Build a Hybrid **SE OTL Amp**

Here's a different OTL amp design that delivers plenty o' power to the speaker.

By AJ van Doorn

PHOTO 1: The OTL PL509-based amp.

To have a proper load impedance for output power tubes, you need an output transformer, regardless of what configuration you use—SE or PP, triode, ultralinear, or pentode mode. At the end of the golden valve age, new low voltage valves have been developed to get rid of output transformers, such as the EL86(6CW5) connected in SRPP mode, delivering 8W to a 500Ω speaker.

POWER TO THE SPEAKER

As you see in *aX* articles, there are several suppliers of good OTL machines. The main problem is the low load seen by the output stage of the amplifier. Even a 16Ω loudspeaker needs an output current of 1A to deliver 16W, which is rather hard to get from vacuum tubes.

It is, however, quite feasible to increase this load impedance in such a way that the tube also delivers a moderate current, with sufficient power going to the loudspeaker. You must monitor the current of the tube and feed this signal to an amplifier that delivers all the extra power to the speaker. This amplifier can be a transistor or tube power amplifier, which should act as a multiplier and make an exact copy of the input signal over a wide frequency range; no phase shift can be allowed, otherwise, information will be lost, especially in the bass and treble.

The first time I used this principle was in the Audio Aero Transtrac amplifier—a stereo PP triode amp using EL34s. The tubes deliver only 2×10W, and, after multiplying the current with a power op amp, 40W was delivered to the speakers. The basic schematic is shown in **Fig. 1**. The OPT has a primary impedance of 3200Ω, the secondary is 8Ω. The secondary current of the OPT is monitored by a 470mΩ non-inductive resistor (Rs) and activates the inverting input of a power op amp (TDA7294), delivering the extra power to the loudspeaker.

I started by monitoring the output voltage of the OPT. There was no chance to get it going, due to LO and HI phase errors, but measuring the secondary current instead did the trick. As the op amp increases the secondary output voltage of the OPT, the plate load increases as well—to about 10kΩ (instead of 3200Ω)—and the tubes are in class A mode all the time, hence the outgoing current has very low distortion, too. The rather small OPT has a large bandwidth and the amp is one of the best of its kind.

At the CES show many people congratulated me for the sound this amp produced. However, this Transtrac isn't a real OTL. I tried several ways to make an OTL, even with the room-heating 6C33 tubes. I decided to look for a system similar to the Transtrac (**Fig. 2**).

CIRCUIT OPERATION

On the right is the loudspeaker connected to the TDA7294 power op amp from Thompson. I've used this chip in many different applications and consider it one of the best of its kind and very musical indeed. The non-inverting input is grounded by R8, and as long as there is no signal on the inverting input the voltage to the speaker terminals is zero. On the left is the tube amp.

With the cathode connected to -100V DC, I used a small input transformer to isolate the input circuit from it. I had on hand a rather good Marantz model with a step-up ratio of 1:2. I loaded

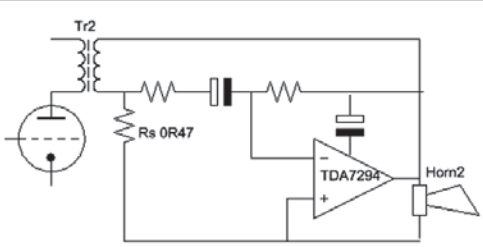


FIGURE 1: Transtrac amp circuit.

the secondary with a 10k resistor. I don't fancy open load transformers.

The input signal modulates the tube via the stop-resistor R2 connected to grid 1 of the tube, a PL509 that can deliver plenty of current. In this configuration the plate current is 200mA DC, going to the speakers via R6, which function to monitor the outcoming plate current. As long as only DC is flowing, R6 delivers 6V DC to OP1, which is a differential line receiver, model INA137.

It has a gain of 1/2, so OP1 outputs 3V DC, which is blocked by capacitor C4 so at zero signal the output of the power op amp TDA7294 is zero. But where is the 200mA from the tube going?

This current produces an offset current in the output stage transistors of the TDA7294 but its internal auto-bias control system keeps the offset voltage below 1mV DC on the speaker terminals, which not only means that the output impedance of the TDA is very low, but also that the positive output power transistor collects the full 200mA DC, so the chip works in class A as well. Maybe this is one of the reasons that the amp has such a wonderful open sound.

It is important to know that as the INA137 line receiver is fed by ±15V DC it will accept input signals up to ±42 Vp before clipping occurs. With an output of 50W to the 8Ω speaker, the TDA7294 outputs ±28 Vp, which is about the maximum possible with the ±32V DC power supply used for the TDA7294.

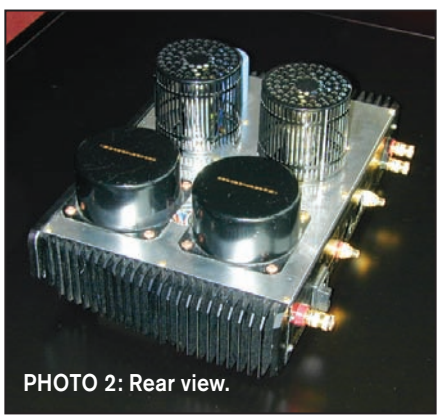


PHOTO 2: Rear view.

