A short story on a year of TubeSociety 2021, by Rens Tellers.

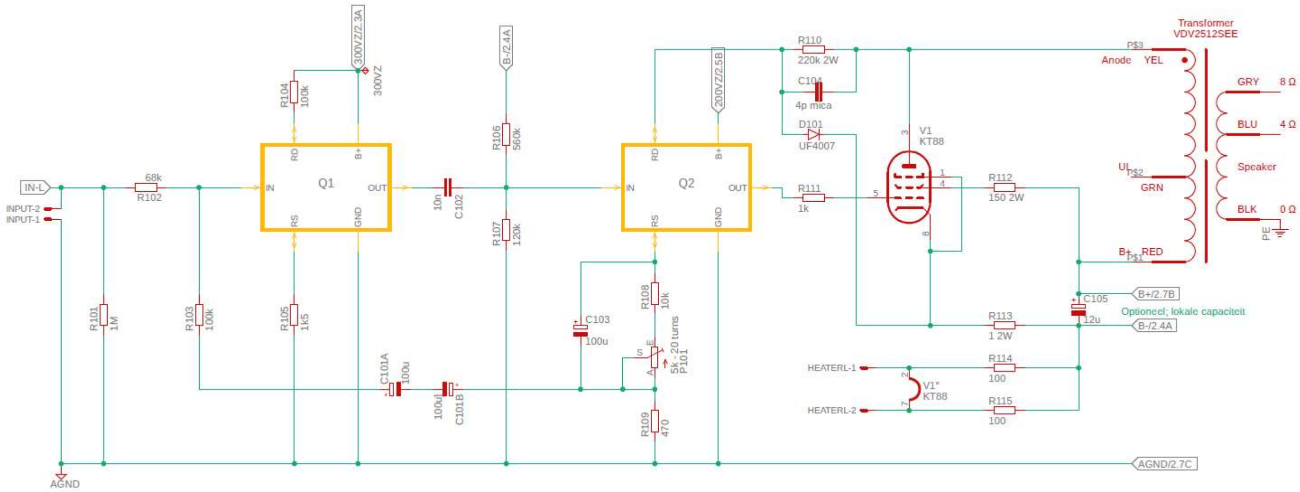
I started this one-year course given by Menno van der Veen as being a hobby musician, with a bit of electrical engineering background, but also being a novelist at building tube amplifiers.

In the first part of the course, theoretical knowledge on tubes and tube amplifier was handed out. At the same time a lot of information was exchanged covering different aspects of music reproduction and also recording. In the second part of the course we were building amplifiers. Giving us the freedom to choose individual projects, Menno ended up with a lot of work for this year's class!

With all the additionals being discussed over the year, it all was really interesting. Information kept flowing on different layers during all classes (and some afterwards), really inspiring the hobby. This course is a tip for everyone into music and/or high-end equipment!

However back to the job at hand, a description of the project itself. I had chosen to implement an earlier design of Menno. See the next link: 2019-december-AudioXpress VDV-TRANS-SE18 artikel.pdf

The first build – the audio section



After building and measuring I felt this should not be the end of this journey for me.

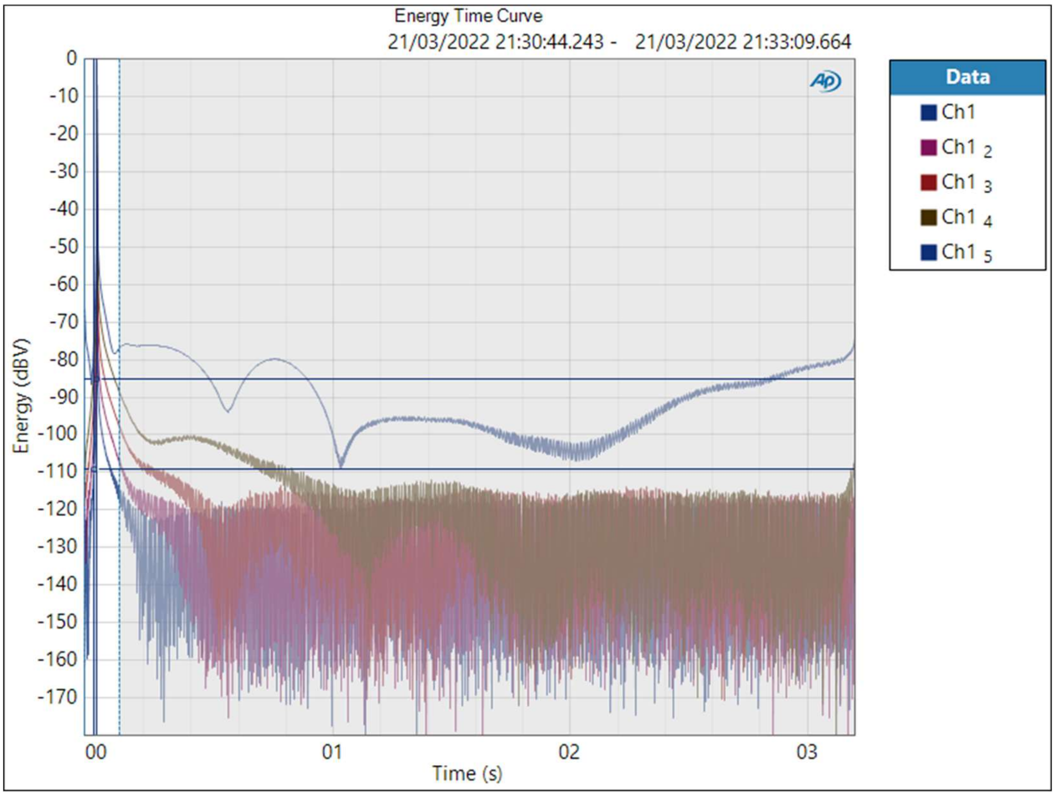
On low volumes the amplifier sounded really promising, but on higher levels I could easily hear some unwanted behavior. My amplifier didn't respond in the same way as the Menno's Trans-SE18 design.

