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OUTPUT BIAS CIRCUITS

In Dan Stanley's otherwise well-written article ("A High-Quality MM IC Pre-amp," July '04), there is an error in Fig. 3, which purports to show an "FET Cascode output bias" circuit. As connected in the drawing, the 100Ω resistor does essentially nothing, as it appears in series with the much higher impedance of the upper FET drain. Its current will be fairly ill determined based on the properties of the lower FET at low drain-gate voltage, and that voltage will depend on the characteristics of the upper FET.

A more appropriate circuit would place the resistor in series with the source of the lower FET, and the upper FET would be selected to have a larger magnitude of pinch-off voltage and saturation drain current compared to the lower FET. As well, a resistive voltage divider between the negative rail and ground could be provided for the gate of the upper FET, to ensure that its source would be sufficiently positive with respect to the negative rail to provide some room for operation of the lower device. The gate of the upper FET should be biased as close to the negative rail as provides proper operation, lest the operation of the circuit cease at large negative output voltage excursions.

Actually, a current sink based on bipolars would be a generally more satisfactory solution, given the availability of well-regulated rail voltages.

Brad Wood
Chatsworth, Calif.

Dan Stanley responds:

The brief reference that I made in my article concerning the use of a FET-based class A output bias was primarily intended to inform prospective builders that better methods than a pulldown resistor exist for biasing. To this end, I included a reference to a very informative Internet article on the subject of biasing for op amps. The 100Ω resistor in my article circuit isolates the capacitance of the FETs from the op amp, but I do not believe that this circuit necessarily represents the highest performance approach to output biasing.

Since I did not actually evaluate the sonics of the FET configuration illustrated in my article, I strongly suggest that readers review the referenced Internet article and search several of the well-known audio forum sites before deciding exactly how they might choose to approach using an improved output biasing circuit. I am sure that there would be welcome interest among readers in seeing diagrams of FET and bipolar op amp output bias circuits that you believe would offer higher performance for this type of application. Even using just the pulldown bias resistors, careful builders will find the sonic performance of this design to be quite good.

AUDIO EVALUATIONS

I know it's foolhardy to go anywhere near a dustup between two silverbacks of the audio world such as Reg Williamson and Ed Dell (Xpress Mail, 9/04 aX, p. 56). But I'll risk being crushed by one or both of them, to sug-

gest that perhaps they're both right about objective and subjective evaluation of audio equipment, if you take into account the audience for each. Subjective evaluation is important to the prospective *user* of the equipment, while objective evaluation is important to the *designer* of it.

As a prospective purchaser, I want to know *what* a piece of equipment will sound like, so I read the opinions of careful, experienced people who have listened to it. Designers need to try to figure out *why* the device sounds the way it does, and what to do to make it sound different, so they take measurements and try to correlate the measurements with what they hear, and with design parameters they could change.

Here's an example. On page 14 of the 9/04 *audioXpress*, I read:

"Prior to final testing, I lightly stuffed the enclosure with 14 oz of poly fiber fill, which reduced the closed box Q from 1.5 to 1.4 and closed box resonant frequency from 40.2Hz to 37.3Hz. Direc-

tionally, this should improve system performance since another basic servo design principle is to develop the best open-loop response possible before closing the loop."

This paragraph is accompanied by graphs showing the subwoofer closed- and open-loop waveforms at 25Hz.

Here, the author used measurements (of Q, resonant frequency, the mass of the added poly fiber, and waveforms) to help decide what to do (add or remove poly fiber) to make the device sound more like he wants it. The measurements were very helpful to him as a designer, as well as to readers who design. But if I were thinking about buying the subwoofer from him, I'd rather have the subjective opinion of someone who had listened to it than the objective measurements of Q, mass of fiber, and so on.

I suppose we could do away with subjective reviews if we knew exactly what to measure and how to interpret the measurements. But we don't, at least not yet.

I remember years ago when *Con-*

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sumer Reports evaluated loudspeakers. They hooked each speaker to a sine-wave generator and measured the response over the audible range of frequencies. They then came up with a single number for each speaker that showed how close its response was, on average, to flat. You just needed to go down the list and pick the one with the highest number you could afford. No subjective evaluations required. Heck, no ears were even required.

