this curve shows a 3.4-mm coil forward offset at the rest position that decreases to 1 mm at the 7 mm, just beyond the physical Xmax for this driver. One of the things I

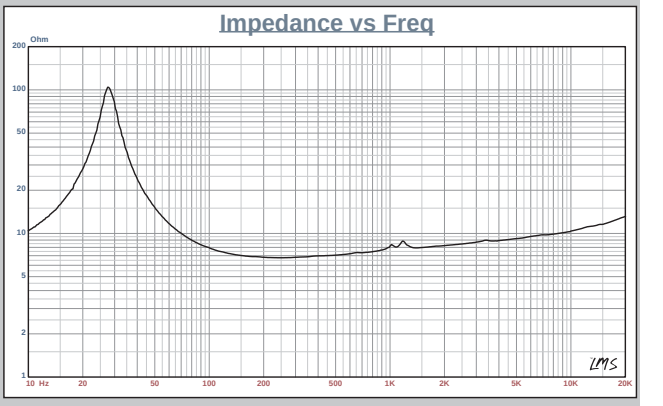


Figure 10: SB Acoustics MW16R woofer free-air impedance plot

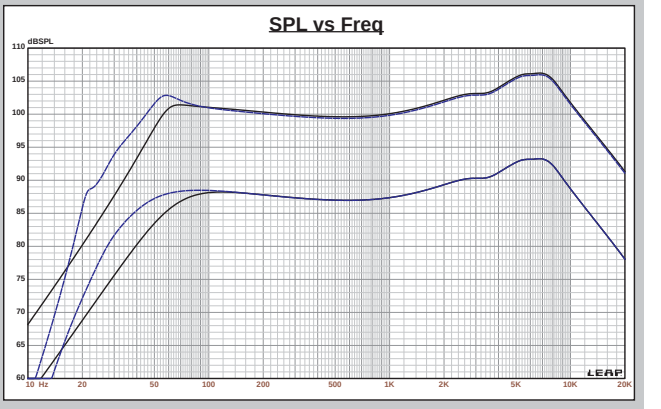


Figure 11: SB Acoustics MW16R computer box simulations (black solid = sealed @ 2.83 V; blue dash = vented @ 2.83 V; black solid = sealed @ 14 V; blue dash = vented @ 13.5 V)

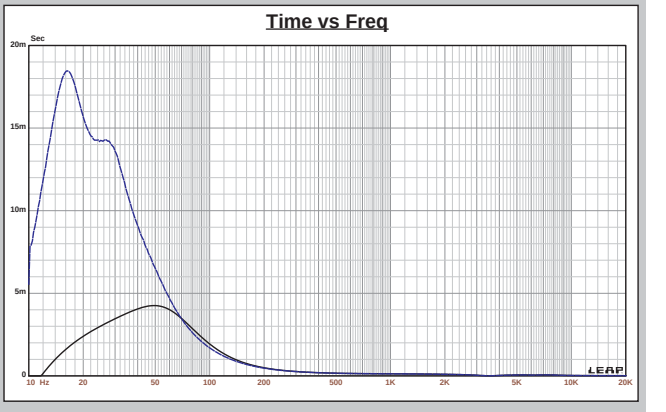


Figure 12: Group delay curves for the 2.83-V curves in Figure 11

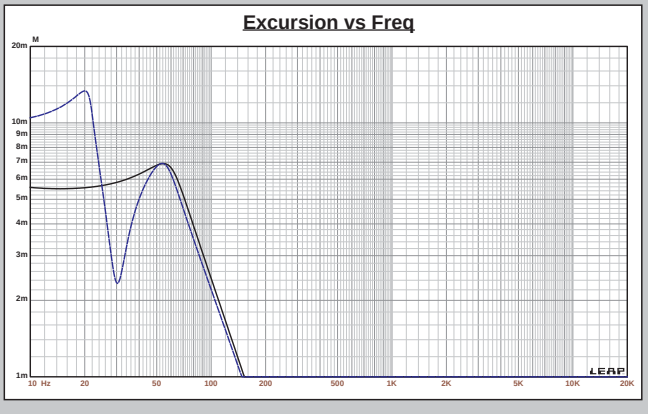


Figure 13: Cone excursion curves for the 14/13.5-V curves in Figure 11

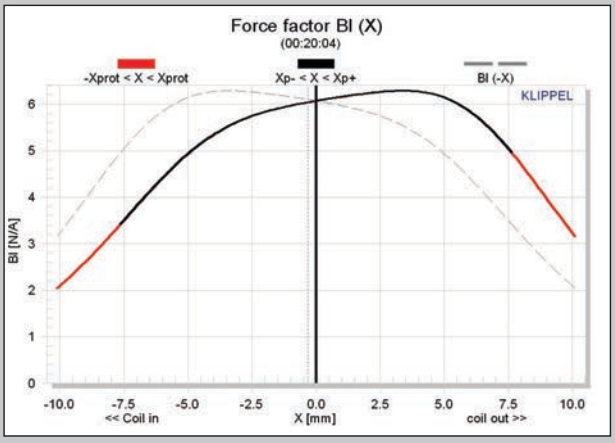


Figure 14: Klippel Analyzer Bl (X) curve for the SB Acoustics MW16R

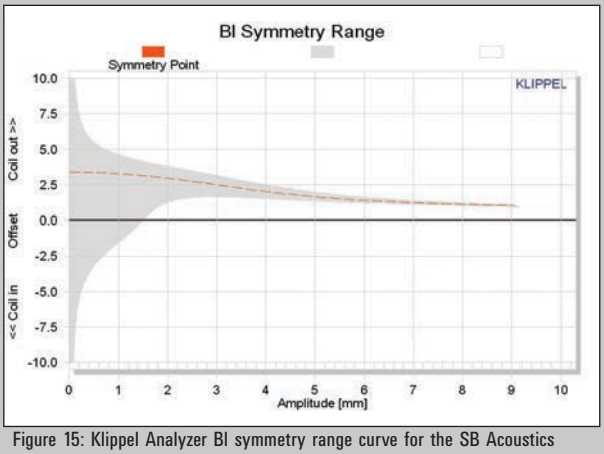


Figure 15: Klippel Analyzer Bl symmetry range curve for the SB Acoustics MW16R

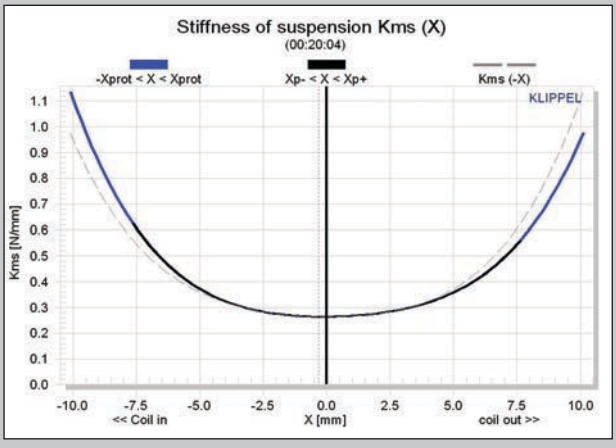


Figure 16: Klippel Analyzer mechanical stiffness of suspension Kms (X) curve for the SB Acoustics MW16R