So, some work was still to be done after my first Trans-SE1 proto-built …

The next step; Finding issues and looking for some improvements!

This is where the fun started;

Looking closer into the article gave away that Menno used one power transformer plus electronics for the supply of the left and right channels. Measured with an impulse signal on the input showed power supply reflections on the output of my amp, also the measurement showed signs of instability at approx. 1 Watt.



Legend;
Measured1 = -24 dBrG
Measured2 = -15 dBrG
Measured3 = -6 dBrG
Measured4 = +3 dBrG
Measured5 = +12 dBrG

Measurement conditions;

Precondition
0 dBrG @ Min. THD

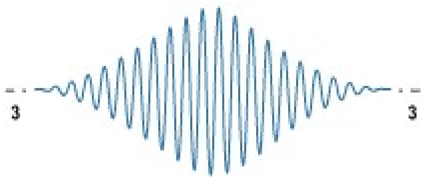
Generator Search
0 dBrG = 39 mVrms

Measurement
0dBrG = RMS 187 mW

Measurement details;

The amplifier output was measured over an 8Ω resistor connected to the 4Ω speaker tap.

The used signal type was an AP-equiripple (see AP-equiripple)



Early findings after this first built;

- Need more power 😊!! (copyright Jeremy Clarkson, Top Gear)
- Biasing this amplifier was a little tricky because of drift (Temperature / pcb design / lack of power stability) and in relation to that the left channel heavily influenced the right channel.
- The design of the PCB showed high temperatures on some of its parts, also a possible cause for bias drift.

So time for the next steps…

Trans-SE2 : A modified version!

Scaling up the power supply and add some ingredients of my own;

1. Build the amplifier in dual mono.
   The only direct connection between the left and right channel is the combined power supply. Using separate electronics for left and right is probably ok, but let's go for dual mono and use two mains transformers as well.

2. Reduce temperature of parts to avoid temperature based drifting.
   Parallel resistors/capacitors where needed, change some component values for dual mono and input stage change (below). Also more cooling on the high voltage regulator.

3. Stabilize the power supply voltage
   The capacitance multiplier was kept at a steady voltage drop of approx. 14V by an extra resistor. However this is a floating ripple-rejection. Referencing to earth avoids voltage drifting, thus creating a stabilized supply by applying Zener diodes.

4. Also stabilize the cathode lift voltage (B- and heater lift)
   However, the power consumption was minimal (60mA, measured AC on the transformer-tap) on this 120V supply part, I'm just not a big fan of voltage doubling. On top of that a new power transformer was needed to supply the opamp section, giving me an easy opportunity to remove the voltage doubler completely.

5. Local capacitance around the heavy consumer, the power tube.
   To improve the internal resistance of the power supply, especially for impulse response, some local capacitance was added after the regulator/stabilizer and close to the consumer.

Then a bit in the audio;

6. Addition of volume control
   Adding a volume control Baxandall style in reference to a Texas instruments paper.
   TI Precision Designs: Active Volume Control

7. Use the volume control also as the first voltage amplification eliminating the first Menno-cel-fet section.

And then some practical;

8. Playing some with the capacitor types/values in the audio-section.
   In the end I kept using FKP-Wima capacitors, but reduced the ESR by putting a few in parallel.

   (Note; different brands also sound different, can we measure this? Future investigation necessary)

