## CORRECTION

In Yury Gelgor's "A Balanced Nonoversampling Retro Dac" (*aX* 6/06), there is a problem with the power supply shown in Figure 6. **Figure 1** shown here is the corrected diagram. We urge that you please disregard the original figure for the safety of the reader and others.

## CORRECTION

Arghhh! In the interview with Peter Bartók (June 2006), I accidentally sent in an incorrect rendition of Fig. 1. A quick glance will reveal that the last 12AU7 stage is in fact a cathode follower, not a voltage amplifier (and, indeed, without a plate resistor it wouldn't be doing much voltage amplifying). **Figure 2** shows the corrected figure; the topology is the same one later made popular in the Audio Research SP3 and subsequent preamps, with beefier tubes. My apologies for the error.

*Paul J. Stamler*

## SOLID-STATE SE AMP

According to Ed Simon's article in the April 2006 issue ("A Solid State Single-Ended Power Amp"), the amplifier is rated at 15W continuous (not RMS!) power output into an 8Ω load. As the author states, such an amplifier would require a peak current of 1.9A, and the output stage must be biased to at least this current.

However, further along in the article the author decides to reduce the bias current to 600mA. I have no quarrel with that, ex-

**FIGURE 1: Gelgor's corrected power supply circuit.**

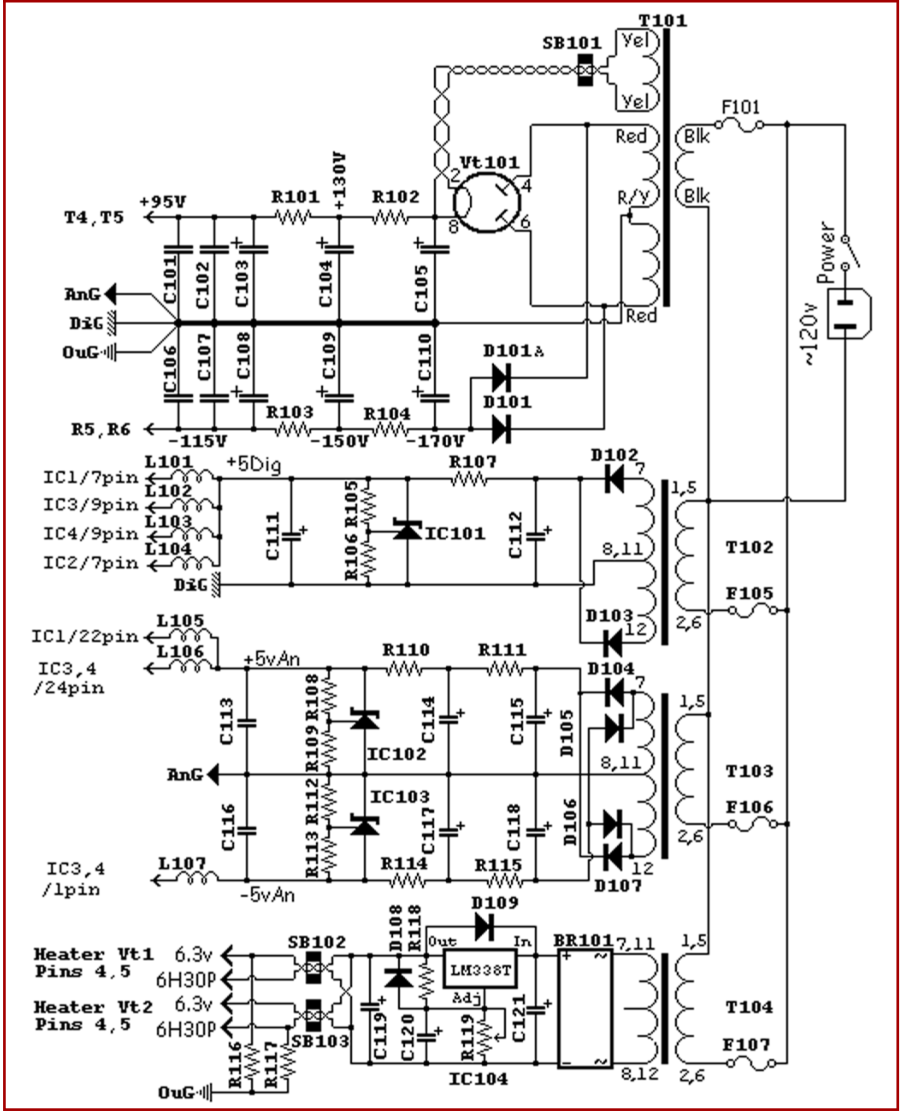
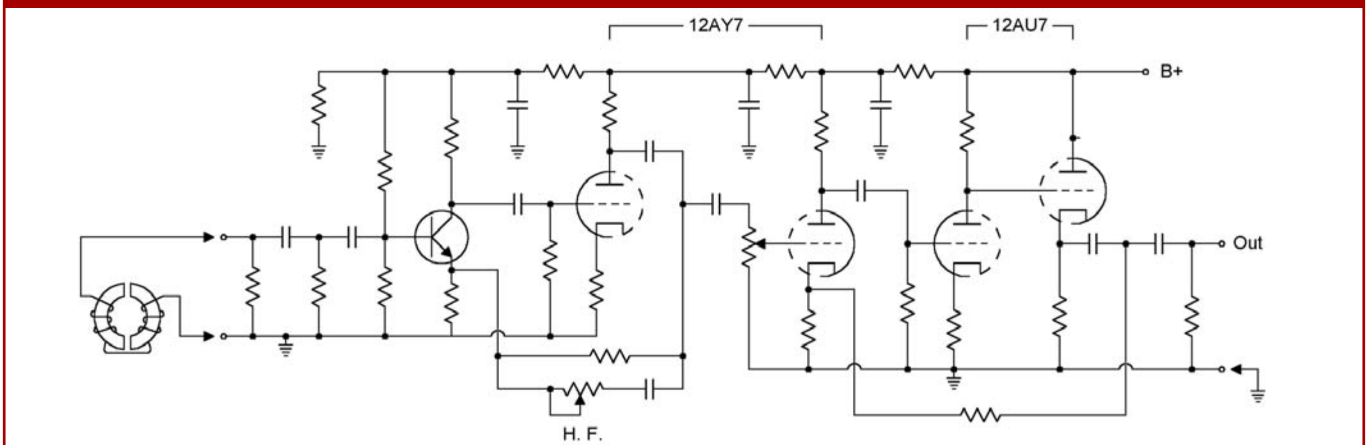