The gain of the TDA7294 is 30×, so for full output the signal on its inverting input must be about ±1Vp. However, the INA137 has a gain of ½, so the signal on R6 must be ±2Vp corresponding to a variaton in current of almost ±70mA peak, hence at maximum output, the plate current of the PL509 varies between 130 and 270mA. If you prefer a larger plate current modulation, just lower the value of R6 to 22 or 18Ω. This will, of course, reduce the sensitivity of the amplifier. The tube, with a plate current of 200mA DC, dissipates only 20W. I measured a small loss in the treble—attributable to neither the transformer Tr1 nor the TDA7294. That's why capacitor C2 is in parallel with the bias resistor R1; it slightly increases the gain of the tube for

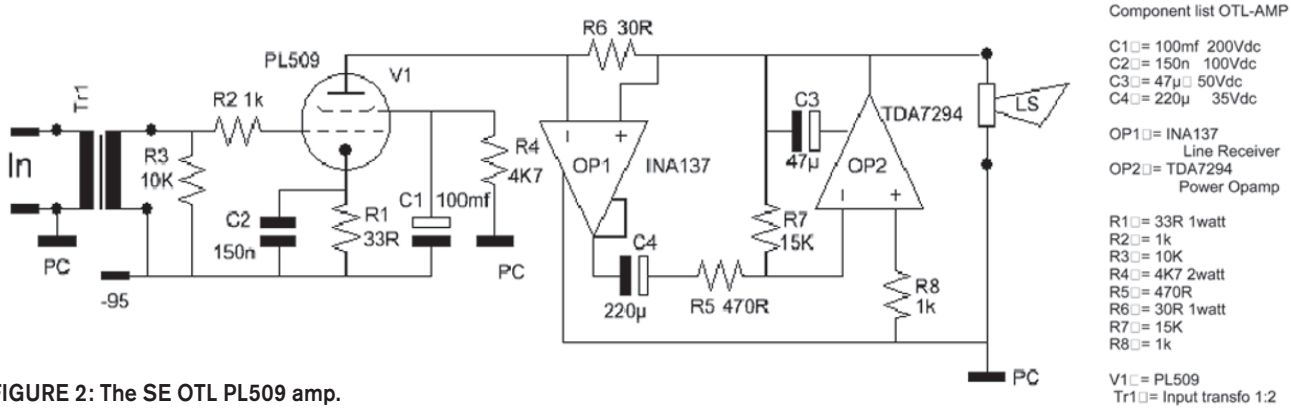
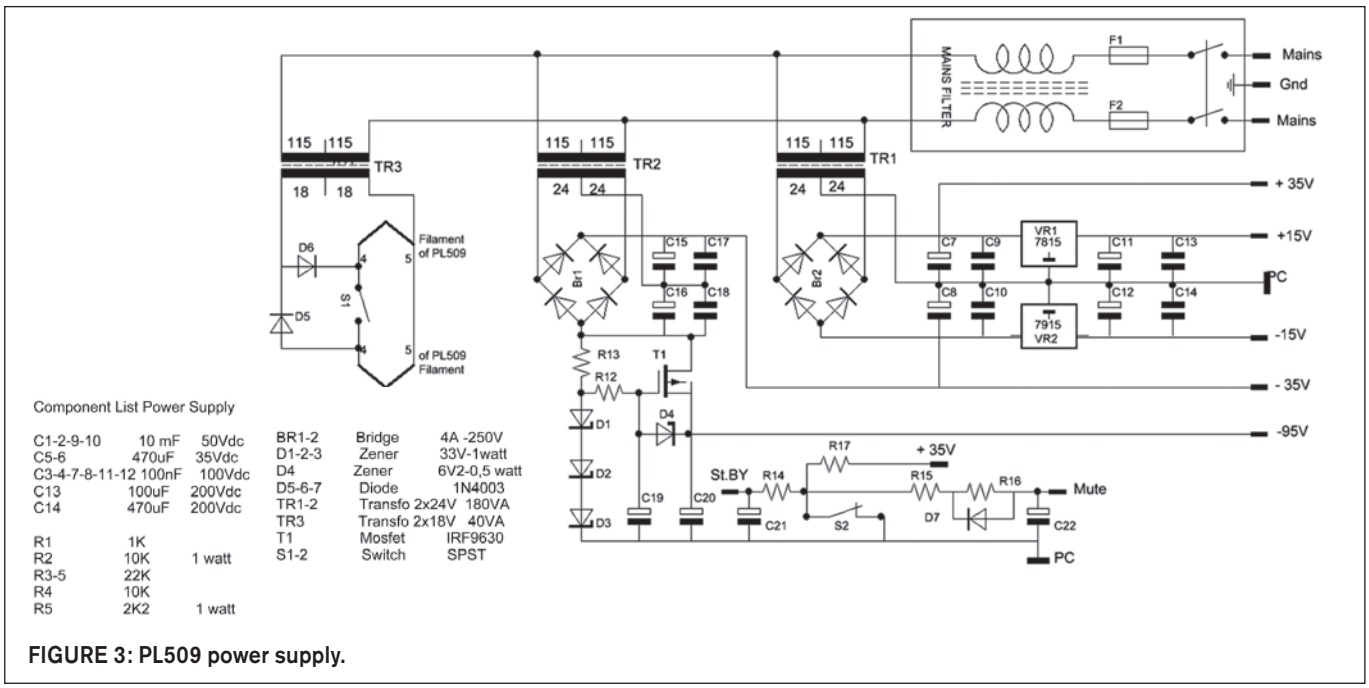


FIGURE 2: The SE OTL PL509 amp.