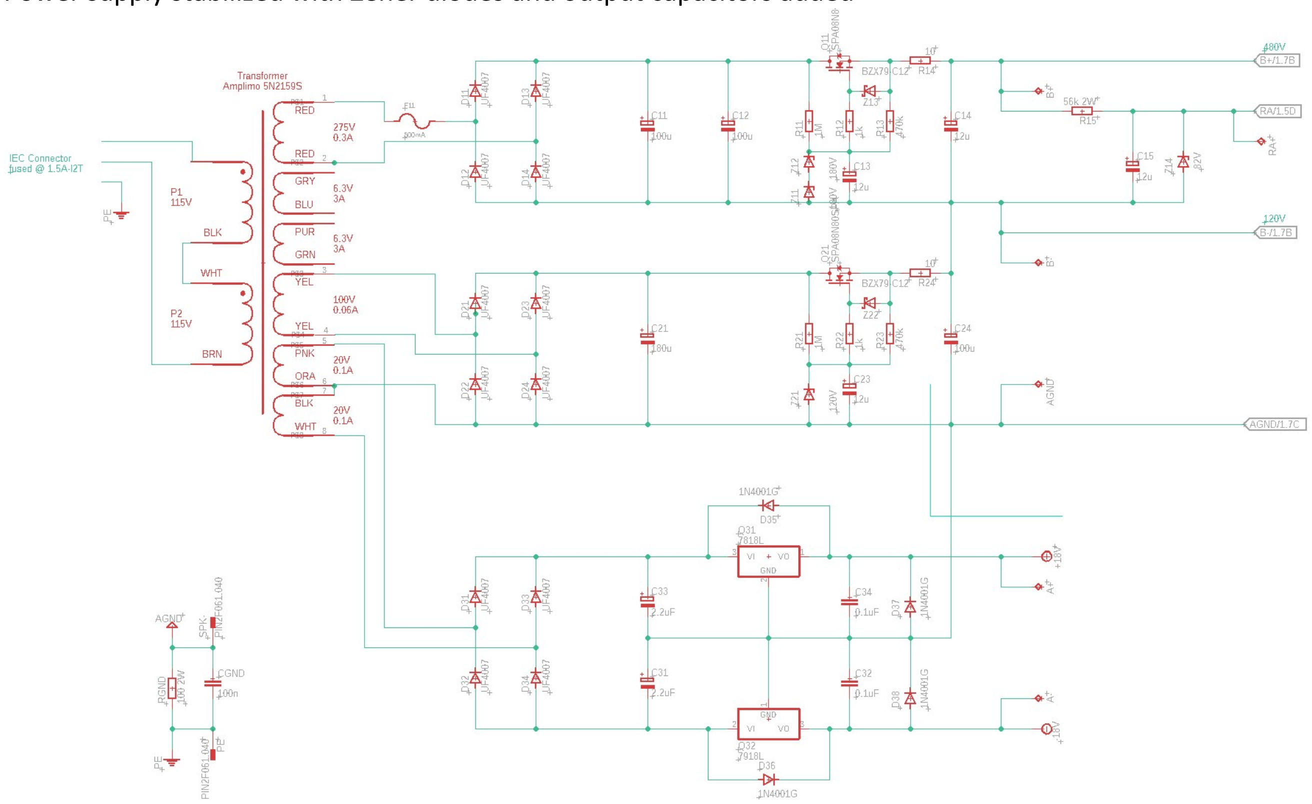
9. Mistake in my Trans-SE1 design involving the local feedback upon second fet-section.
   Removed feedback, second section is now used for transconductance principle only. Increased current amplifier setting to reduce harmonic distortion from fet a bit further.

10. Rolling with some tube types. I'll spare the details here, but for this particular design the (reissue) Genelex KT88 worked really well.

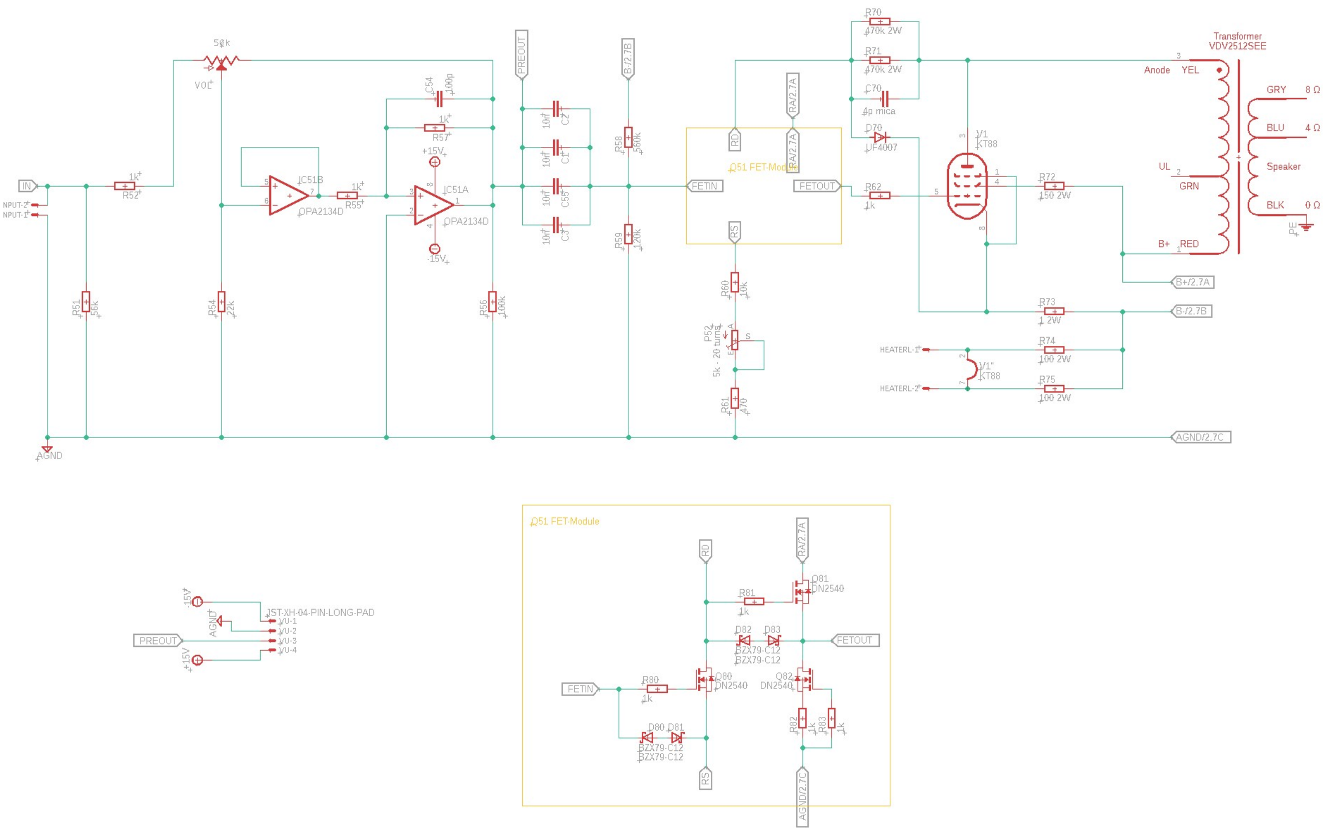
11. Changed speakers to high-efficient types.
    Last but probably the biggest change 😊. Now running with Klipsch speakers @ 99 dB/W,m , I can stay away from the higher load for this single ended KT88 amplifier.

