

DC-coupled valve power

Throughout the years I have seen many valve circuits. I have seen single-ended designs without coupling capacitors, but I have never seen a push-pull design that was DC coupled.

I believe that coupling capacitors have a major influence on the overall sound quality of an amplifier. The goal here was to produce a relatively simple push-pull valve amplifier using an output transformer, but without any coupling capacitors.

Valve amplifiers have appeared without an output transformer. But the benefits of transformerless designs are outweighed by their high complexity and high component count.

We have found that single-ended designs are affected by speaker choice so we produced this DC-coupled amplifier using an ECC85 and EL84s in push-pull.

Design goals, amplifier No 1

The goal of this amplifier project was to design an amplifier with a low component count that was DC coupled throughout. It also had to be low cost and relatively easy to build.

Figure 1 shows the complete amplifier. Because one of the design goals was low component count, we had to come up with a simple input stage. A long-tail pair was chosen.

An ECC85 is used for its low impedance in combination with a relative high amplification factor. The low impedance is important because the valve has to work with a relatively low plate voltage. We have found the ECC85 to perform well in audio applications. It is also widely available and inexpensive.

For the output stage, we chose the EL84. It is also inexpensive and widely available. In push-pull mode, it can deliver over 10W.

Most valve amplifiers use a common-cathode circuit directly coupled to a long-tailed pair as driver stage. We thought, "why not skip the common cathode and find a way to couple the long-tail pair directly to the EL84 push-pull output circuit?" After all, the ECC85 can provide enough gain.

The EL84 needs -11V of bias for 40mA at 300V plate voltage. Thus, we had to find a way to couple the long-tail pair and the

output stage in such a way that the 11V bias voltage remained.

Our power supply provides +390V. Knowing this allows the anode voltage of the ECC85 to be calculated. Maximum plate voltage of the EL84 is 300V, so cathode voltage has to be something like +85V. This is derived from,

$$V_{cath} = V_{psu} - (V_{plate} + V_{transformer}).$$

Now that the cathode voltage of the EL84 is known, it is easy to determine the plate voltage of the ECC85. As the cathode voltage is +85V, this has to be +74V in order to maintain the -11V bias voltage. The screen grid voltage should be 85V-11V=74V.

A transistor is used as a current source, setting current for the ECC85. Because of the high values of the cathode resistors, the EL84s automatically find the correct operating point.

The current source also makes the amplifier more stable via DC feedback by means of the two 120kΩ resistors. These resistors apply some correction for current differences in the EL84s by setting the voltage at the base of the transistor. This correction feature is not essential, but it works fine with the current source used.

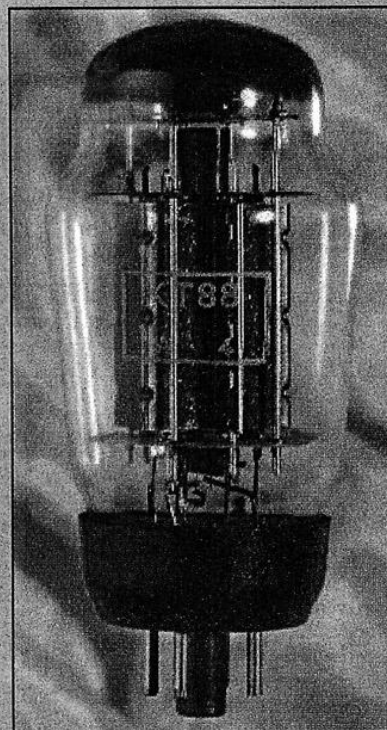
A negative supply is needed for the current source. We chose -6.2V for convenience, using the heater winding and zener diode to produce it. If you use 12V and modify the current source as shown in Fig. 1b), you can remove feedback and the amplifier will be very stable.

Using a cascode as a current source with a LED forming the reference should improve the current source even further. In this alternative, Fig. 1c), the DC feedback is again superfluous.

Potentiometer P_1 is 220Ω and is added to correct imbalance in the output stage. We used a voltmeter made from a small 50μA-0-50μA meter for adjustment. If the needle of this meter is in the middle, balance is good.

Adjustment for imbalance is not critical. A difference in the cathode voltages of 2.2V will result in a current imbalance of only 1mA. This is because of the large DC current feedback of the large cathode resistors.

Adjustment should be made 20 seconds after power-up and again after 15 minutes



Coupling capacitors and output transformer greatly simplify valve power amplifier design, but they both degrade linearity. Because of the inherently high impedance of valves, eliminating the output transformer is difficult. Numerous single-ended designs without coupling capacitors have appeared in the past, but there have been few DC-coupled push-pull amplifiers like this one from Kees Heuvelman and Wim de Haan.

This article was prepared by Wim de Haan, Kees Brakenhoff and Kees Heuvelman. The idea for the amplifier came from Kees Heuvelman.