**FIGURE 2: Stamler's corrected hybrid tape playback preamp.**



cept that he neglected to mention that this would limit the peak current to the speaker load to that same amount (at least for symmetrical output), and the maximum power output would be reduced to about 1.5W continuous, a far cry from 15W.

Otherwise, I found the article very interesting and commend the author for letting the reader know his design decisions in detail.

*Jaime Arbona*
*Mayaguez, Puerto Rico*

**Ed Simon responds:**
I am sorry that my prose left you with a different meaning than I intended. I did not make clear that the heat dissipation is different from the amplifier's output. The 15W figure is derived from my discussion of the power transistor's ability to dissipate heat.

I was careless and should have explained more clearly that in a Class A amplifier the output device dissipates far more energy than is delivered to the load. In a Class B amplifier way more energy makes it into the load. That is why most amplifiers are Class AB. The continuous bias current makes Class AB sound far better than just Class B, and the Class AB amplifier is more efficient than a Class A amplifier.

In a linear amplifier the output device(s) varies the voltage and current from a fixed supply (the "rails") to the load. During the reproduction of any waveform when the output is exactly at half voltage, the output device(s) has half of the supply voltage across it, as does the load; since the current is the same, the device must dissipate as much power as the load. When the voltage out is equal to the supply voltage (rails), then in theory maximum current is delivered to the load, but since there is no or, in practice, a very small voltage across the output device(s), there is very little power dissipated in the output device(s). Almost all the power has gone into the load.

When there is no output voltage, all of the supply voltage is across the output device(s), but in a Class B amplifier there is no current going anywhere, thus no power dissipation. In a Class AB amplifier only the small amount of current used to bias the output transistors is dissipated. In a Class A amplifier all of the power is dissipated because the maximum linear output current is going through the output device(s) and none into the load.

Almost all courses or books that cover this material also teach that maximum power transfer occurs when the load impedance is the same as the source impedance. However, what they often neglect to mention is that under those conditions the power source dissipates as much energy as does the load.

Yes, I deliberately did not give the amplifier's actual power output. A 600mA bias current can deliver an RMS current of only 424mA. The 21V supply can deliver only 14.15V RMS. Thus the maximum power would be 6W (power is power not RMS power, RMS × RMS cancels) split between the optimum load and the amplifier. The optimum load resistance would be 16.69Ω for the article's amplifier.

