The Open-Source Directly-Heated Triode Electrostatic Headphone Amplifier (OSDEHA)

Matthias Brennwald

Document version May 14, 2024

Warning: This DIY project involves high voltage. Individuals utilizing the information provided must possess expert knowledge, adhere to stringent safety precautions, and accept all risks associated with electrical work. The authors and contributors of this project expressly disclaim any liability for injuries or damages arising from the use or misuse of this information.

THIS DOCUMENT IS UNDER CONSTRUCTION

1. OVERVIEW

This document describes an audio amplifier for electrostatic headphones. The design of the amplifier is targeted at DIY builders and is published as open hardware (see Sec. 3).

Electrostatic headphones operate on audio signals characterized by high voltage and low current. This is the domain of vacuum tubes, making them most suitable as drivers for e-stats. While there exist a number of tube amplifiers for e-stat headphones, many of these designs do not utilize directly-heated triodes (DHTs), which exhibit outstanding linearity and sound quality.

The OSDEHA uses DHT tubes for its output stage and implements the following design goals:

- The audio output is taken directly from the anodes of the DHT output tubes. No transformer or capacitors to transfer the power to the headphones.
- The amplifier input takes balanced input at signal levels of modern audio sources (mostly DACs these days).
- Focus on quality of audio reproduction and electronic design, not on low cost.
- The amplifier should be reasonably compact.

2. AMPLIFIER CIRCUIT

Electrostatic headphones use three electrodes. The two outer electrodes (stators) are fixed, while the one in the center (diaphragm) is free to move. The diaphragm is biased relative to the stators at a high voltage (with the charge on the diaphramg held constant). The audio signal is applied to the stators, whereby the voltages applied to the two stators are of opposite polarity to drive the diaphgragm. The amplifier output therefore must provide symmetric audio outputs at opposite

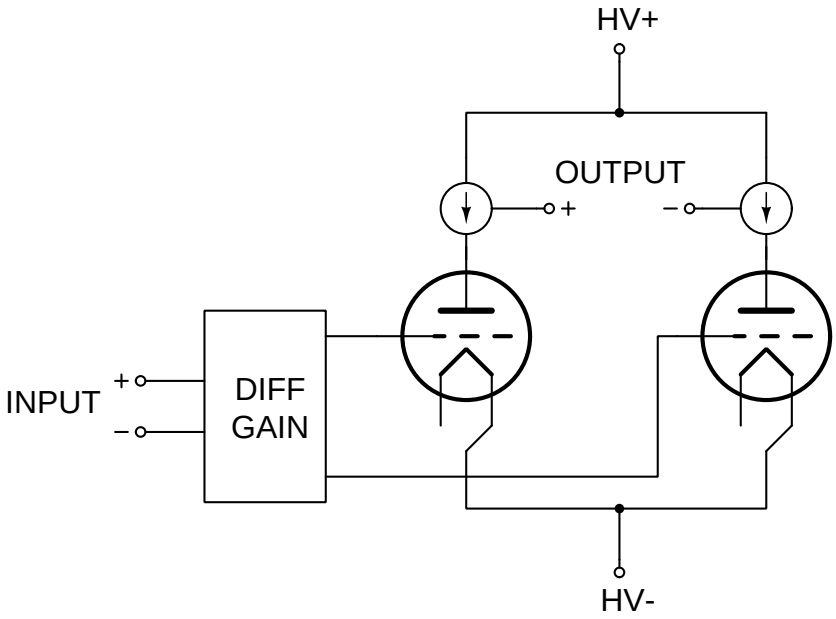

Figure 1: Conceptural layout of the OSDEHA: differential input, gain stage stage, and push-pull DHT output stage.

polarity. According to th design goals, the amplifier also needs a differential input and gain stage. Fig. 1 shows the conceptual layout of the OSDEHA.

2.1. Output Stage

FROM DIYAUDIO POST: The output stage needs to drive very high impedance estat headphones. To make sure the audio/AC power is used efficiently into the headphones, the anode loads need to present a (much) higher AC impedance to the anodes. So we're looking at constant-current loads (current sources/sinks, CCS). CCS loads also help with optimizing the linearity and voltage gain of the amplifier, and with suppressing ripple and noise from the +HV rails. The gyrator CCS type (as discussed by @mogliaa and others) works as a CCS in the audio/AC domain, but provides a fixed voltage at DC. This may be a useful feature to fix the DC voltages at the anodes, and hence to adjust and maintain the amplifier outputs close to 0 V.

3. LICENSE INFORMATION

Source location: `https://github.com/mbrennwa/OSDEHA`

other products you make using this source.