

## POWER AMP MODS

Of the many letters we received regarding Ed Simon's "A Solid-State Single-Ended Power Amplifier" (April '06 *aX*, p. 24), perhaps the most ambitious was from our good friend Ron Tipton, who built the design as outlined in the article, and then went about making some changes. His final version—complete with text, parts list, sources, photos, and figures—is posted on both our website [www.audioXpress.com](http://www.audioXpress.com) and the TDL website [www.tdl-tech.com](http://www.tdl-tech.com). We encourage you to check out his work. —Eds.

## ATTENUATOR COMPONENTS

Milan Uskokovic's article, "High-Quality Stepped Attenuators for Less" (Oct. *aX*) left me puzzled. It spends several pages discussing which resistors "sound best" and which are the most practical steps of attenuation to use, yet it says nothing about switch types, construction, or sources.

As to the "for less" part, I would think that in most cases, the cost of the switch would dwarf the cost of the resistors. I also think that a quality switch would make all the difference in reliability, if not sound quality; after 35 years of electronics experience, I know two things for sure:

1. In any electronic device, a component with moving parts will be more likely to fail.
2. In any electronic device, a com-

ponent with moving parts that is touched by human hands will be the first thing to fail.

*Larry DiGioia*  
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### Milan Uskokovic responds:

When designing a piece of electronic equipment or a part, commercial designers generally aim to produce products that would suit the needs and requirements of as many users as possible, which means that the final design will inevitably be some sort of a compromise. DIYers, on the other hand, have no other responsibility but to themselves. They have the luxury to tailor their designs to their individual needs and preferences and are completely free to go about their projects as they wish.

It is precisely this difference that is at the core of my article(s) on stepped attenuators. Instead of blindly following industry-imposed standards that may lead to inappropriate and costly investments, DIYers may be much better advised to focus on the specifics of their particular applications and look at what it is they need their attenuators to do.

In this regard, I intended to help DIYers with some general tips and guidelines on how to optimize their attenuators in terms of the number of resistors and switch sizes, leaving the actual choice of resistor and switch types/brands up to individual considerations to allow maximum flexibility within the constraints of their given financial realities and personal preferences. The practi-

cal example with tantalum resistors, given toward the end of the article, is shown for illustrative purposes only, with no intention whatsoever of demonstrating superiority of any particular type of resistors or switches.

As someone who has been professionally involved with the installation, repair, maintenance, and design of audio broadcast equipment for the last 16 years (currently serving as the CTO for Radio 101, Croatia), I completely agree that mechanical components in electronic devices tend to be the most critical aspect of professional audio systems, and so must often be "overdesigned" for quality and reliability to give longer service life. However, it is my opinion that electronic parts longevity is not as critical in high-quality DIY projects. The most important issue in DIY audio is the "audiophile-grade" sound quality, most often determined as a combination of objective measurement results and the subjective listening tests of an audio component.

Because the correlation between the durability/reliability of a piece of audio equipment (or any part thereof) and the resulting sound quality (its subjective component, in particular) is relatively weak, any recommendation on a specific type or brand of resistors and switches to use would be rather difficult and arbitrary. With this in mind, my intention was first and foremost to show DIYers how they can cut costs by avoiding "overdesigning" and customizing attenuator applications to their individual needs and preferences. The actual choice of resistors and switches is left up to them, for reasons mentioned.

If you wish, I would be glad to discuss with you any further issues regarding the reliability of mechanical parts in professional audio systems, which may be of little interest to the general readership, by e-mail ([milan.uskokovic@radio101.hr](mailto:milan.uskokovic@radio101.hr)).

## AMP SUGGESTIONS

The "Tube-Based Power Solid-State Amp," by Wim de Haan (Sept. *aX*, p. 34) is very interesting, and I enjoy articles on high-quality audio amplifier circuits that are simple in design. Returning capacitors C7 and C9 to the output rail (junction of R14 and R15) instead of ground would bootstrap resistors R7 + P2 and R10 to the output, raising the input impedance of the output stage to almost that of the bases of Q2 and Q3. This could eliminate the cathode follower and allow smaller value coupling capacitors at C3 and C4.

Another tube to try is type 12BH7, which has an  $R_p$  of 5300 $\Omega$  and is used as a driver in some high-end amplifiers. Speaking of tubes, ECC82 is American type 12AU7. I know of no European number for 6SN7GT, but if there is one, it would be ECC3-something because of the octal base.