The power into such a load would be 3W, before any asymmetry. The peak current would be much greater, allowing the amplifier to behave as if it were the equivalent of 15.5W of power. That is one of the reasons why Class A amplifiers sound as though they have more power than the equivalent Class AB amplifiers.

You have also correctly calculated that the power into the speaker is reduced at lower impedances. Loudspeakers heat up as they are played. This causes the voice coil to increase its resistance. This effect is called thermal compression.

In an amplifier of this design, as the impedance goes up so does the power available to the loudspeaker. That is one of the reasons why Class A amplifiers are often called more dynamic than other designs. They tend to counteract the thermal and mechanical compression inherent in most loudspeaker designs.

I read Ed Simon's "A Solid-State Single Ended Power Amp," which I found rather intriguing; however, I do have some personal observations and questions regarding the design.

I found it interesting that the lack of symmetry in the drive is justified, and I also question the quality of sound. That may be due to ignorance on my part, but here is my thinking process: As the cone of the speaker is drawn in from the driving section of the circuit, electrical energy is converted to mechanical energy. When the driving energy is released, the stored

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**Continued from p.59**

mechanical energy would force the cone of the speaker outward. If all the converted energy is released after storing the mechanical energy, then bidirectional drive would not be required at all.

It seems to me that some speakers would not have the capability to rebound from the stored energy. In fact, it would not surprise me that every speaker is different, or that the current source developed by Q5 would need to be different for different speakers that are driven. The amount of drive for the return of energy to the wave energy in the air should balance the energy that was being stored.

If a speaker had the capability to return all the energy that was stored in driving it backwards, then the current source would not be needed, for the mechanical energy stored would have been converted to the sound wave in the air!

So, here's the big question: Why are push-pull topologies used? If the assumption is that the speaker has the capability to push the air with minimal drive, then even the push-pull topology would distort sound, for it is pushing the air with more energy than it was pulling with, for the total energy in moving the air would be the sum of the stored mechanical energy of the speaker plus the additional energy of the driver pushing the speaker more.

It seems to me that speaker design is such that it requires push-pull drive, but it may be possible to design a speaker that would not require a push-pull design. It is difficult for me to comprehend how a non-symmetric drive can produce sound that is not, in some degree, distorted. How is the sound quality and distortion of the proposed amplifier evaluated and how does it compare with a push-pull driver of the same capability with the same power being delivered to the speaker?

Granted, the design is simple and "plurality should not be assumed without necessity." "Keeping it simple, stupid" is a good concept, but there are times when "keeping it simple" must be balanced with stupidity. Perhaps I am ignorant regarding the design and in that case I will need to better understand or more fully appreciate the meaning of "plurality should not be assumed without necessity."

*Robert G. Black Jr.*
*Oro Valley, Ariz.*

**Ed Simon responds:**

I think a bit of clarification is in order. A push-pull amplifier can also be Class A, which is generally considered the best-sounding amplifier. If you built one that way, the limit on amplifier power would most likely be heat dissipation. The drive to the loudspeaker would be symmetric until you ran out of power and then you would get clipping. How the amplifier is designed to handle clipping would affect the sound quality of the amplifier. At all signal levels there would be more areas for distortion other than clipping to occur, as there are more active devices in the signal path and every one has some form of nonlinearity.

In a single-ended amplifier the output is symmetric until you reach the limit of the current source. During most recorded music the drive becomes push only on loud bass passages. At that time the woofer cone can reach a 10 to 20dB greater output than from most push-pull configurations of the same power rating. If the loudspeaker took the power in and the cone didn't move, the inductance of the voice coil would cause the voltage to increase until it found a place to go. That is why there are diodes from the output lead back to the power supply in most solid-state amps.

Treating the cone as a moving mass without any electrical conversion is not a good model, as obviously there would be no cone movement from the start. Also any losses from the mechanical movement would still have compensations from the amplifier. The only time greater power would be needed is to stop the cone suddenly. The good news is that in music plosive starts are common, instantaneous silence is not.

Push-pull topologies are great for driving resistive loads. Unfortunately, they have distortion artifacts throughout the audible spectrum that are more unpleasant to the ear than a single-ended design. Their advantage is greater power out for each output device when they are used as Class AB. The question is, "Does greater power with a noticeable form of distortion sound better or worse than less power with a distortion that may occur more often but is less objectionable?" Most folks who listen to a single-ended design clearly prefer them when the power is equal. *aX*