SMPS in HiEnd-Tube-Audio

… why and how to use them

By Barbara E. Gerhold "TUBECLINIC"

SMPS (Switch Mode Power Supplies) are standard issue in commercial and, especially, consumer equipment. No modern TV set, personal computer, or laserdisc, etc., would be without one. Nearly all consumer electronics are supplied by them. There are benefits, and nobody can deny those benefits, but are they suitable for high-end tube audio, too?

How does a DC-supply work?

A standard DC-supply for Audio equipment consists of a transformer, a rectifier and a filter section.

Behind the filter section, regulating components or gyrators may be situated to improve the filter effect (the smoothing of the ripple voltage and/or current). The remaining ripple is only dependent on the expenditure on the filter(s) and its frequency is twice the mains frequency or 100Hz (120Hz in the US). The higher frequency harmonics are due to the saw-tooth behavior of the capacitive smoothing as well as electronic regulation (if used) and its transient behavior.

A SMPS looks the same, as it applies its regulating components behind a single filter cap. But there is a big difference: The difference in voltage between input and output is not fully converted into heat. That makes a huge difference from the fact that heat produced by the components typically shortens the lifespan of the power supply as well as the whole parts of the amp. The biggest enemy of electronics lifespan is heat resp. power loss! This reduction in power loss is achieved by switching of the raw voltage and filtering by a choke + cap (LC) filter. The remaining ripple is well beyond the hearing limit due to the high frequent switching. This makes the use of small and cheap filter components possible, opposed to large chokes and capacitor filters in standard supplies. So we can apply extraordinary quality filters without spending a fortune.

The calculation of standard DC-supplies for Audio purposes is covered in the following article -> "Calculating HiEnd-Audio supplies".

For which purpose can we use a SMPS?

The first application of a SMPS I tested was in a DC-heater-supply of tubes. DC-heaters are used to eliminate the hum induced by AC-heaters. Although some designers would swear that AC-heaters present a livelier sound, I am not fully convinced of that. Hum smears parts of the sound, esp. in quiet sections, as well as it masks fine inner details and imaging information. OTOH – DC heaters tend to present a cleaner sound and it somewhat destroys the "tube magic", which is sometimes confused by listeners with a "little hum from the speakers".

Anyway, I quickly assembled a 2,5A SMPS DC-supply for the heaters. Using a separate transformer 12V/50VA, a filter cap of 10.000µF/35V and a pre-made step-down ("buck") module from the market, I built my first attempt.

Even the first result was outstanding! I did not change anything else to the existing pre-amp and its performance was widely improved. No more audible hum and much clearer in sound. There was much more space in between the instruments and voices, and a real improvement in imaging.

So I started to research. The remaining ripple was still app. 125mVrms @ 300kHz (though that did not affect the performance sonically) and regulation on the static heater load was perfect. Over time, the variation of the heater voltage stayed in the ±5mV range.

Then I watched the plate of the first triode by scope and found some small residues of the remaining ripple, again @ 300kHz therefore not audible but a drawback that needed to be fixed. So I attached an additional filter at the output of the module and – bingo – the residual ripple was down to app. <1mVrms. Now there were no more residues at the plate too. Sonically this effort did not change all that much – but if anything else - it helps us all sleep better, knowing there are no residues …

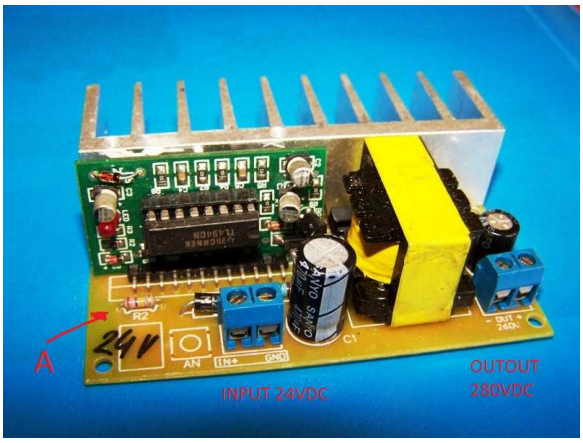
Regulation did not change too as heaters are a static load, therefore the R_{dc} of the additional ring choke does not matter.

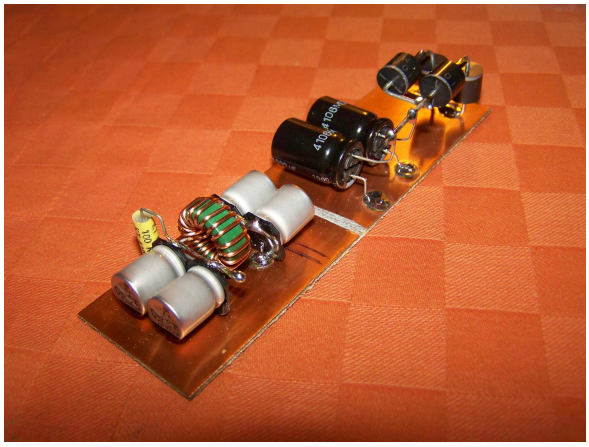
I made H&N (hum and noise) measurements before and after the modification and found that the H&N-figure decreased from former -79dbA to -96dBA. A big improvement from nothing else than changing the heater supply!

Well, for readers not so comfortable with dBA-figures, the H&N-ratio of my pre-amp decreased to 14% of the former figure - dBA denotes a weighted, logarithmic measurement in the Audio band.

Following tests showed that the ideal input voltage of this assembly is app. 24VDC – rather than my former 18VDC. So a transformer's secondary of 18VAC is ideally suited. Efficiency rose to app. 90% too, when using 24VDC.

Because this first test on the heater supply was really rewarding, my next attempt was to supply the B+ voltage too by a SMPS. The B+ supply of my pre-amp is 300VDC @ 38mA. I looked for a pre-made SMPS module for this job and found one at "Chinese taobao". Here a 280VDC/20W module is offered by some dealers. A Hong Kong friend helped with the purchase of a bunch of such modules after I had analyzed published pictures of this module.





The left picture shows the B+ module, while the right picture shows the rectifier plus storing el.caps and the additional filter.

The problem was how to adapt the output voltage of the module to fit my needs. It functioned like I supposed and showed no problem with adapting. Only the resistor (marked A at the left picture) needed to be adapted. Its switching frequency is lower than the heater buck-module and reads app. 150kHz. Its input voltage is given at 24VDC, so my transformer of 2 x 18V was fine for this job too.

A quick check of the remaining ripple at rated load showed app. 250mVrms but app. 5Vpp. Spikes of 20 times the rms-figure were superimposed to the output. That necessarily called again for an additional filter at the output. After attaching the filter, the rms-value came down to app. 5mV and

the spikes were nearly gone. Because my pre-amp uses a gyrator for each channel, the residual, superimposed ripple went below measurable values.

Anyway, we do not build Tube-Audio equipment to achieve best figures - it's because of its sound! Some days after finishing this project, I invited some of my audiophile friends to audition and judge for themselves. We all agreed to the improvements of the overall performance. Biggest improvements were to the increased brightness and clarity as well as better imaging.

Further information on the mentioned supplies can be found at the separated articles on **"SMPS Heater supply"** and **"SMPS B+ supply"**. Here I describe the design and calculation of such a perfect supply.

If you have further questions or advices on improvements that you feel should be published here, please contact me via eMail.