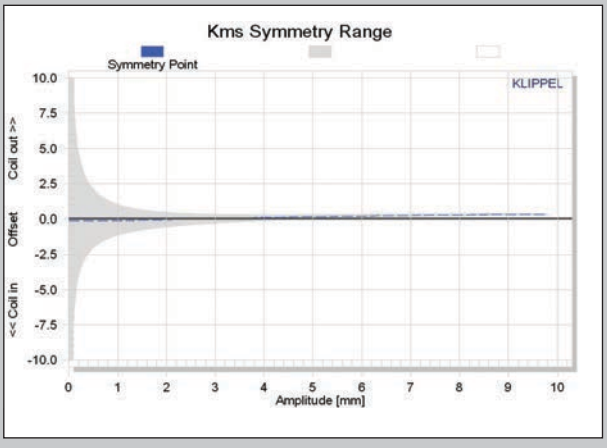


Figure 17: Klippel Analyzer Kms symmetry range curve for the SB Acoustics MW16R

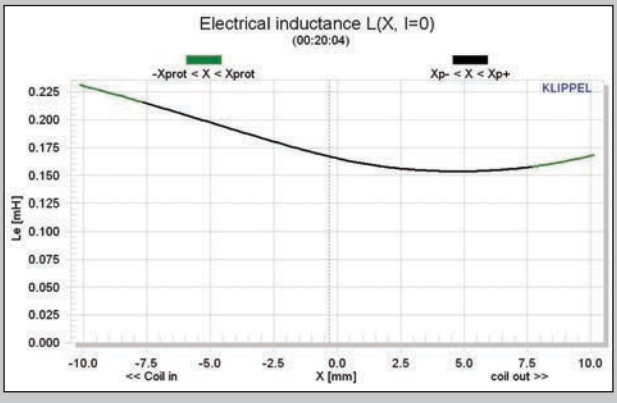


Figure 18: Klippel Analyzer Le(X) curve for the SB Acoustics MW16R

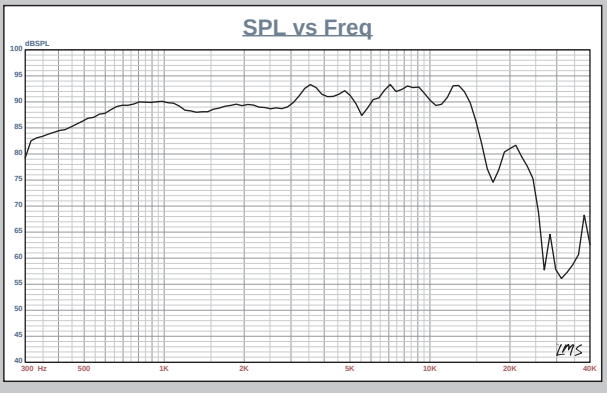


Figure 19: SB Acoustics MW16R on-axis frequency response

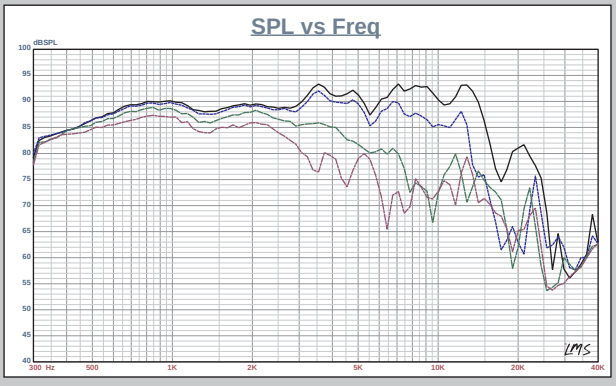


Figure 20: SB Acoustics MW16R on- and off-axis frequency response

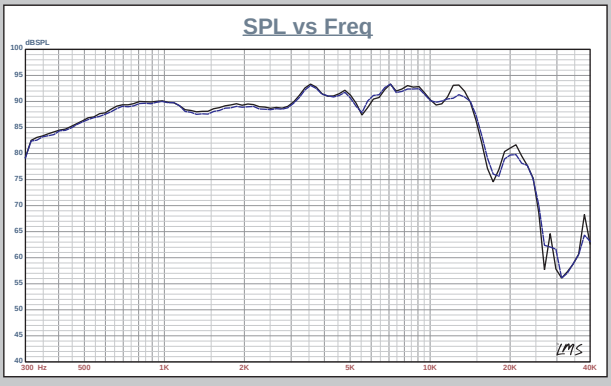


Figure 21: SB Acoustics MW16R two-sample SPL comparison

have not talked about very often is the grey area on the graph. This represents the area of uncertainty for the analyzer. Since Bl curves are typically flat until you reach the knee where Bl begins to decrease, it is difficult to resolve exactly what is happening to the motor system. **Figure 16** and **17** show the Kms(X) and Kms Symmetry Range curves for the SB Acoustics MW16R. The Kms(X) curve is very symmetrical in both directions, but also with a small rearward (coil-in) offset of about 0.1 mm at the rest position and transitioning to 0.1 mm-coil-out offset at the physical Xmax position. Looking at both sets of data, Bl and compliance, the conclusion is likely that the coil is about 1 mm offset from magnetic center. I say this because that is the offset at a place of strong certainty in the measurement at 7 mm.

Displacement limiting numbers calculated by the Klippel analyzer for the MW16R were XBl @ 82% Bl = 4.9 mm and for XC @ 75% Cms minimum was 4.6 mm, which means that for this Vifa woofer, the compliance is the most limiting factor for prescribed distortion level of 10%.

Figure 18 gives the inductance curves Le(X) for the Satori 6.5". Inductance will typically increase in the rear direction from the zero rest position as the voice coil covers more pole area, which is what you see in the MW16R Le(X) curve, however, the variation is only 0.20 mH to 0.15 mH from the in and out Xmax positions, which is very good.

Next, I mounted the MW16R woofer in an enclosure which had a 13" × 6" baffle and was filled with damping material (foam) and then measured the DUT on- and off-axis from 300-Hz to 20-kHz frequency response at 2.83 V/1 m using the LinearX LMS analyzer set to a 100-point gated sine wave sweep. **Figure 19** gives the Satori woofer's on-axis response indicating a smoothly rising response to about 1 kHz then flattening out up to 3 kHz with a small amount of anomalous behavior up to the low-pass roll-off beginning at 16 kHz. **Figure 20** displays the on- and off-axis frequency response at 0°, 15°, 30°, and 45°. At 30°, –3 dB