The fully complementary power output circuit was heralded as a major breakthrough in solid-state power amplifier design in the early 1970s. See Reginald Williamson's "The Twin-Twenty, Mark II" (*Audio Amateur*, Winter 1970 p. 2) and Arthur Bailey's "The Bailey 30-30" (*Audio Amateur*, Fall 1970 p. 7). Probably both the full- and quasi-complementary are capable of equally good sound, because, even today, NPN and PNP transistors do not have exactly mirror-image transfer curves. ICs use quasi-complementary outputs because it is probably not feasible to fabricate both polarities of power transistors on one substrate.

Michael Kiley  
Crestwood, Ill.

### Wim de Haan responds:

You have a point. The input impedance of the current stage is rather low, and because of this the coupling caps should be  $> 3\mu\text{F}$ . However, I believe ClarityCap [SA type] and ICEL [PHC type] offer good-sounding caps at rather low cost, so it is not really

a problem to me, and it should not be. By increasing the input impedance, you could indeed use a smaller cap, but I doubt if we can eliminate the cathode follower without degrading distortion figures. To obtain higher input impedance, I experimented with changing the R7 + P2 and R10 to current sources.

Your idea to use bootstrapping is an option that didn't occur to me but would be interesting to try. This approach doesn't reflect the design philosophy of this project because now you must add two large electrolytic capacitors to the circuit and are thus adding positive feedback. Therefore, the coupling cap should still be  $1\mu\text{F}$  or so, I guess. My test setup is still working so I will give the bootstrap option a go, but it needs to be tested.

The 12BH7a would be an option. I chose some common tubes which I thought would make the circuit work. I didn't have any 12BH7a tubes on hand, so didn't try this tube. The 6SN7 equals the ECC82 in most aspects; the biggest difference is the socket. The 6SN7 is not used because it simply didn't fit the noval socket as used in the amplifier that was actually built. A driver with an octal socket using the 6SN7 should work just fine.

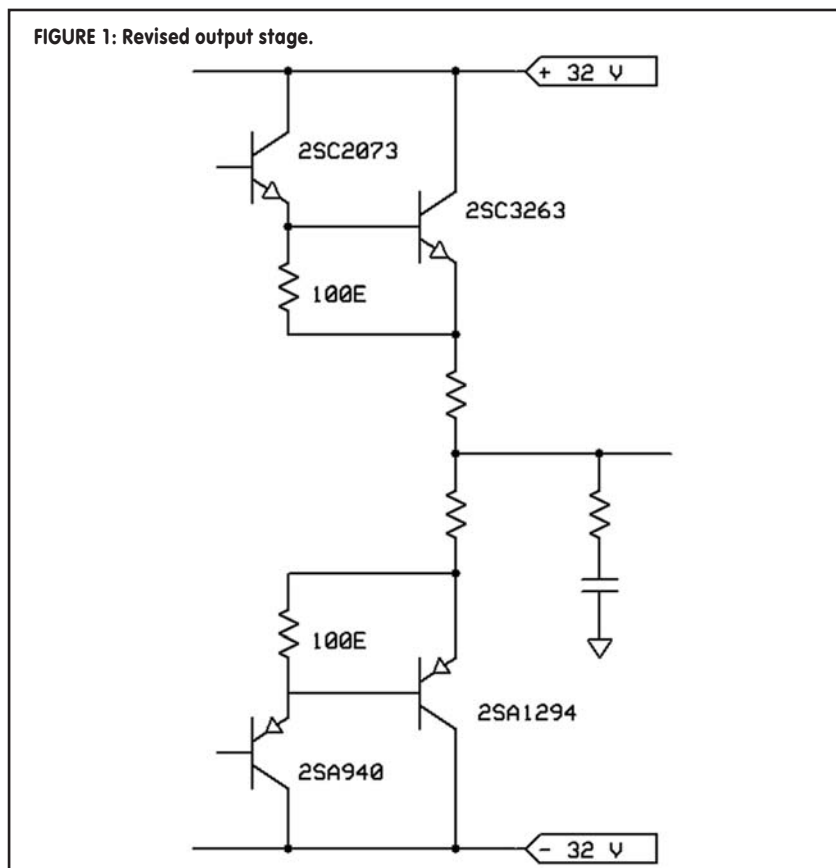
The quasi complementary output stage is a design approach. I wanted the use of power transistors and not power MOSFETs as used in a former hybrid project. I also wanted to use a quasi-complementary configuration, as stated in the article. In the first test set-up a complementary pair was used and changed to a NPN only configuration at the time the design started to be something. It would be interesting to compare the two and see (read: hear) what the difference is. The current stage using complementary output power transistors is shown in **Fig. 1**.