Schematic of Trans-SE2, as demonstrated in Hichtum on June-21-2022

Power supply stabilized with Zener diodes and output capacitors added



And the audio section

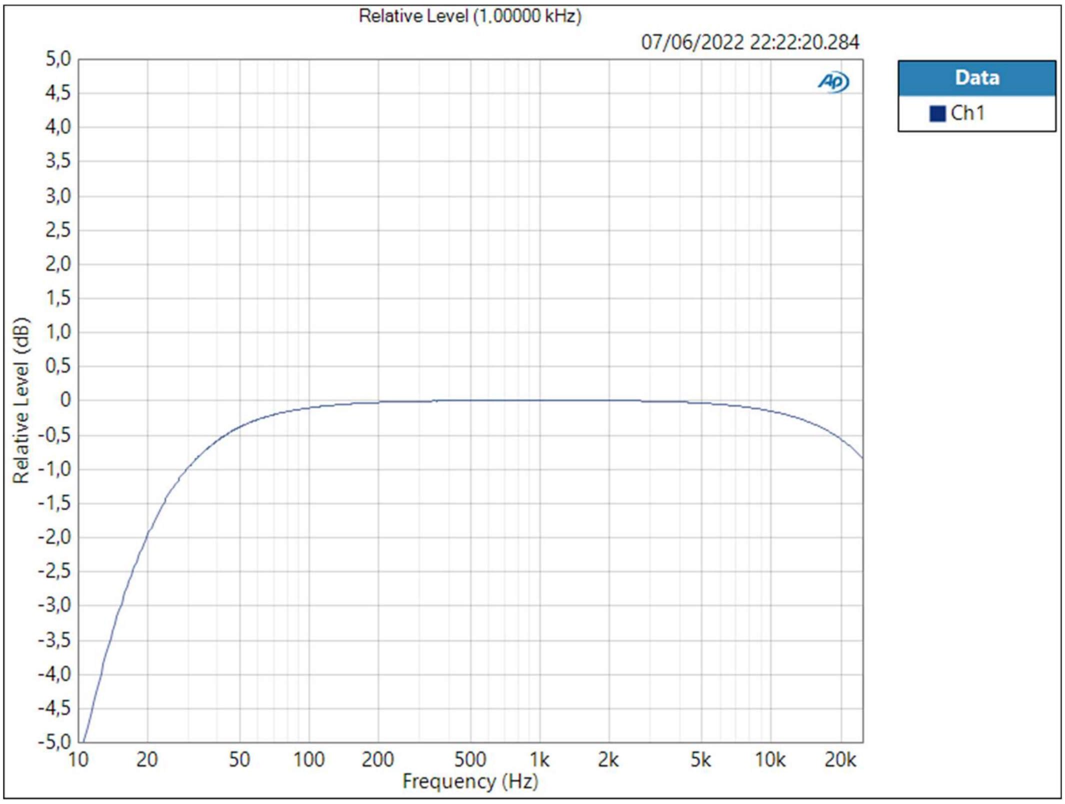


Some measurements of the Trans-SE2:

All measurements were taken under the same conditions;

- The generator connected to the input, the volume potentiometer on max. setting
- The output connected over an 8Ω resistor which is connected to the 4Ω tap of the output transformer