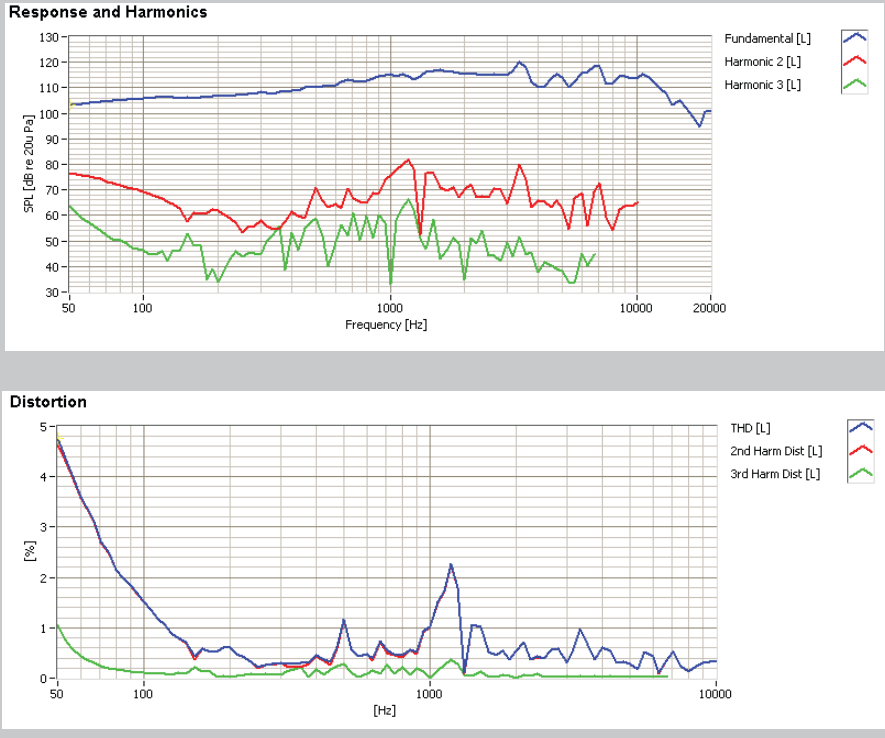


Figure 22: SB Acoustics MW16R SoundCheck distortion plots

with respect to the on-axis curve occurs at 2.8 kHz, so a cross point at 3 kHz or lower would be appropriate. And finally, **Figure 21** gives the two-sample SPL comparisons for the 6.5" SB driver, showing a close match to within 0.5 dB throughout the operating range.

For the remaining group of tests, I employed the Listen, Inc. SoundCheck analyzer and SCM ¼" microphone (courtesy of Listen, Inc.) to measure distortion and generate time frequency plots. For the distortion measurement, the Satori woofer was mounted rigidly in free-air, and the SPL set to 94 dB at 1 m (5.6 V) using a noise stimulus, and then the distortion measured at with the Listen, Inc. microphone placed 10 cm from the dust cap. This produced the distortion curves shown in **Figure 22**. I then used SoundCheck to get a 2.83 V/1 m impulse response for this driver and imported the data into Listen Inc.'s SoundMap Time/Frequency software. The resulting CSD waterfall plot is given in **Figure 23** and the Wigner-Ville (for its better low-frequency performance) plot in **Figure 24**.

All things taken together, and since I know that Frank and Ulrik (Danesian Audio) spend a lot of time listening to various iterations of a driver as they go through the development process, I'm guessing that this is a very fine sounding product. For more information on the SB-26STAC and MW16R Satori woofer and other SB Acoustics drivers, visit the SB Acoustics website at www.sbacoustics.com. *aX*

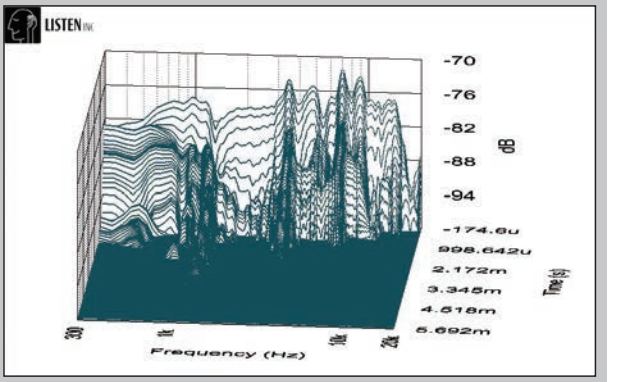


Figure 23: SB Acoustics MW16R SoundCheck CSD waterfall plot

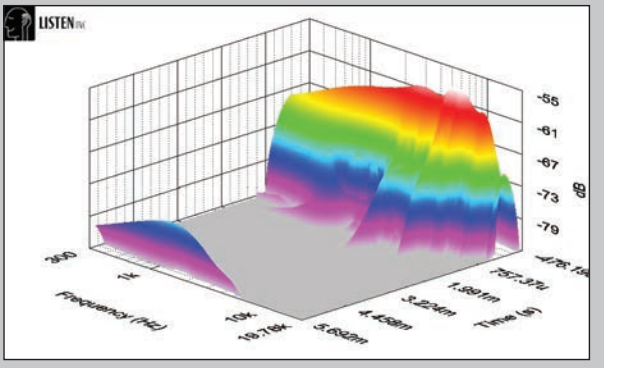


Figure 24: SB Acoustics MW16R SoundCheck Wigner-Ville plot

By Gary Galo (United States)

Oppo BDP-95 Universal Network 3-D Blu-ray Disc Player

A look at Oppo's new BDP-95 player

Oppo BDP-95 3D Blu-Ray Disc Player
Oppo Digital, Inc. 2629B Terminal Blvd. Mountain View, CA 94043 (650) 961-1118 www.oppodigital.com service@oppodigital.com
Price: $999

Photo 1: The front panel of the BDP-95 Universal Blu-ray player is extremely attractive. A touch-sensitive array on the right side of the display controls basic transport functions. Power and Eject buttons are mounted flush with the front panel. (Photo courtesy of Oppo Digital)

Photo 2: Rear panel of the BDP-95. The player offers the same digital and video connectivity as the BDP-93, but the audio portion includes dedicated two-channel outputs for the highest possible performance from stereo material. (Photo courtesy of Oppo Digital)

Oppo Digital players have consistently delivered excellent performance for their relatively modest asking prices, but Oppo has promised a good deal more than that for the eagerly awaited BDP-95 (**Photo 1**). The BDP-95 is physically taller than the BDP-93 (reviewed in *audioXpress* June 2011), occupying two standard rack units (a rack mount kit is available as an accessory). The player also weighs in at a robust 16 lbs, over 5 lbs more than the BDP-93. The extra size and weight are taken up by the audio circuitry and supporting power supply.

On the video end, the BDP-95 is identical to the BDP-93, using the same Marvell 88DE2750 Kyoto-G2 video processor, and offering the same video performance and features. In short, it offers state-of-the-art video performance both for HD Blu-ray sources and upconversion of DVDs to 1080p. I won't repeat all of the details here. Readers should consult my BDP-93 review. The BDP-95 also offers the exact same connectivity as the BDP-93 (**Photo 2**), the same media and file support, and the same remote control.

NEW AUDIO CIRCUITRY

The audio portion of the BDP-95 bears no resemblance to its lower-priced sibling. The audio circuitry of the BDP-95 has been designed from the ground up for true high-end performance. Unlike the BDP-93, which uses the switching-mode power supply to feed both the audio and video circuitry, the BDP-95 has a totally separate linear power supply for the audio portion of the player (**Photo 3**). This linear supply uses a Rotel toroidal power transformer and a two-tiered regulator scheme. The main linear supply board contains a full-wave bridge rectifier and three pre-regulators: a pair for the positive and negative analog supplies, and another for the digital circuitry. The main audio circuit board, which included the D/A converter chips and all analog circuitry, also contains local regulation for the analog and digital hardware.