But people who dinked around with audio knew that frequency response wasn't the only factor to consider. You could make the speaker sound better if you tilted it back a little—same frequency response, better sound. Designers started measuring and modifying their designs for proper time adjustment. In his letter, Mr. Williamson gives an excellent example having to do with amplifiers. People didn't used to know how to measure phono input stage response until they figured out that you needed to include a phono cartridge in the test circuit.

Thanks to people such as Mr. Williamson, we can now design better products more easily. But we still don't know everything that needs to be measured, how to measure it, or how, exactly, to correlate the measurements with what people hear.

Until we do, I'll continue to rely on expert subjective opinion, and let designers make use of objective measurements. If I care to know how comfortably a car rides, I'll read the opinion of someone who's ridden in it. I don't care about the Q and resonant frequency of the suspension, but the designer had better give one.

I don't buy wine based on lab analyses, either; I read Robert Parker. But vintners certainly use measurements to design and produce their products. And until someone can look at one of those waterfall plots and tell me exactly what a speaker will sound like, I'll keep reading reports from listeners.

Ken Craven
ax@kcraven.com

DSP TECHNOLOGY

My thanks to Rune Aleksandersen for his article on using DSP technology to produce loudspeakers with flat fre-

quency and phase response ("Room Correction, Part 1," 8/04 aX, p. 6). I have been trying to achieve the same results, but with analog technology, and his approach seems better. However, I do have some comments on his article:

The summed response of the high-pass filter and the low-pass filter is not truly flat, having about 1dB of ripple. This may be due to either or both of the following:

1. The filters are not symmetrical; that is, the low-pass has a much steeper cutoff than the high-pass.
2. The filters are said to have a 500Hz cutoff, but from Fig. 8 the low-pass seems to have a 6dB cutoff closer to 550Hz.

What is desired is a set of filters whose sum adds up to unity over the audio band. One example of this would be the Linkwitz-Riley filters with phase correction.

Also, there is a discrepancy in the THD curves. Figure 12 shows the THD as being generally below 0.01%. Figure 14 shows the 5th and 7th harmonics peaking at about 0.02%. If the 5th and 7th harmonics are each 0.02%, then the THD should not be less than that. 0.02% is very good performance, but I would like to know which measurements to trust, or else I cannot trust any of them.

Dick Crawford
dickcrawford1934@aol.com

Rune Aleksandersen responds:

Thanks to Mr. Crawford for his letter. Regarding the 1dB ripple, my evaluation of the high- and low-pass filtering was a very simple and quick one. I did not spend much time optimizing the amplitude response; the cutoff frequency of the filters were moved around a bit until the amplitude became reasonably flat. Most important is the perfect time response obtainable from the digital filters, an impossible task for any analog filter but the first-order filter.

The THD measurement shows 0.02% around the 4–7kHz range. I've been a bit enthusiastic. My text should have used the

words "mostly around 0.01%." This would be a more correct statement.

HANDS-ON AUDIO

The sentiments expressed in Mr. Fullmer's letter to the editor ("Electronic Sentimentalists," aX 8/04, p. 66) echo my own. I, too, have been involved in the design of audio equipment, beginning with amplifiers built out of old radios while in junior high school back in the mid-1950s.

The nonsensical hysteria over the "sound" of cables and capacitor dielectrics is sad; after all, the bottom line is generally one's enjoyment of reproduced program material . . . seemingly impossible to spoil with any amount of silly clock jitter short of that which would generate an appalling bit-error rate.

audioXpress is one of the few remaining "hands-on" publications that address our interests in hands-on audio. Gone are *Radio & Electronics*, *Popular Electronics*, and the like; and what used to be quite interesting under the name of *Wireless World* seems about ready to bite the dust. Even the *AES Journal* isn't much fun to thumb through anymore.

I attribute much of this to the immediate availability of inexpensive, good-quality, ready-made gear. It's no longer necessary to wire tube sockets with twisted filament leads (grain-oriented and oxygen-free, of course!) to drive a pair of speakers properly. Indeed, the area in which *audioXpress* excels, in my opinion, is in the speaker-building department, where innovative ideas are not duplicates of off-the-shelf items.

Perhaps some of us old-timers ought to pen the occasional article for something truly useful, rather than for some esoteric unity-gain, class-A buffer stage. I'm confident that such efforts would be welcomed by the *audioXpress* editorial staff, and might even foster a renewed interest in useful and practical DIY projects. As an employer in the industry, I often wonder where the next generation of engineers with practical, "tinkering" experience will come from (India seems likely).