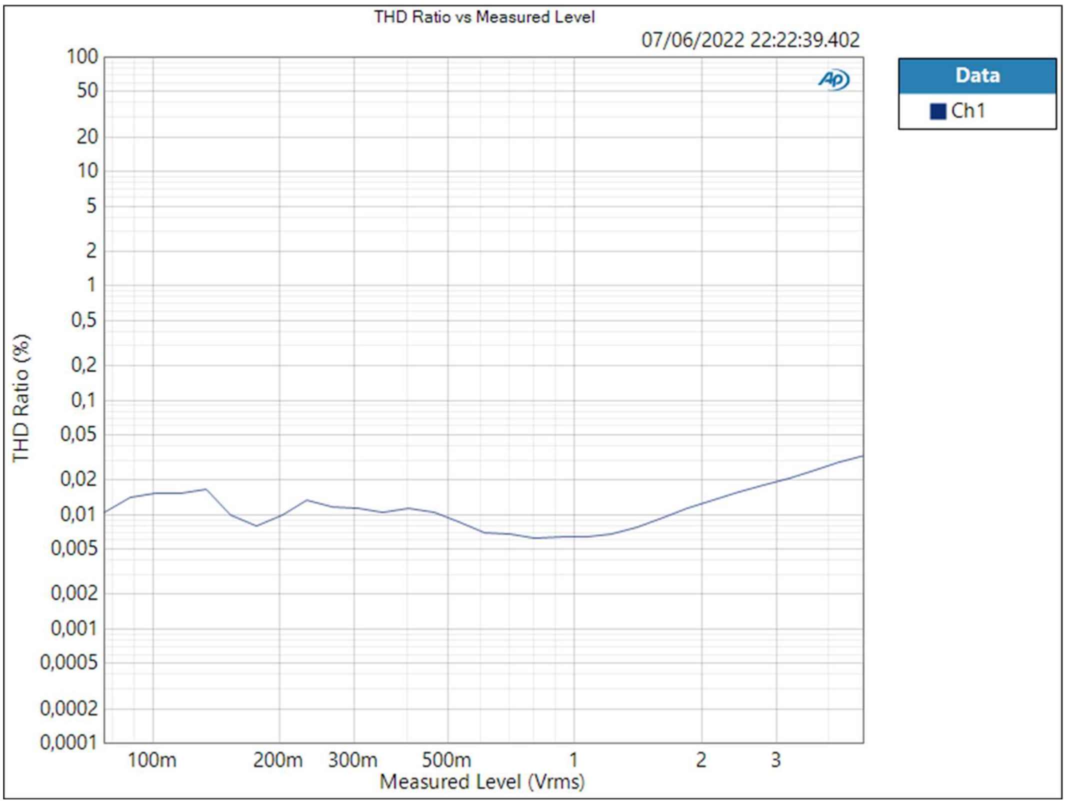
- Signal Precondition 0 dBrG @ Min. THD
    - A generator search then gives 0 dBrG = 149 mVrms
    - Output measurements 0dBrG = RMS 185 mW



Relative Level Sweep;

Amp gain = 18,2 dB
THD+N = 0,0095% !!

Dev +/- 0,98 dB over a 20 - 20k Hz Freq band.