Component List Power Supply

C1-2-9-10	10 mF	50Vdc	BR1-2	Bridge	4A -250V
C5-6	470uF	35Vdc	D1-2-3	Zener	33V-1watt
C3-4-7-8-11-12	100nF	100Vdc	D4	Zener	6V2-0,5 watt
C13	100uF	200Vdc	D5-6-7	Diode	1N4003
C14	470uF	200Vdc	TR1-2	Transfo	2x24V 180VA
			TR3	Transfo	2x18V 40VA
R1	1K		T1	Mosfet	IRF9630
R2	10K	1 watt	S1-2	Switch	SPST
R3-5	22K				
R4	10K				
R5	2K2	1 watt			

FIGURE 3: PL509 power supply.

the treble region.

POWER SUPPLY

SE amplifiers, especially, need a proper power supply (**Fig. 3**).

Luckily, I had most of the parts on hand from old Marantz monoblocks.

One transformer provides the ±32V DC for the TDAs and ±15V DC by adding two simple regulators. The ±15V DC feeds the INA137, but you must be sure that its pin1 (ref) is connected straight to the input circuit of the corresponding TDA, otherwise hum and noise may appear.

The PL509 should operate at about -100V DC at 200mA. Please note that this PL500 power supply is the same as for the TDA but is connected to the negative rail of the TDA power supply so both the positive as well as the negative rail of supply deliver the 400mA for both tubes.

You could use a separate -100V DC supply for the tubes. But then only the positive rail of the TDA supply would deliver the 400mA DC for the tube plates and the unbalance would produce a higher ripple on the TDA. Also, the ripple was rather low, so I added the MOSFET regulator for an absolute quiet -100V DC supply.

A third transformer is used for the filaments of the PL519s. When starting, each filament gets only the halfway-rectified voltage, and when closing switch1, the full AC voltage will be supplied; the loss in the diodes is negligible in this case. The TDA7294 has a standby and muting circuit activated by switch 2. For details just look at the TDA specs. If you like, you can combine S1 and S2 into one single DTDP model.

Figure 4 is just the same amplifier but using PL500s instead. I didn't make this amplifier myself, but it may be handy to know that PL500s are easy and cheap to get. For further information refer to the following websites.

www.st.com (type TDA7294)—TDA7292

www.ub-audio-shop.de/downloads/a80kurzen.pdf—PC boards for TDA circuit

www.ub-audio-shop.de/downloads/nt-kekurzen.pdf—PC boards for PSY circuit

www.tubedata.org—PL509 or PL500

http://ti.com (type ina137)—INA137 or INA2137

amplimo.nl—Transformers

RESUME

I use this amplifier at home with a pair of 98dB LYRA speakers from WLM, Austria. You can find out all about these fabulous speakers on the web globeaudiomkt.com. Years ago, I developed all the tube gear for Audio Aero in Toulouse, France, and now I'm making all kinds of very special so-called tracking amplifiers, of which I'll report at a later date.

Several friends (with golden ears) came to listen to this amp and they all agreed that this OTL was one of the best they had ever heard. At the VAD HI-FI show we replaced some P-P and SE tube amps with this little OTL and this one was a clear winner, so make one! *aX*

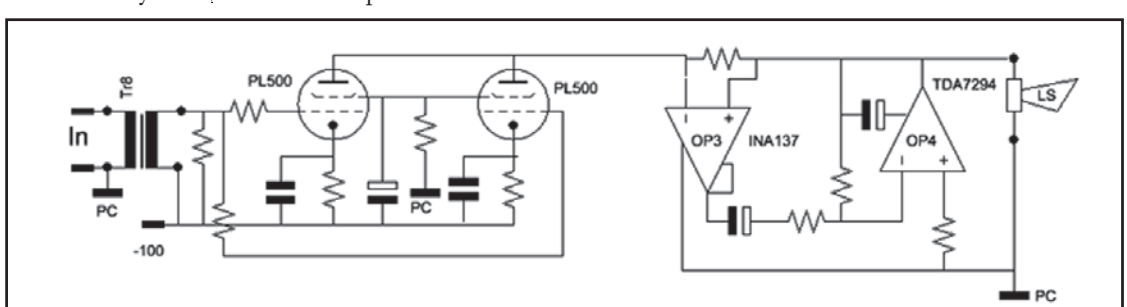


FIGURE 4: The SE OTL PL500 amp.