Oppo has included separate two-channel stereo outputs on the BDP-95, in addition to the 7.1 multichannel outputs, which have been optimized for the best possible stereo performance. The two-channel and multichannel outputs have each been given separate local supply regulation for the D/A converter chips and the analog circuitry. The switching-mode supply that powers the video circuitry is shielded to prevent interference with the audio circuitry and the linear audio power supplies.

A NEW STANDARD

For several years my reference digital player has been a NAD M55, a universal player accommodating all digital formats from DVD and SACD on down. Introduced in 2006, with a list price of $2,000, the M55 set a standard for players in that price range, both for audio and video performance. The Blu-ray disc was officially released that same year, but the first players were very expensive, as is always the case, and universal players that would accommodate them were several years off. The M55 used a Burr-Brown/TI DSD1608 DAC chip, an eight-channel Sigma-Delta, 192 kHz/24-bit converter. The DSD1608 was introduced

in 2002, and was state-of the-art at the time. It was among the first of the D/A converters that would accept the DSD datastream directly, so SACDs didn't require a potentially degrading conversion to PCM before conversion to analog.

NAD also took extra care with the analog circuitry, using Burr-Brown/TI OPA2134 dual op amps, FET-input devices designed specifically for high-performance audio applications. Each op amp was buffered with a single-ended discrete JFET output stage, with DC-servo control to eliminate the need for coupling capacitors. In the listening tests I conducted while developing the Music Library Preamp (*audioXpress* March 2005), I found the OPA134 (the identical single version) to be a good chip, but not one of the very best, outperformed sonically by the OPA604, OPA627, and Analog Devices AD825. NAD used a switching-mode power supply for both the video and audio portions of the M55.

I use the M55 as a stand-alone player for SACDs, but for PCM material I use it in conjunction with a PS Audio Digital Link III D/A converter (reviewed in *audioXpress* August 2009). The PS Audio DAC uses a Burr-Brown/TI SRC4192 asynchronous sample rate converter chip and their 192-kHz/24-bit PCM1798 D/A converter, with discrete I/V and output circuitry that's DC-servo controlled. The Digital Link III is a significant sonic improvement over the M55 used as a stand-alone player.

SABRE32 DAC

For the BDP-95, Oppo has moved on to a new generation of D/A converter chips: The Sabre32 Reference series manufactured by ESS Technology (www.esstech.com; no relation to the loudspeaker company). Oppo chose the flagship ES9018, an eight-channel chip. One ES9018 is used for the 7.1 multichannel outputs, and a second chip is dedicated to the two-channel stereo outputs (**Photo 4**). The principal designer of the Sabre32 chips is Dustin Forman, senior design engineer for ESS, who worked closely with Martin Mallinson, ESS's director of design engineering. (Mallinson previously was product line manager for Analog Devices.) The Sabre32 is a noteworthy departure from the Sigma-Delta architecture so familiar in high-performance DACs, and uses a HyperStream multi-bit modulator.

Although an I²S/S/PDIF input receiver is built into the ES9018, it does not employ the usual analog phase-locked loop. Instead of reducing jitter on the incoming clock, the ES9018 generates an entirely new clock, unrelated to the incoming clock. This ensures zero jitter transfer from the incoming clock. ESS claims that the Sabre32 chip achieves 100% jitter rejection.

The ES9018 upsamples the incoming datastream to 864 kHz, but it doesn't employ a poly-phase filter used in most asynchronous sample rate converters. The Sabre32 DAC's upsampler has two advantages over the poly-phase filter approach. First, rate conversion is unlimited, so the Sabre32 can achieve conversion up to exceptionally high clock rates, from as low as 4 kHz to as high as 40 MHz in one step. Second, the process is essentially perfect at the bit level.

ESS has trademarked their noise-shaping and bit-reducing modulators, calling them the HyperStream modulators. The HyperStream multi-bit modulators can operate up to 100% modulation depth, with lower noise than Sigma-Delta modulators can achieve. ESS also claims that the HyperStream modulators do not exhibit the nonlinear noise behavior inherent in some Sigma-Delta modulators when transients are processed.

ESS's DAC circuitry employs a patented form of Dynamic Element Matching that shifts any residual DAC mismatch well out of the audio band. The Sabre32 chip has eight independent and fully balanced DACs. Multiple output channels can be connected in parallel for improved dynamic range and low-level linearity. An eight-channel chip can be configured for stereo operation, with four output channels connected in parallel. With this configuration, the ES9018 achieves a dynamic range of 133 dB and THD of –120 dB. What I've given here is a necessarily imperfect summary of the Sabre32 design. A detailed paper on the Sabre32 chips by Mallinson and Forman is available at www.esstech.com/PDF/sabrewp.pdf and is highly informative.

The ES9018 supports a digital volume control as part of its internal DSP functions. Oppo's Lanping Deng says that, technically, the DSP volume control should not affect the sound quality, but also notes that ESS recommends using an external volume control if possible. The ES9018 supports volume adjustment in 0.5-dB steps, but Oppo's implementation

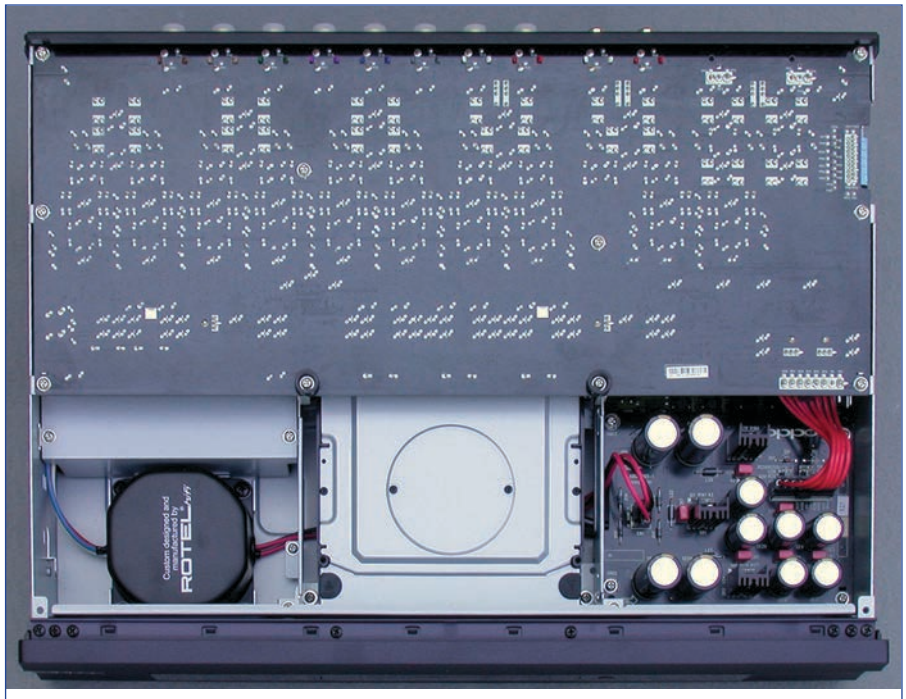


Photo 3: Inside the BDP-95. A dedicated linear power supply fed by a Rotel toroidal transformer powers the audio circuitry. The switching-mode supply used for the video portion of the player is fully shielded to prevent interference with the linear supply and audio circuitry.

is in 5.0-dB increments. The chip also supports Red Book digital de-emphasis automatically.