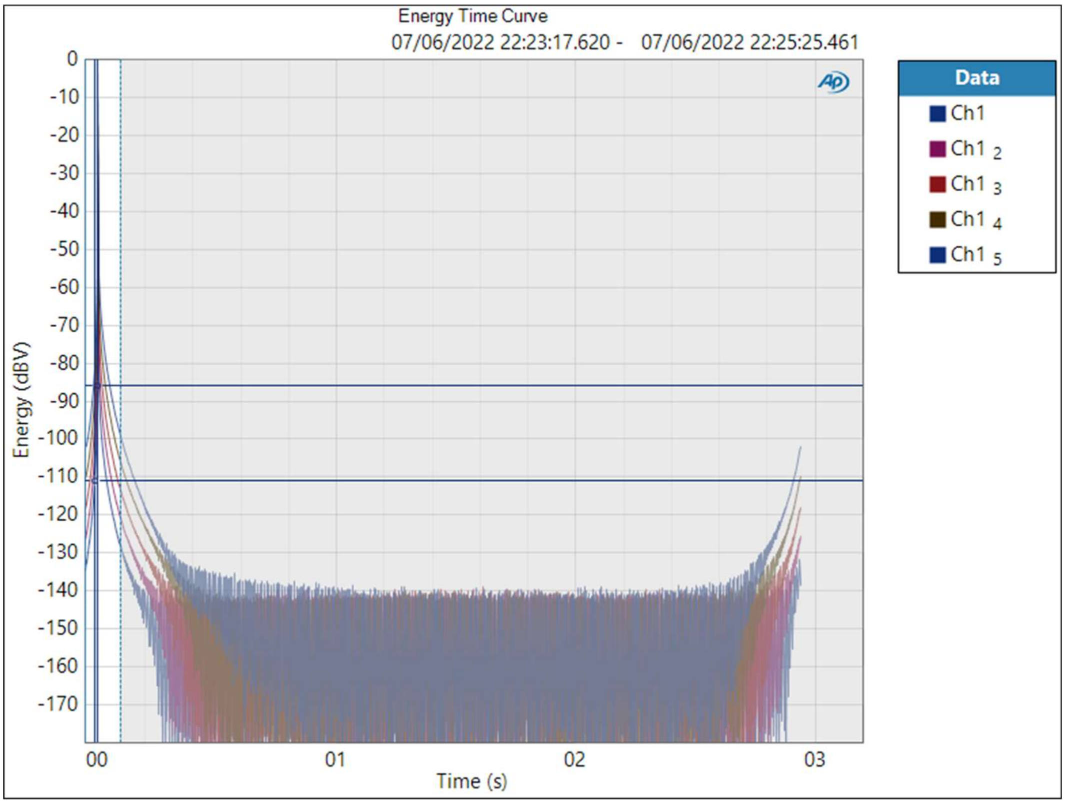
Stepped Level Sweep

31 points linear from -24 dBrG to +12 dBrG @ 1 kHz

Impulse Response and THD at different volume levels.

The amplifier remains stable up to 4,5 Watt output. However all measurements were taken at the same operating area so, once more, input 149 mVrms, output 185 mW. Usable with high efficiency speakers.

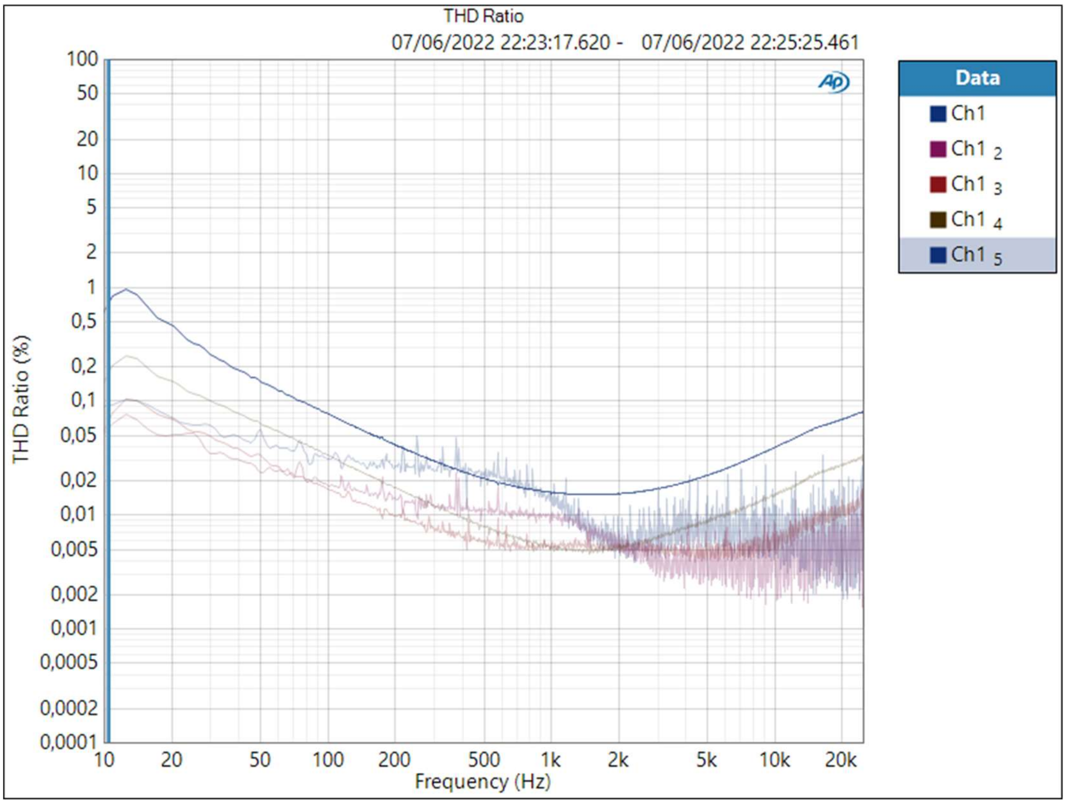
Measured1 = -24 dBrG
Measured2 = -15 dBrG
Measured3 = -6 dBrG
Measured4 = +3 dBrG
Measured5 = +12 dBrG



Energy Time Curve

The impulse response of an AP-equiripple signal

(see AP-equiripple)



