

## 1. Cause

Why choose a tube amplifier? As a guitarist I have come to appreciate the sound of the tube amp. The sound can best be described as warm and full at normal volumes and beautifully raw in overdrive without becoming unbearable. That has largely determined my interest in these types of amplifiers. And in particular the central question: How is that possible? What makes these types of amplifiers so unique? Old tube technology?

Self-build or buy ready-made in the store? I chose DIY because I have good experiences with DIY electric guitars. You simply learn a lot from it. You do research, read, build, test, optimize and make mistakes. You understand in detail how and why a Fender sounds different from a Gibson. That gives enormous satisfaction. Especially if you build something that can compete with factory work. Nowadays there is a huge amount of information available online and that helps. For example, there is also a lot of information on YouTube about the design and construction of tube amplifiers. But to immediately start using that as the main source as a starter.....I thought that was doubtful. Moreover, dangerous! After all, you work with high voltages. Knowledge and experience in the field of electronics is then important to achieve a good and safe end result. At that point I still had some catching up to do. But that also made it challenging and very rewarding. No pain, no gain... that's just how it works. With that in mind, I started looking online for training opportunities. I found the TubeSociety and I was able to register for the 'academic' year 2022/23. Here I found the network of enthusiastic self-builders (including guitarists), led by the very experienced and expert teacher Ir. Menno van der Veen. An authority/specialist in the field of tube amplifiers and also a gifted guitarist. The learning, networking and knowledge sharing could begin! It should be noted that no guitar amplifier was designed and built in the course, but an audio amplifier, the TS-2022-OTL. Nevertheless, this is more or less complementary in terms of set-up/logic. In other words: once you can design and build an audio tube amplifier, that is also possible for a guitar amplifier.

## 2. Theory, Design, Construction, Testing and Delivery

Central to the training was the TS-2022-OTL amplifier. The challenge was to demonstrate that the specific tube character is fully preserved with a tube driver plus mosfet output stage.

Design (schematics) were handed out in the initial phase of the project. All participants therefore logically built the same amplifier. Physically they were not the same.

In addition to general concepts, the theory - Menno's lectures - mainly focused on design

A working prototype has been demonstrated in the early stages of the project. Impressive and motivating! The sound was as intended; the specific tube character was indeed fully preserved even with the use of the mosfet output stage. This was demonstrated, among other things, by means of measurements and listening tests, in which the same piece of music was played through different (tube) amplifiers and assessed by the group.

In fact, the initial design was immediately stable enough for production. Gradually some small optimizations have been made.

Around the turn of the year everyone was on their way to shape their amplifier based on the design and BOM. The mosfets were purchased centrally and you could do the rest yourself.

In particular, being able to work in a team on the same amplifier was very important to me. This makes coordination and the exchange of knowledge and experience a lot easier.

At the beginning of 2023, I focused on a physical design that was starting to become too difficult and confusing. Moreover, I did not have all the components yet, so whether everything would fit was not yet clear. Better half turned than completely gone astray. That had to change. I then decided to completely stop using version 1 of the amplifier. I completely focused on electronics. I set up version 2 on a spacious shelf with old-fashioned resistance boards screwed on. That went a lot better and faster, no fiddling, plenty of room to solder and make connections. On the back of the shelf a sturdy aluminum bracket is made for the mains entrance/mains switch, fuse holder, speaker and audio-in connections. Plank completely stuck in thick silver tape.

The TS-2022-OTL transformer was mounted centrally on the shelf and connected to the mains switch and tested that all voltages were supplied as per specification. That all worked fine.

Then the ground-bus/star structure was constructed and the resistance boards for the various amplifier functions were logically mounted along it.

Based on the TS-2022-OTL schematic and examples and instructions/help I received from Robert-Jan, I built the pre-stage, output stage, ECC88 environment, channels (soldering, mounting and connecting). The placement of the mosfets in particular was a challenge. I mounted them directly on the heat sinks together with the corresponding resistors and capacitors. The soldering work around the ECC88 tube was also complicated. A lot comes together under/near that part and you have to watch out for malfunctions and faulty circuits.

The end of the training was now approaching. I had nothing working yet. Joost then helped me to start up the amplifier, to put it under voltage. I had no test equipment. There appeared to be a number of errors in my work. Resistors went up in smoke, mosfets died spontaneously and capacitors popped. Errors corrected and in a 2nd and 3rd round with Menno we finally removed the errors. That is one of the commendable things about the training. You will be helped and you will learn a lot from it!

About '1 minute to twelve', after setting the potentiometer on 1 channel, we had a nice sine wave on the oscilloscope.

Then Menno decided to stop our testing work and LET IT COME LIVE on the final day. The day on which we as a project group had to have the amplifiers musically assessed by those present. However, my amplifier had not yet produced any sound....

And that final day arrived.....The amplifier played the piece of music of 2 minutes very decently and modestly. Applause ! What a beautiful moment that was! To enjoy!

### 3. Conclusion

I managed to achieve my personal goal. Learned a lot but still far from perfect in this subject.

Particularly now focusing on testing and measuring with the oscilloscope and further expansion of my test environment (variac, lab power supply). I am now going to build the TS-2022-OTL amplifier as I initially envisioned. Now based on printed circuit boards that Erwin Reins will make for this amplifier. Below a picture of PLANK (the naked amp)