By the way, the original ClarityCap SA by ICW is available at [E-speakers.com](http://E-speakers.com) and as OEM at THL Audio [OdiOcap SA] and at [World-Designs.co.uk](http://World-Designs.co.uk) [Soniqs SAX].

## AUDIO FORMATS

Regarding Jesse Knight's article on DVD audio (Oct. *aX*, p. 36), agreed, the PCM stereo option is often better fidelity than either the Dolby or DTS options, but I was surprised Mr. Knight made no mention of the fact that very few labels use the 96K sampling rate or even the 48K. According to a reader who has researched this in depth with his player which displays the rates, many

FIGURE 1: Revised output stage.



are just 44.1K—same as standard CDs! In fact, most of the early DVD-A releases from both Naxos and Universal proudly listed the sampling rate on the 5.1 surround tracks as 44.1K—until I pointed out perhaps they wouldn't want to publicize that. There is a new reissue label—HDTT—which specializes in custom-burned DVD-Rs at 96K made from out-of-copyright prerecorded two-track open reel tapes, and the fidelity is often startling.

It should have been pointed out that *all* the DVD and CD releases from Bel Canto Society use the same highly-tweaked conversion from the original analog to 96K/24bit PCM. Here's an article on the process: <http://www.belcantosociety.org/pages/pcm.html>.

I was also surprised no reference at all was made either to DTS or 5.1 surround. Opera especially cries out for surround reproduction. More and more music DVDs are coming out with DTS 5.1—often omitting the Dolby option (since a survey showed about as many users have DTS decoding ability now as Dolby)—and the fidelity has become greatly improved. Both new hi-def DVD formats have an option of the new super versions of DTS and Dolby 5.1 or even 7.1, which use less perceptual encoding and in some forms are even totally lossless.

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#### **Jesse Knight responds:**

Mr. Sunier has pointed out the need for much more detailed labeling on DVDs. Although I did research on formats, I was not aware that what is listed as 48kHz may be only 44.1kHz sampling. I did not mention the 96kHz sampling, because I have yet to run across such a disc.

Getting good sound on two channels turned out to be problematic, as the distortion was very gross, not subtle, on gear that was above "low end." This is no different from when 78 RPM gave way to LP, then stereo LP, which in turn gave way to CD. Each time there were steps forward and steps backward. We, the customers, get to do the beta testing and complaining.

The issue of various 5.1 formats is some-

thing that needs to be looked at very carefully. I am not equipped to test the 5.1 formats properly via a two-channel headphone mix. What I have noticed so far is that the Dolby 5.1 collapsed to two channels is very distorted on applause when there are no significant dominant tones for the encoding system to lock onto.

Vocal music contains sibilance which might not always reproduce well enough, for lack of dominant tones. I am not totally convinced that even Dolby 2.0 does a good job in this respect, because I sense something about sibilance that is not quite right, but can't really say whether I hear it or imagine it out of a predisposition to question perceptual encoding. Looking for trouble always gets me what I am looking for, trouble. Dolby 2.0 does appear to handle applause well.

I will willingly admit to being a two-channel purist for now, until colleagues and I acquire more listening experience. For me personally, more distortion as a result of more channels is totally unacceptable.

Others are absolutely free to their own opinion. I feel so strongly about this that I may avoid 5.1 and 7.1 until lossless compression is available at least on the front channels. Someone less biased on this issue can be more fair than I.

At this time I am avoiding doing anything with speakers because I have found some serious issues with how they handle operatic voices. I am not alone in thinking this way. In my work recording choirs, I learned to trust phones much more than speakers. Experiments with two variables for me will just confuse things at this point, until I have a better idea of what speakers are doing to voices. Headphones designed for four channels might be very misleading, as would digital signal processing to force perspective. Building a good surround system that does not add artifacts of its own is more than I feel qualified to do at this point.

Future HD systems will require a total retesting of everything. My first big question is: Will we go through the bad decoding circuit issue all over again? It is now apparent that Sony has produced a new DVD player (DVP-NS55P) that sells for \$70 that has no Dolby 2.0 or LPCM decoding issues that I can hear. What's more, it allows you to restore dynamic range on Dolby 2.0 DVDs that are DRC enabled. Sometimes the improvement is huge. Of course, this does not restore dynamic range that was

limited before Dolby digital encoding was applied. DRC allows highly dynamic sound to be compressed for TV speakers. We audiophiles want all the dynamic range, hence our need to deselect compression.