I hope you will reconsider renewing your subscription; you will be missed as a reader and as a possible and, I'm

sure, welcome, contributor.

Jim Wood, Pres./Chf. Engr.
INOVONICS, INC.
Santa Cruz, Calif.

Richard K. Fullmer responds:

I am flattered to see that Mr. Jim Wood of Inovonics was motivated to reply to my comments. He is absolutely correct in his description of the current "audiophile" hard-pressed to achieve any real audible improvement from home-built electronics, assuming he is willing to spend a reasonable fee for good-quality factory-built equipment. Forty plus years ago there was very little high-performance audio electronics available, without spending well over five-hundred real 1950 dollars.

When Heath, Eico, and later Dynakit made very good equipment available for under \$100, there was a ready market of people who wanted to get the best out of the new LP recordings, some of which were quite good. Not only did most of the kit builders succeed in getting their rig working, a new consumer hobby market was produced, in which people were look-



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ing for, and buying, upgrades that were audibly superior to anything on the consumer market.

As always, the weakest link was the loudspeaker. It was here that creativity reigned supreme, and anyone with a sheet of $\frac{3}{4}$ " plywood and a copy of Audiophile, Radio-Television News, Popular Science, and so on, could indulge in speaker building. Individuality and "the sound" were discussed with gusto, and there were very few speaker systems of this era that would be considered respectable by today's standards. It was great fun! Hardly anyone published any meaningful data. What measurements that were taken were mostly locked up in a file at the labs of the few manufacturers who owned an anechoic chamber.

In about 1960, with the advent of Villchur's AR-1, and Thiele's papers in the early '70s, the low-frequency performance of moving coil speakers became somewhat predictable. The individual "sound" of different manufacturers' loudspeakers was becoming less of an art, or an asset.

At the same time, solid-state audio electronics started to appear. After an oversupply of really awful "transistorized" power amplifiers, the kit builders had another heyday, and could build a dependable, and very respectable sounding power amp for less than \$300. Kit building was still fun. However, the design-it-yourself era was drawing to a close for most amateur audiophiles. Some good loudspeakers could now be had for less than \$600/pair (1980 dollars), and home-designed transistor equipment tended to become smoky. We could still massage our records and cartridges with various emollients, and a quiet LP recording was a rare gem worth seeking.

But the inscrutable future was in the wings. The hobbyist was suddenly attacked on both flanks by digital recording, followed by the CD, and the dreaded DSP. The consumer-level implementation of all this was made possible by large-scale circuit integration. It is hard to become very sentimental about a lump of black potting compound, which is the ultimate in inscrutability. And the final nail in the coffin for the creative audiophile is that good factory stuff is relatively low in cost, and 99.99% dependable.

Try that with your Mark III Dynaco, which sounds great and glows in the dark wonderfully well, but will use up a pair of \$100 KT-88s in six months. Ditto for the

Marantz power amplifiers.

Fortunately, really good reproduced sound is still elusive, but not due to mysterious electron encounters with copper molecules in the wire. The acoustics of rooms is a major factor, made even more apparent with the relatively uniform performance of most good equipment. Unfortunately, the home decoration factor is probably responsible for more bad listening experiences than all of the metaphysical murmurings and nasty electrolytic capacitors now in circulation. It is still an engrossing hobby.

Please, let us search after truth. In this climate of "diversity" and universal acceptance of any and all philosophies, we are better served by some serious objectivity and common sense.

CLEVER CIRCUIT

At the risk of being drummed out of the corps, I would like to direct readers to an article that appeared in another publication, *EDN Magazine*, a "qualified circulation" biweekly that is sent without charge to design professionals in the mainstream electronics industry.

While hi-fi audio is not a subject typically covered by *EDN*, the magazine does incorporate a regular Design Ideas section that showcases circuit hints and shortcuts sent in by readers. Every so often an article will appear that has application in our domain.

The September 16 issue contains a design idea by a fellow from a university in Moldova. He shows that the simple addition of a diode to a classic Class-A junction transistor audio stage reduces second harmonic distortion by more than two-thirds in a maximum-gain, open-loop situation. Doubtless none of us would ever consider a gain stage without at least local feedback, but I can't see any reason that the diode trick would not be applicable to designs that utilize "global" feedback, helping to improve overall linearity with a minuscule investment in additional parts.