Frequency Sweep

Total Harmonic Distortion as function of frequency at different power levels

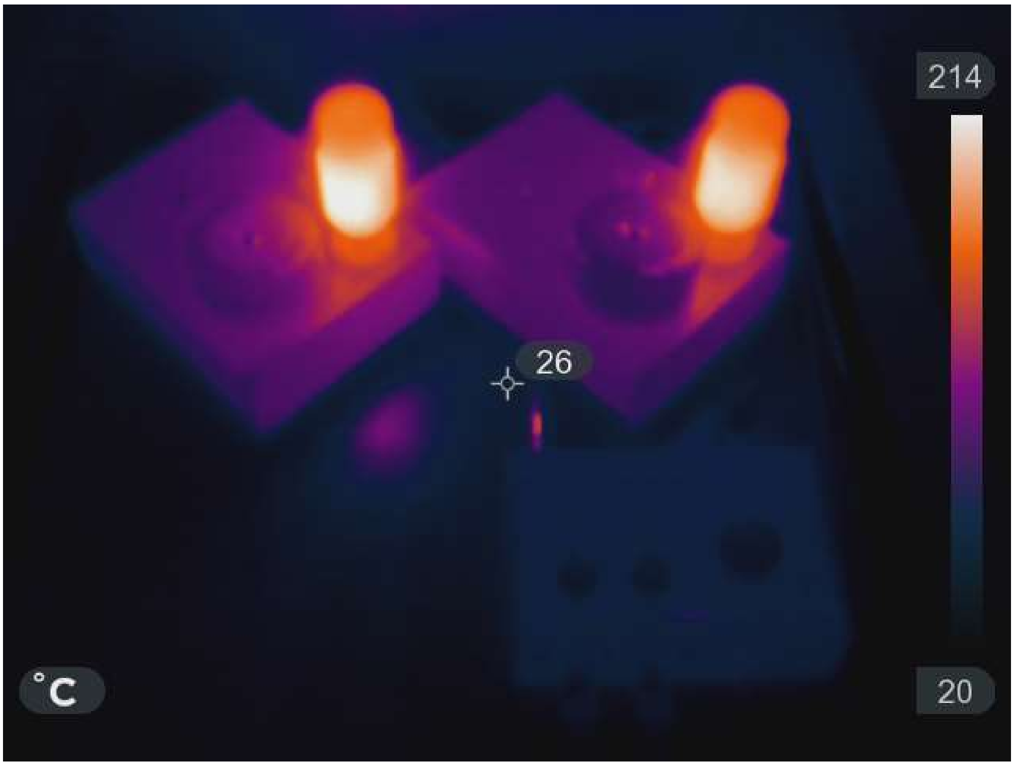
Conclusion,

We’ve built a really nice high-class amplifier during this TS-2021!

While looking perfection; Trans-SE3 version is on the way as we speak, and more ideas are ready for a possible version 4. Even more improvements! Then the next step; give Trans-PP a go, with all the new knowledge and inspiration gathered this year, I feel confident in proceeding to the next built!

--- To-Be-Continued! ---

To Menno and all fellow TS-members, thanks for an inspiring and fun year!



And then just a hint of side projects during this year 😊

Test-Case Complex Measuring;

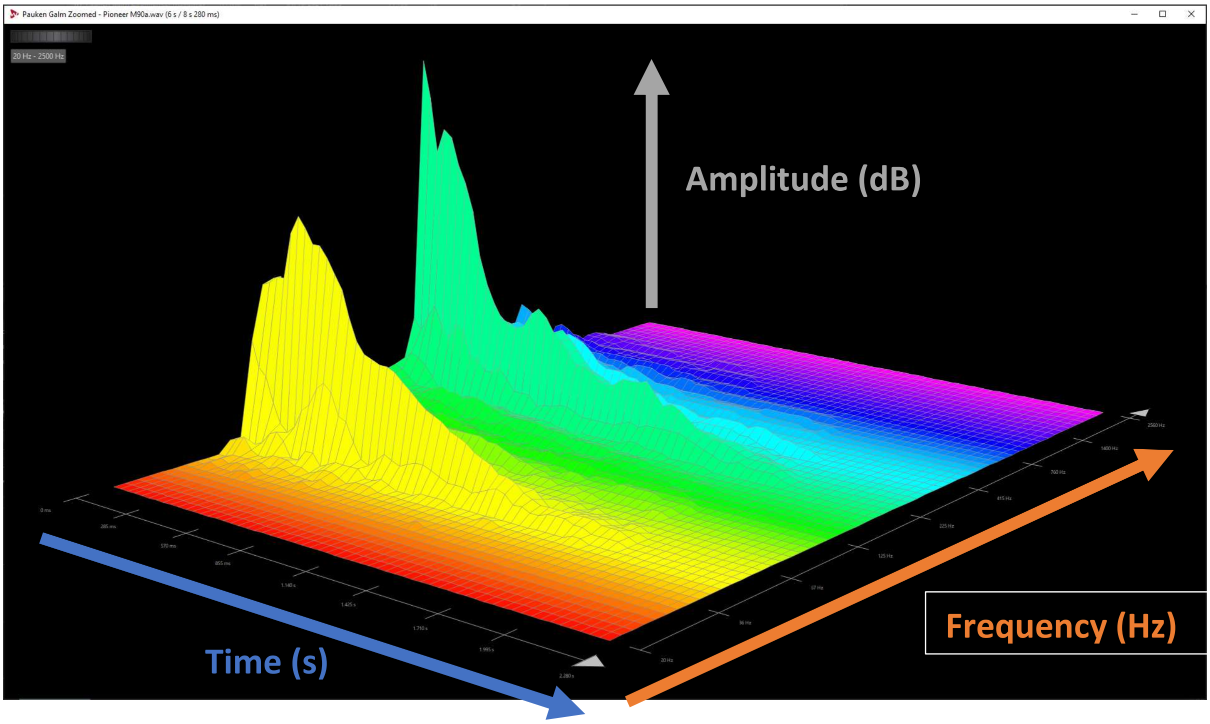
While Menno was covering the theoretical part of tube amplification and amplifier building, I've chosen to do some testing with measuring equipment;

To give this a practical subset, it started out with a test-case;
I always had the impression that with complex music the low-end suppressed the mid and higher end from being articulated in full. As said, no science, just an impression, but I wanted to see whether it was possible to measure this impression in an amplifier.