The ES9018 is a chip I'd expect to find in players costing many times what Oppo is asking for the BDP-95. Indeed, McIntosh Laboratory has selected it for their new MCD1100 CD/SACD player, which retails for $10,000 and, strangely, does not play DVD-Audio discs! The Weiss DAC 202 outboard D/A converter also uses the ES9018, and retails for $6,700. If better DAC chips were available, surely McIntosh and Weiss would have used them, and it's amazing to find the ES9018 in a product costing one-tenth of the McIntosh player.

The multichannel portion of the BDP-95 uses one ES9018 DAC section per output. But, to obtain the highest level of performance from the two-channel stereo outputs, Oppo has paralleled four DAC sections per stereo channel, as described above, for the best possible performance from the stereo outputs. The outputs of each individual DAC within the ES9018 are fully differential. The + and – outputs are fed to National Semiconductor LM4562 op-amps.

The LM4562 is part of National's high-performance line of audio amplifier chips. This dual, bi-polar device has a slew rate of 20 V/μs, a gain-bandwidth product of 50 MHz, a very low input noise density of 2.7 nV/√Hz, and THD of 0.00003% with a 600-Ω load. Slew rate is identical to the OPA2134 used in the NAD M-55, but the Burr-Brown/TI op-amp is inferior in other important respects, with a gain-bandwidth product of 8 MHz, input noise density of 8 nV/√Hz, and THD of 0.00008% with a 600-Ω load. (I seriously doubt that the static, measured distortion difference of 0.00005%, by itself, tells much about the sonic characteristics of these two chips; bandwidth and noise are probably more important, especially with high-resolution digital formats.)

For each channel, one of these dual op-amps is used as a differential I/V converter and half of a second device is the differential-to-single ended converter/output buffer. The topology effectively cancels DC offsets, leaving extremely low residual DC levels, so the entire analog signal path is DC coupled; there are no coupling capacitors.

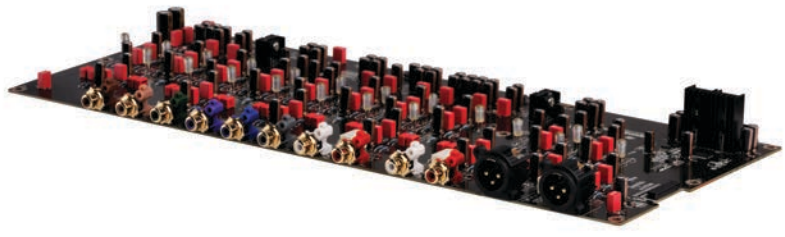


Photo 4: The BDP-95 audio circuit board. Separate ESS Sabre32 eight-channel DAC chips are used for the multichannel and stereo outputs. Analog circuitry is based on high-performance audio-grade op-amps from National Semiconductor. Oppo uses on-board regulation and generous local supply bypassing. (Photo courtesy of Oppo Digital)

In addition to the RCA stereo outputs, the BDP-95 also has a pair of balanced outputs with standard three-pin XLR connector. For the balanced outputs, Oppo uses a National LME49724, described by the manufacturer as a "High-Performance, High-Fidelity, Fully-Differential Audio Op-Amp." This device has specifications very close to those of the LM4562, and is clearly intended as an alternative to the THAT 1200-series of balanced line receivers and 1600-series of balanced line drivers. The LME48724 has differential outputs and inputs, so it can function as a balanced line receiver or a line driver, depending on the configuration. Two critical specifications—slew rate and bandwidth—are superior to the THAT chips.

It would make sense for Oppo to use the LME49724 as a fully differential device, so it's probably connected directly to the outputs from the LM4562 differential I/V converter. This simplifies the signal path for the balanced outputs by eliminating an extra op amp in the signal path. A typical balanced line driver would be connected to the output of the op amp driving the single-ended output, so the balanced outputs would actually require an extra active stage relative to the unbalanced outputs. The LME49724 allows the balanced and unbalanced outputs to each have its own independent gain stages after the I/V converters, with no redundancy.

Oppo uses Wima polypropylene capacitors, along with a few polystyrene types for smaller values, in the analog filter circuits. Wima film caps are also used in parallel with electrolytics for local supply bypassing. Resistors are 1% metal film types and, with their light blue lacquer, look like the Yageo resistors sold by Digi-Key. It's just not possible to use expensive, exotic resistors in a player in this price range. Oppo has their priorities in order, using entry-level metal film resistors in order to avoid compromising the capacitors used for the analog filters.

The BDP-95 is supplied with gold-plated, chassis-mount RCA jacks. These are not exotic, Teflon-insulated jacks, but they are single-jack types, with spacing between them that's wide enough to accommodate high-end RCA plugs. Many high-end plugs are too bulky to fit side-by-side in double PC-mount jacks—they should all work fine with the BDP-95. The player comes with an 85-page manual that, like the other Oppo manuals, is clearly written. Updated versions are always available on the Oppo website. The on-screen setup procedure is easy and intuitive. Only the most inexperienced users will need to refer to the manual.

I have only two operational quibbles with the BDP-95. When you insert a disc, after a few seconds the player identifies the inserted medium on the front panel display, but it does not display time and track information for the disc. The Oppo does not allow you to go directly to any track from the "Stop" position. You can only enter the desired track after the disc has commenced playing. Nearly all other players allow you to do both of these things.

THE SOUND

The Oppo BDP-95 improved after a few days of break-in, but the difference is not dramatic, and the player sounds excellent right out of the box. The BDP-95 bears no family resemblance to the BDP-93. This player is in an entirely different

league. The BDP-95 excels in revealing the most subtle inner details of a musical score. When I reviewed the Benchmark DAC-1 USB (*audioXpress* January 2009), I praised its pristine clarity and detail, calling it "the most transparent DAC I've auditioned." But, I also noted that this detail was accompanied by a tendency toward brightness in the treble region, which I attributed to the 5532 op-amps. While the PS Audio Digital Link III didn't offer quite the same level of detail as the Benchmark, I found it musically more satisfying—warmer and smoother.

The Oppo BDP-95 doesn't force you to choose between that last ounce of detail and the most natural-sounding treble. It delivers the best of both worlds: exceptionally articulate, detailed sound combined with a smooth, silky treble region, and overall tonal neutrality that just makes you want to keep listening. What's really impressive is the BDP-95's ability to reproduce fine harmonic detail on first-class recordings, such as the high strings in Respighi's "The Birds with Dorati" and the London Symphony (Mercury 432 007-2), or the strings and winds in Dukas' "The Sorcerer's Apprentice" with Munch and the Boston Symphony (RCA Victor Living Stereo 68268-2).

Low strings—cellos and violas—are palpably rich, gutsy, and amazingly realistic ("Gnomus" in the Mussorgsky/Ravel Pictures at an Exhibition, Reiner/Chicago, RCA Victor Living Stereo Gold 61958-2; "Interlude and Dance" from de Falla's La vida breve, Ansermet/Suisse Romande, Esoteric/Decca SACD ESSD 90016; and Rachmaninoff's "Symphonic Dances," Johanos/Dallas, Classic Records 96/24 DVD DAD 1004).