This is, of course, separate from perceptual encoding. Last year I tested a Cinevision player that was in the \$300 ballpark and it produced some audible intermodulation distortion. It took a Rotel home theater amp plus a separate DVD player with digital output—to the amplifier—to get rid of the IM. That rig was over \$1300. Clearly Sony has a winner here.

In conclusion, DVD is trying to be all things to all people. I believe it can eventually do this quite well, but we are just beginning what will be a very complex project. Issues of stereo stylus shapes, RIAA curves, and tonearms consumed my younger years. Cutting a proper 15° angle, with a Capps scoop cutting stylus that compensates for the rebound of the master disc material, after cutting, now looks like a simple issue today, compared to perceptual encoding issues.

At the time, those of us cutting records did a great deal of work trying to solve simple geometric problems. CD arrived before we were all happy with how cutting and playback issues for vinyl were resolved. Having lived through that, I expect history to repeat itself. I thank Mr. Sunier for his insights.

## **MEASURING GEAR**

I very much like the way Charles Hansen tests all kinds of audio gear and the diagrams presented in *audioXpress*. I am very interested to learn in detail his measuring method and to build something similar. Any information that you are willing to share about your measuring method, programs, or hardware will be highly appreciated. I have much interest in audio and have designed a zero over sampling DAC, a tube line preamplifier, and output transformers. Currently I am working on discrete op amps with very good results. I would like to measure my designs and confirm what I hear.

*Miro Petrovic  
Belgrade, Serbia*

#### **Charles Hansen responds:**

Thank you, Mr. Petrovic, for your kind letter. My test gear consists primarily of equip-

ment produced by the major test equipment manufacturers (Tek, Fluke, Sound Technology, HP/Agilent, Pico, and so on), as well as equipment that I designed and built myself. I have also modified some of my commercial equipment to improve its capability or functionality. A Pico ADC-216 digital storage scope interfaces to my PC to capture scope waveforms and FFT data. The analog test equipment measurements are processed through a custom HPGL language interface that overlays the data plots onto boilerplate blank graphs. (Note to readers: Please don't request information on this. It is a cranky old DOS-based interface with no documentation that I wrote in the 1980s, and it won't run on anything newer than Win 98.)

You will need a distortion analyzer with at least 100dB of resolution for proper audio measurements, and a sine wave generator with similarly low THD performance. Candidate analog measurement systems are the HP-339A distortion test set, the Tektronix AA501 distortion analyzer/SG505 sine oscillator, and the Sound Technology ST-1700 or ST-1701 distortion measurement system. You'll frequently find these items on eBay.

You will also need a function generator with excellent square wave quality, and an analog or high-performance digital oscilloscope. If you can afford to do so, I would investigate the purchase of a used Audio Precision System One audio analyzer (occasionally available on eBay), or the newer Prism Sound dScope series of equipment. Both are automated computer-controlled test gear with huge libraries of standard test protocols.

You can learn all about audio measurement techniques from the *Audio Measurements Handbook* written by Bob Metzler, and published by Audio Precision, Inc. You can also learn a great deal by carefully reading the test measurements of John Atkinson in *Stereophile* magazine.

## TAKE NOTE

I just read the article by Peter J. Smith entitled "NeoNoir." I was excited to see such a speaker system. I looked at some of these same components with interest. I am delighted to see a complete project based around them.

One thing that caught my attention was in the sound section of the article. Unless you were listening to some recording of Brubeck's that I am unfamiliar with, it should be alto saxophone

not clarinet. On the recording of "Take Five" from the album *Time Out*, the liner notes list Paul Desmond as playing alto sax. I know. . . picky, picky, picky. Thank you for the article.

Archie Anderson  
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## LITTLE JACK HORNER

I have been a regular subscriber since 1990, and have an idea for a project, but not the expertise for the design details.

How about a folded bass horn which occupies one corner of a room, with the driver near floor level, facing the ceiling, one fold near the ceiling, and sound exit near the floor? Many rooms have a corner where it is inconvenient to place any furniture because access would be limited. Also, many rooms do not have two symmetrical locations for pairs of speakers to give their best. Doors or windows might be spoiling the fun. Such a horn could have a total sound wave length of 16' or more, and just fill one corner of a room.