So, I took a sample from one of the music pieces we've heard and used as a reference during this course;
'Sarah was Ninety Years Old' played by the The Hilliard Ensemble, written by Arvo Pärt.

An explicit excerpt from reverberant kettledrum playing was taken from this piece as a test-case.
(+/- 8 seconds from around 19min).

By generating fft-waterfall-plots (time -> frequency -> amplitude) the excerpt can be broken down into a 3d-plot.



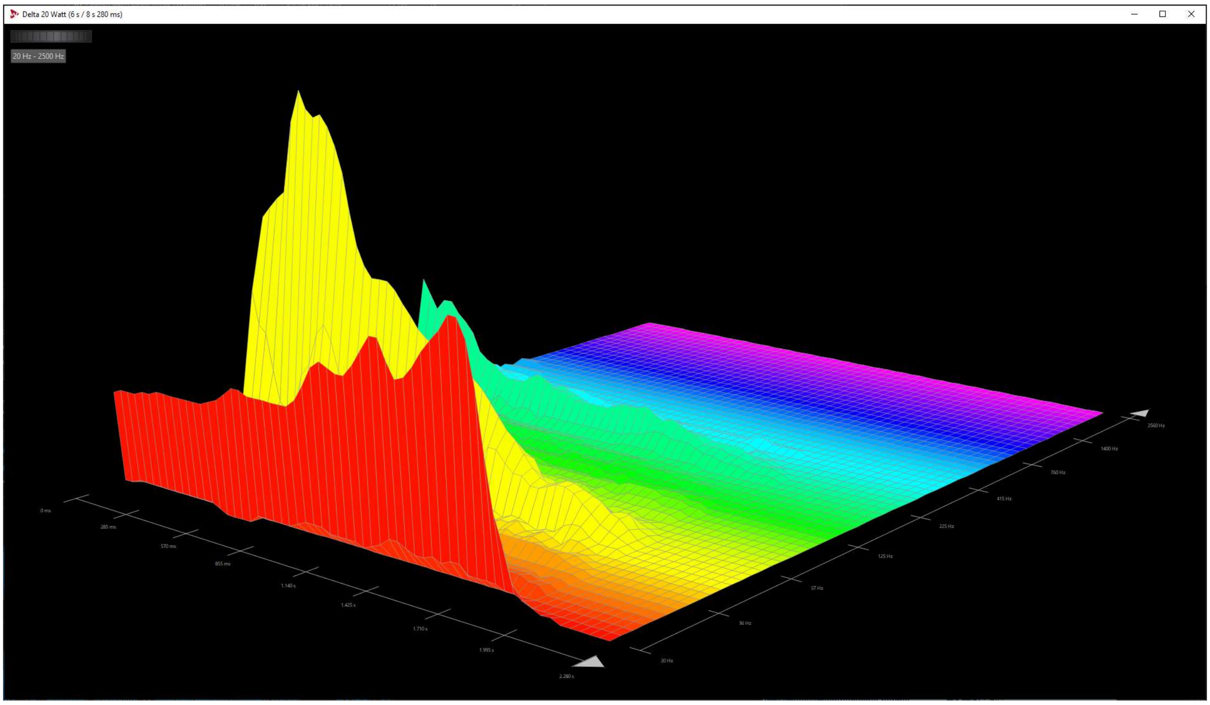
A graphical view of the used source-file

Not sure whether the changed perception after amplification was in hearing / speakers / amplifiers, the deviation after playing this sample @ 1 Watt over an 8 ohm's resistor through a Pioneer M90a power amplifier actually shows some differences. And turning the volume louder on the amplifier playing around 20 Watts shows even bigger differences.

Differences source vs resistor measurement; peak level at -28,8 dB, noise floor around -65dB!

Red;
Low frequency, the high pass filter from the amplifier is to be found here.

Yellow / Green;
Musical data, absolute differences on lower frequencies are bigger then on the higher ones.



A graphical view of the difference between the input and gain-corrected-output of a Pioneer M90a power amplifier playing the source file.

This is opposite from expectation!

Please note that these are just idea tests and some cautiousness is in place;

Frequency resolution is defined by sampling frequency and number of datapoints for the FFT plot. If a filter window is applied, this resolution becomes worse. So, noted that to use measurements accurately, high sampling rates are necessary and before results are trustworthy some further investigation needs to be done on this item!

For now; investigation on hold, but this measurement technique could be interesting for future research.