The BDP-95 excels at soundstage reproduction. On a first-class recording of a large symphony orchestra (Schoenberg; Five Pieces for Orchestra, Dorati/London Symphony, Mercury 432 006-2), everything is precisely localized, front-to-back and left-to-right, with lots of depth. The localization of the various brass instruments in the Reiner/Chicago Rimsky-Korsakov "Scheherazade" is outstanding (RCA Victor Living Stereo Gold 68568-2).

Low-frequency extension is excellent, combining weight with clarity, articulation, and control (Copland: "Symphony No. 3," last mvt., Levi/Atlanta Symphony, Telarc CD-8020; Stravinsky: "Le Sacre du Printemps," Oue/Minnesota Orchestra, Reference Recordings HRx DVD with 176.4 kHz/24-bit WAV files, HR-70). Dynamics are also impressive, with a very low noise floor and the ability to maintain clarity and detail, without strain or congestion, in the most complex, fully scored material.

My preamp doesn't have balanced inputs, but I wanted to evaluate the Oppo player's balanced outputs. I took advantage of the digital volume control built into the ES9018 DAC, and connected the balanced outputs directly to the balanced inputs on my Monarchy SM-70 Pro power amps, bypassing my preamp completely. The Monarchy amps are fully differential when the balanced inputs are used and really perform at their sonic best this way. The Oppo player had plenty of gain to drive the Monarchy amps directly—most of the time I was running the digital volume control at around 40% of maximum level. The performance was superb, with a modest, but audible, increase in detail, depth, and precision of soundstage localization. Some of this may be due to the improved performance of the Monarchy amps used fully-balanced instead of the bridged mono configuration required when fed from unbalanced sources, including my own preamp.

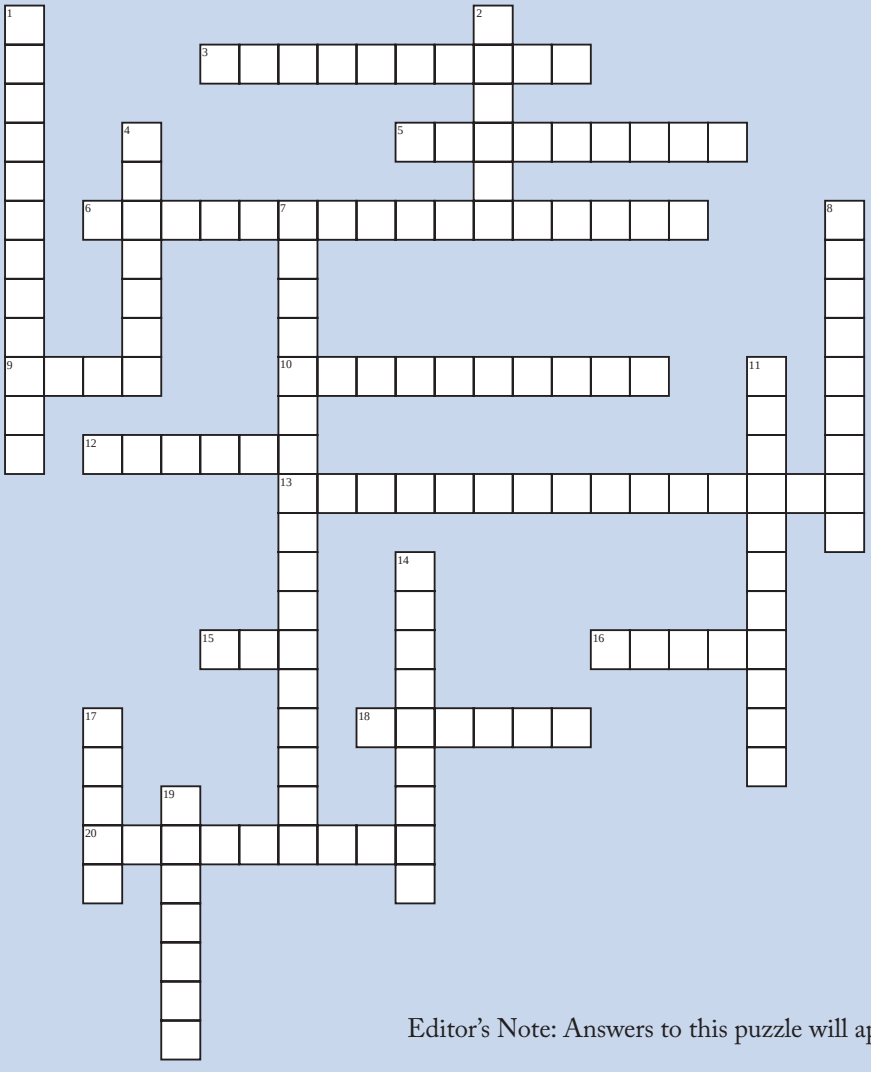
Suffice it to say, the balanced outputs on the BDP-95 seem fully up to the superb performance of the rest of the player. Although the Oppo's 5.0-dB volume increments may seem rather coarse, I didn't find it as much of a problem as I would have thought. If you play only digital media, and own fully differential power amps, this option is definitely worth trying. But, unless your power amp (or preamp, if you use one) is fully differential, you'll gain nothing from this type of configuration and may as well stick with the unbalanced outputs on the player.

Improvements are always possible, and more expensive products (probably much more) using the Sabre32 DAC will inevitably take the sonic virtues of the BDP-95 even further. But, in my many hours of listening to this player, I never found any obvious weaknesses, or areas of performance that I wish they had "fixed." As an audiophile who is surrounded by live, unamplified music on a daily basis, the Oppo continually impressed me by just how "right" it sounds.

Sonically, I prefer the BDP-95 to either the Benchmark or the PS Audio outboard DACs, and it easily beats my NAD M55 as a stand-alone player. For the first time in over 20 years, I'm not using an outboard D/A converter for PCM sources. The Oppo BDP-95 is that good!

CONCLUSION

With the BDP-95, Oppo Digital has moved way beyond the performance of their previous high-value products. Although the BDP-95 is, without question, a great player for the money, it's really a great player—PERIOD! For under $1,000, the BDP-95 offers musically outstanding performance; so good, in fact, that I consider it to be an even greater value than the $499 BDP-93. Unless you're able to spend a small fortune on a digital player or an outboard D/A converter, you're going to find the BDP-95 very hard to beat. *aX*



Editor's Note: Answers to this puzzle will appear in the next issue.

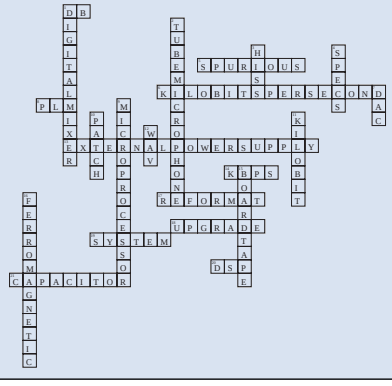
ACROSS

3. The converse of reflection
5. An audio signal's electrical strength
6. Negative feedback (two words)
9. A point of minimum amplitude
10. A unit of capacitance
12. A metal-oxide field-effect transistor
13. The load presented by a device's input to the output of the device feeding it (two words)
15. Electromagnetic interference
16. The part of the outer ear that directs sounds to the ear canal
18. A physical barrier intended to obstruct sound waves
20. The state of all the adjustments in an electronic or mechanical device

DOWN

1. The electrical analog of a sound (two words)
2. A residual AC component in the DC output from a power supply
4. An amplifying tube having five elements
7. A diagram of the wiring of an electronic device, in which the components are represented by two symbols (two words)
8. A diode, used for converting AC to DC
11. The area surrounding a radio transmitting antenna within which reception is unreliable or of marginal quality (two words)
14. To accuracy with which the output from any system follows changes in the amplitude of its input signal
17. A switch that is actuated by another electrical signal
19. The range frequencies from 40 to 80 Hz

Answers to the December 2011 Puzzle



Bob Carver offers a new line of vacuum tube amplifiers

A NEW LINE OF VACUUM TUBE AMPLIFIERS RELEASED

Bob Carver—a specialist in the design, manufacture and marketing of audiophile products for the custom installation and retail markets—now offers a new line of stylish, powerful vacuum tube amplifiers.