Simon Todd  
Miami, Fla.

## MIGHTY LITTLE DRIVER

I am 30 years old and experienced my first hi-fi rush at the age of 10. I have been building speakers for about 5 years and used to build subwoofer boxes for my friends' cars with my dad years ago. I am not new to the scene of full-range drivers, having quite a few of them—Aura, Fostex, Zenith, HiVi Research, and now Tang Band.

I just bought a Tang Band 4" titanium full-range driver model #w4-1337s from Parts Express for \$47.99. I think you should do a speaker project with this driver because

1. It can take the hot and cold changes of a basement or an attic room.
2. It is well made, and the surrounds are frozen and then used so it will not rot as easily as other surrounds.
3. It is rated 70Hz to 20,000kHz and can play down to 5Hz on a test tone generator without breaking a sweat. Wow!
4. It seems not to have the ringing that you hear with most metals used on speaker drivers.
5. It's hard to beat for the money.
6. It's very fast—one of the fastest

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I certify that the statements made by me above are correct and complete. Publication No. 787-840. Karen Hebert, Vice President.

drivers I have seen, beating Focal drivers. I thought Focal was fast, but these are faster.

7. It has an Xmax of 3.5mm.

The only thing I do not have is the equipment to measure the speakers off-axis or 30' from the front of the box. I can do everything else and have someone help me do all the measuring of this driver.

I do a lot of listening in my basement where it gets hot or cold and damp. This driver can withstand such extremes. Also I put some water on this cone to see what it could do; it drips right off, as though you sprayed wax on the cone. I made sure it did not come into contact with the center phase plug and drip into the voice coil. I hope I helped spark some interest in this driver.

Jeff March  
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## HELP WANTED

I'm trying to locate someone nearby (closest I've found is California and Philadelphia) who can convert an old reel-to-reel tape to a digital file/CD for me. The recorded speech has some background noise and might need some tweaking.

Mike McLachlan  
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Are any readers familiar with a Marantz model 1060 solid-state integrated amp from 1971? This has become a constant "work-in-progress" for me in that I'm always trying to figure ways of upgrading its internal components. I know this amp (probably) never was meant to be some exotic, world-class piece of equipment. However, I like its general sound quality, reliable sturdy build, and overall appearance (the one I found [still] had its original—optional—walnut cabinet, which cost \$29.95 extra when new).

I need to know whether there are any *changes* (besides the one I've already completed and listed below) I can further make to *really* get the most out of it.

My DIY upgrades include:

- re-soldered all circuit board contacts
- replaced power cord with 12AWG grounded-type (up from original,

18AWG standard one)

- disregarded MAIN IN/PRE-OUT "horseshoe"-type jumper interconnects in favor of 1M-length MONSTER LINK II (an earlier series I'd bought a couple of years ago) RCA cables
- replaced all power supply-stage filtering caps with Nichicon, VZ series, aluminum electrolytics (from Digi-Key)
- replaced critical point-to-point wiring with 16AWG wire (as opposed to the stock 22AWG)
- replaced the heatsink grease and insulators of the power output transistors (I also polished their pins with silver polish before I re-installed them—they're discrete, TO-3 case devices)

James Hoover  
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I have a rather large subwoofer cabinet that I have been happy with for years. It is about 19ft<sup>3</sup> inside after subtracting bracing. I used a 15" driver from Brian Chenney at VMPS and made a custom crossover that is 16dB an octave and cuts off everything above 40Hz. So this box is the deeper sounding of my two subs.

Anyway, my speaker is tired after eight years, and instead of a recone I want a better driver. Keep in mind that this is a sealed, not a ported, box. I use a Parasound amp to drive the subs that can deliver 1000W at 8Ω, 1500W at 4Ω. My driver now has an fs of 17.

What would you recommend in the 15" lineup? I could easily fit an 18" into the cabinet but I think a 15" would be a little faster base and maybe sound a little tighter. In the past Focal made some very expensive drivers that seemed to fit, but what else could I use that is in the under-\$500 range?

Dave Wilson  
ycs@bmi.net

*Readers with information on these topics are encouraged to respond directly to the letter writers at the addresses provided.*  
—Eds. **ax**

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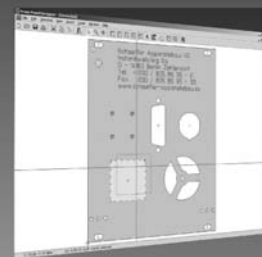
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