The article can be accessed at: <http://www.reed-electronics.com/ednmag/article/CA450599?pubdate=09%2F16%2F2004&spacedesc=designideas>.

Jim Wood
Brea, Calif.

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FIGURE 2: STOCK TANG BAND W3-881S, SERIAL NUMBER 206, FREQUENCY RESPONSE GRAPH. THE FREQUENCY RESPONSE IS DRAWN IN BLACK, THE DECAY RESPONSE IS DRAWN IN RED, AND THE ONSET RESPONSE IS DRAWN IN BLUE.

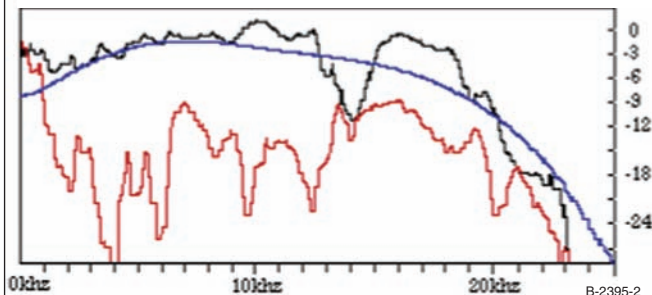


FIGURE 6: STOCK TANG BAND W3-881S ONSET RESPONSE COMPARISON GRAPHS. THE ONSET RESPONSE OF DRIVER SERIAL NUMBER 206 IS DRAWN IN GREEN; THE ONSET RESPONSE OF DRIVER SERIAL NUMBER 495 IS DRAWN IN BLUE.

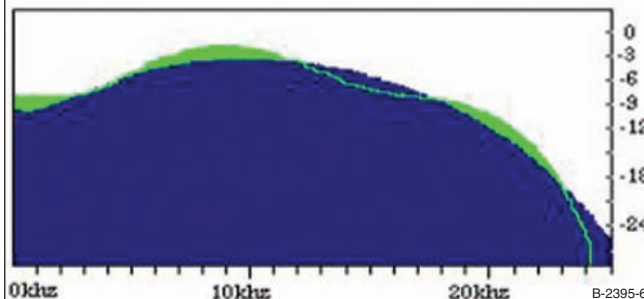


FIGURE 3: STOCK TANG BAND W3-881S, SERIAL NUMBERS 206 AND 495, FREQUENCY RESPONSE COMPARISON GRAPHS. THE FREQUENCY RESPONSE OF DRIVER SERIAL NUMBER 206 IS DRAWN IN GREEN; THE FREQUENCY RESPONSE OF DRIVER SERIAL NUMBER 495 IS DRAWN IN BLUE.

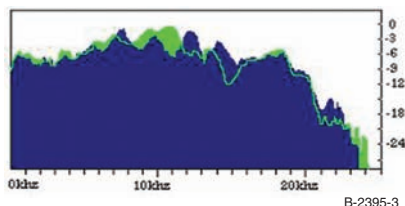
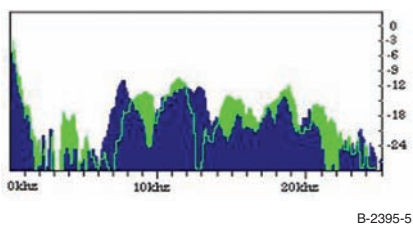


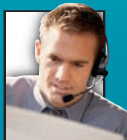
FIGURE 5: STOCK DECAY RESPONSE COMPARISON OF W3-881S DRIVERS SERIAL NUMBER 206 AND 495. SERIAL NUMBER 206 DECAY RESPONSE IS DRAWN IN GREEN, AND SERIAL NUMBER 495 DECAY RESPONSE IS DRAWN IN BLUE.



EDN is an excellent periodical with whom we have always had cordial relationships over the years. Several of the editors are aX readers.—E.T.D.

CORRECTION

Several graphs accompanying Mark McKenzie's "Remaking Tang Band's W3-881S (Dec. '04)" were inadvertently placed in the black and white section of the magazine, but make more sense when published in color. The relevant graphs are reprinted here in color. *Xm*



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