The new series of mono block amplifiers are the perfect blend of form and function and the ideal choice for serious music listeners. The Cherry 180 is conservatively rated at 180 W_{RMS} into 8 Ω, the Black Beauty 305 W_{RMS}. Both were designed to drive the most demanding speakers. These two models offer extreme performance that is difficult to believe, and each amplifier features a high impedance input, an automatic DC restorer circuit, a "set and forget" bias adjustment, and low idle current which greatly increases output tube life. They have an ultra-wide bandwidth output transformers with interleaved windings capable of the most nuanced voice as well as huge peak output capacity. Selectable feedback control allows the user to change the sound of the amplifier from vintage classical to modern contemporary.

From a listening perspective these amplifiers provide a warm, rich sound with a sumptuous and enveloping sound stage, a great front to back depth of field, and very tight, pin-point imaging within that larger acoustic. A special current feedback circuit allows the amplifier to "listen to the room" via feedback from the speakers acting as microphones (using the law of reciprocity). The room-speaker-amplifier interaction provides a sense of believable ambience and acoustic space that is thoroughly realistic and quite enjoyable. Additionally, the transformer output impedance allows the signal to follow the impedance curve of the speaker system, allowing more voltage to be delivered to the loudspeaker at very low frequencies—providing an exceptional and satisfying low end response.

The VTA180M lists for $7,400, and the VTA305M is $12,900. For more information, visit www.bobcarver.com.

MONSTER REDEFINES THE LOUDSPEAKER

Monster—a manufacturer of high-performance headphones, connectivity solutions and A/V accessories—is redefining the loudspeaker for the digital age with its ClarityHD Model One High Definition Multi-Media Speaker Monitor (SRP: $749.95/pair). Featuring a built-in high-powered digital amplifier and iPod dock, the all-in-one speaker system delivers an unprecedented level of higher-definition "big sound" for a bookshelf-sized speaker, with all the advanced connectivity options to satisfy the needs of today's most ahead-of-the-curve audio consumer.

The Monster ClarityHD Model One can be set up easily in just seconds and provides room-filling sound right out of the box. It is available in several designer colors, including automotive grade gloss yellow, and red to start, with additional colors coming this fall. The Model One is ideal for use in the living room, den, bedroom or kitchen, as well as for in-home or professional music studio use.

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The speaker's full complement of inputs accommodates virtually any type of source from consumer audio and video gear to professional recording and DJ gear as well. In addition to the iPod dock, a full complement of versatile inputs are included for total user flexibility and "future readiness," including: a mini-jack input for smart phones, MP3 players and computers; a balanced 0.25" TRS input for recording and DJ applications; RCA inputs for any audio or video device; and a StreamCast port for future technologies, including an optional Bluetooth module that will allow you to connect any Bluetooth source wirelessly to the Model One.

For more information, visit Monster at www.monstercable.com. *aX*

The Monster ClarityHD Model One in high-gloss red

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CONTRIBUTORS

Vance Dickason ("A New Tweeter and a New Woofer," p. 31) has been working as a professional in the loudspeaker industry since 1974. He is the author of the *Loudspeaker Design Cookbook*—which is now in its 7th edition and published in English, French, German, Dutch, Italian, Spanish, and Portuguese—and *The Loudspeaker Recipes*. Vance is currently the editor of *Voice Coil: The Periodical for the Loudspeaker Industry*, which is published monthly.

Gary Galo ("OPPO BDP-95 Universal Network 3-D Blu-Ray Disc Player," p. 38) retired after 34 years as audio engineer at The Crane School of Music, SUNY at Potsdam, NY. Not ready to quit entirely, he works half-time in that capacity. Gary is the author of over 260 articles and reviews on both technical and musical subjects. He is a regular contributor to *audioXpress* magazine.

Charlie Hughes ("Subwoofer Alignment with a Full-Range System," p. 28) earned a physics degree from the Georgia Institute of Technology in 1988. After graduation he worked for Peavey Electronics in Meridian, MS as a loudspeaker design engineer where he remained for 14 years. In late 2004, he started his own company, Excelsior Audio, located near Charlotte, NC. Excelsior Audio primarily provides consultation, design, measurement, loudspeaker optimization, and related services to loudspeaker manufacturers.

Mike Klasco ("Spiders and Sourrounds (Part 1)," p. 7) is the president of Menlo Scientific Ltd. in Richmond, CA, a consulting firm for the loudspeaker industry. He is the organizer of the Loudspeaker University seminars for speaker engineers. Mike contributes monthly to *audioXpress*. He specializes in materials and fabrication techniques to enhance speaker performance.

Nelson Pass ("JBL L300 Modification," p.12) received a degree in physics from UC Davis while working for ESS, a loudspeaker maker known for the "Heil Transformer." He co-founded Threshold Corporation, and served as its President from 1975 to 1991, selling his interest in 1987. In 1991, he founded Pass Laboratories. At Pass Labs he helped popularize solid state single-ended Class A power amplifiers. Pass started another "kitchen table" company, First Watt, in 1998 and has used it as a vehicle to introduce small Class A amplifier designs which otherwise would not find a way to market. Nelson has been deeply involved in the "do-it-yourself" audio community since 1973 and has published over 50 pieces aimed at construction by hobbyists.

Steve Tatarunis ("Spiders and Sourrounds (Part 1)," p. 7) is a senior engineer at Menlo Scientific and a 30 year veteran of the loudspeaker industry. He runs Menlo's Boston-area test lab where he tests speakers, microphones, headsets, and other audio devices for Menlo's clients.

David J. Weinberg ("CEDIA 2011: The Integrated Home," p. 17) is an engineering consultant and technology journalist on audio, video and film technology. He provides audio and home theater engineering consultation and professional location digital audio recording services to companies, radio stations and individuals. He brings to his work an MSEE, a First Class Radiotelephone license, and five decades of continued study and active involvement in the audio, video, and computer industries. He is chair of the Audio Engineering Society's DC section, and a manager in the Society of Motion Picture and Television Engineers' DC section.

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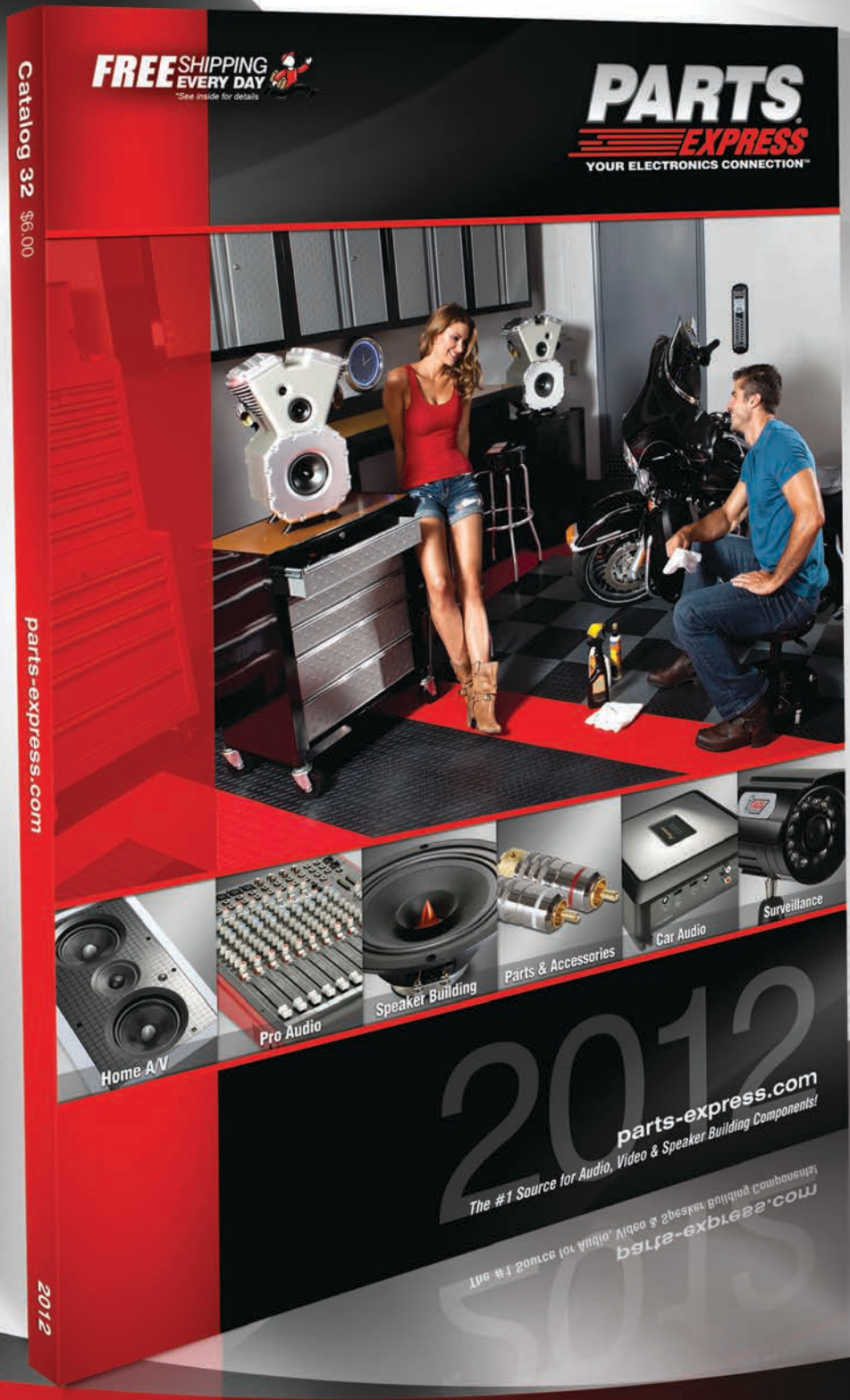

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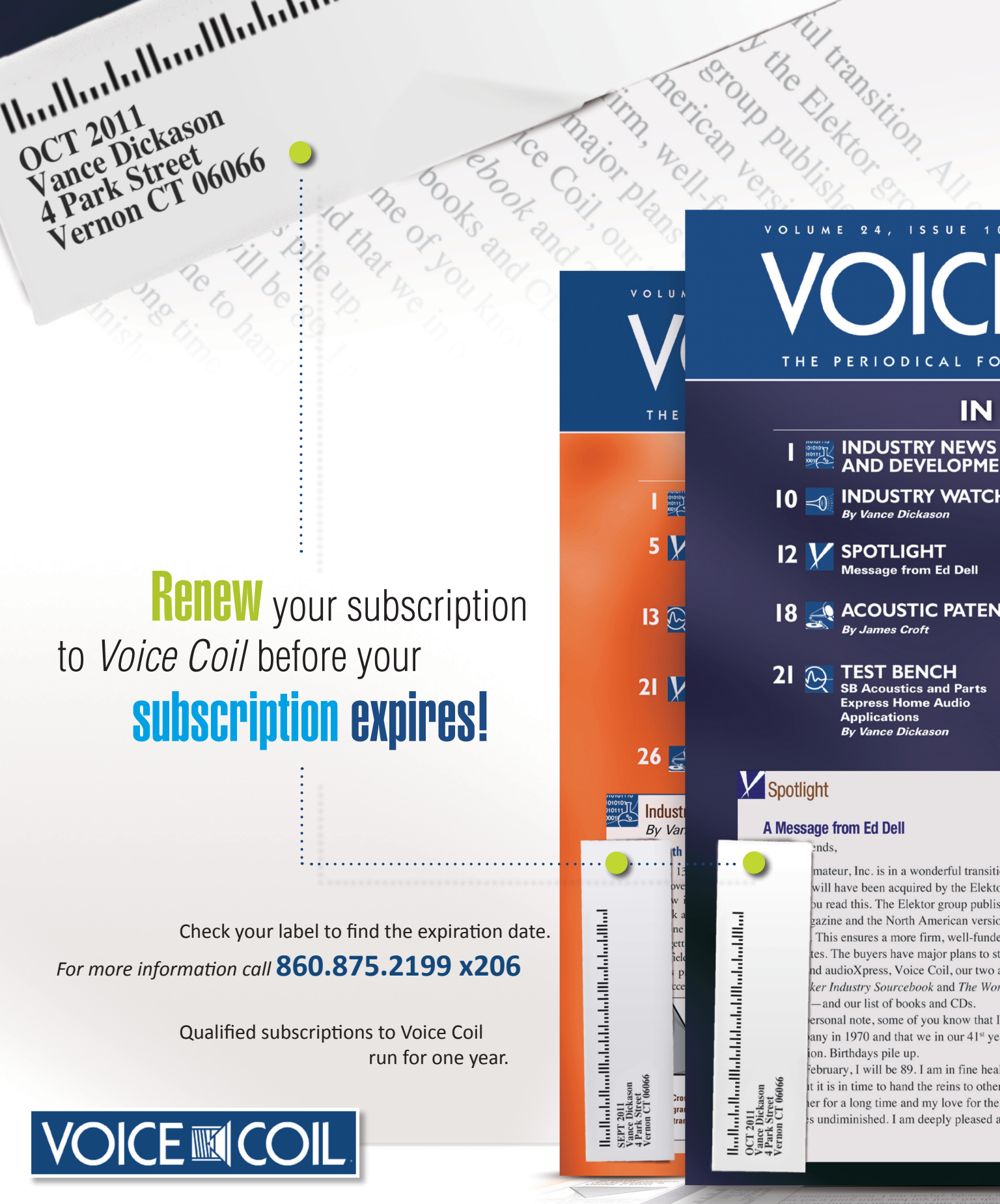

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