Vanderveen 73 Watt valve power amplifier PR20HE-S2

This special valve amplifier, although firstly intended for guitar amplification, proved to belong to the top of high-end amplifiers. He sounds extremely open and detailed. I added some important improvements to the original design, amplifier 20 as published in "The Project" on my website. Now this amp really has atmosphere, depth and emotion, combined with a nice 73 Watt output power. This manual gives the schematics, specifications and description how to build.

KIT components and why no case

This DIY-kit contains all the necessary components, transformers, valves chassis connectors and the drilled aluminum top plate on which the complete amplifier fits. On purpose no further casing is added to the kit. The look and construction of the case is left to the imagination and designer skills of the do it yourselfer. One might consider a case of wood, granite or titanium, everybody has its own favors. The dimensions of the top plate are such that the complete casing of Personal Audio Concepts (as shown on the photo's) can be applied. See the end of this article for more info about this fantastic case.

Introduction

What makes valve amplifiers that special? Are it the valves, the special output transformers or is there also another reason? In the year 2004 I started an in depth research where I studied the effect of different topologies on the sound quality. I developed a kind of universal amplifier, an universal output transformer and power supply. Only by changing some internal wiring totally different amplifiers could be made with powers reaching from 5 up to almost 80 Watt. Essential in this research is that in every amp exactly the same components were used. So, only the influence of the schematics would be heard and nothing else. This complete research can be found at my site, see "The Project" and also literature 1) to 5). Last year I selected the best sounding and most powerful amplifier (amp 20) of this research, added some important improvements, and the PR20HE-S2 amplifier was born. The number per mono block amplifier is PR20HE, when you add -S2 it only means that you use two mono blocks, so you work in stereo.

Audio schematics

Figure 1 shows the schematics of the audio part. The input on the left side is balanced and meant to be driven by a balanced output of a pre amp. With a minor change of R3 and R7 also an unbalanced RCA input is possible; see the remarks in the schematics.
The long tailed ECC81 input valve functions as pre amp and phase inverter and driver of the push pull power valves. The two cathodes are connected to each other, while R6 functions as a constant current source, fed by the negative voltage Vn = -73 V.

One might consider to limit the wide frequency range of this section, by adding a C1 = 100pF/500V silver-mica capacitor directly between the two anodes of the ECC81. This will suppress a small 90 kHz resonance in the output transformer. My experiments only showed a result on the oscilloscope, I could hear no difference between with or without C1.
After the ECC81 the audio signal goes through the coupling capacitors C3 and C4 to the power valves. The circuit is optimized for the famous EL156 power valves. They can handle a maximum anode dissipation of 50 Watt each, which enables a large quiescent current. The amp functions therefore mostly deep in class A, which also explains its great audio qualities. Also the famous 6550 valves with Pa,max = 40 Watt can be used, although with a little less quiescent current, see the table with measurement results for more details.
With the 10 turns trim pots P12 and P13 the quiescent currents Io can be set, and measured with a volt meter over the cathode resistors. With the EL156 the quiescent current are set at 50mA per valve, so the voltmeter should read 50 mV over R17 and over R18.
The anodes of the power valves are connected directly to the primary winding of the universal VDV-GIT80 output transformer. See the datasheet of this transformer for more technical details. Its primary impedance Zaa equals 8 kOhm in this application. The high voltage V0 = 720 V is connected to the center tap of the primary winding. The screen grids are connected with R16 and R17 to the supply voltage V1 = 360 V.
Now that the voltages and currents are known, the actual anode dissipation per power valve can be calculated. Using 720 V times 50 mA delivers a mere Pa = 36 Watt. This is smaller than the maximum value of 50 Watt, but ensures long valve life. However, if one wishes to go as deep as possible into class A, then the maximum quiescent current can be set at 69,4 mA. Probably the anodes of the EL156 will start to glow under this condition and please don't blame me that the lifespan of the two valves will be short.
The cathodes of the power valves are connected through R17 and R18 to the secondary of the VDV-GIT80. Make sure that the secondary winding tap point 2 (blue wire) is connected to the ground, else no current can flow through the power valves. This kind of local feedback at the cathode is used by Audio Research, and also proves in this design to have excellent qualities. This cathode feedback raises the damping factor at the speaker and lowers the harmonic distortion in the power valves and the output transformer.
Loudspeakers with impedances of 4 (use tap 1 and 2) and 8 (use tap 1 and 3) and 16 Ohm (use tap 1 and 4) can be connected to the secondary. Never connect tap 1 or tap 3 or tap 4 to ground, else you will shortcut the secondary. Only tap 2 is connected to ground.
Figure 2 shows the pin numbers of the EL156 valves with octal base, which are equal to the 6550 pin numbers.

About hum and grounding

The audio schematics in figure 1 shows two grounding points with the numbers 1 and 2. They are connected by a single wire to each other, while grounding point 1 is floating with respect to the metal case and grounding point 2 is directly connected to the metal case. This looks a little bit like magic, so let me explain the reason why. By grounding using this method, almost no hum is heard and also the purity of the amplification will be optimal.
Grounding point 1 belongs to the power supply voltage V0 and the power valves and their large currents. Grounding point 2 belongs to the ECC81 where only small currents flow. Never the large currents of the power section should run through wires of the sensitive pre amplification section. By connecting R1,3 and C2 to grounding point 2, while C5,6 and P12,13 and secondary tap 2 are at grounding point 1, you can meet this demand. The question is: can you hear the results of this kind of separate star grounding? Yes, you can hear the micro details in the sound much better and clearer. So, please follow my advise; this brings the PR20HE-S2 to its highest levels.

Power Supply

Figure 3 shows the schematics of the power supply. The special power transformer VDV-POW80 can be used worldwide because of its many primary voltages. See for more details the datasheet in this manual. Keep in mind that per voltage an optimal primary surge should be used, which is indicated as well. The mains grounding is firmly connected directly to the metal of the top plate, for optimal safety. Please pay close attention to this. The transformer has a metal shield (green-yellow wire) between the primary and the secondary windings, that should also be connected to the metal case with the shortest wiring possible.
The two 270 V secondary windings are separately switched with the stand-by switch S2 and surged and rectified and buffered with 330 uF in parallel with bleeders of 100 kOhm. This delivers two times 360 V and by placing these high voltages in series one gets the V0 = 720 V for the power valves and the V1 = 360 V for the screen grids.
The third winding of 50 V delivers after rectification and buffering the negative voltage Vn = -72 V. On purpose there is NO surge in this part of the circuit, to ensure that this negative voltage is always present. Else your precious power valves could burn in front of your eyes, caused by a stupid malfunction of a surge of 20 cents.
The filament winding of 6,3 V needs no further explanation, only that it is center grounded through two 100 Ohm resistors at star ground 2.

Specifications

They are given in the table and most speak for them selves. The -3dB power bandwidth start at the excellent low frequency of 18 Hz. At a low level output power of say 2 Watt (which is mostly where we listen), the low frequency bandwidth starts at 4 Hz. This very low frequency is caused by the extreme large primary inductance of the primary winding. The

listening result is that you can hear, depending on the loudspeakers used, the low frequency breathing of the air, which gives much spatial information in the sound stage.
At the high frequency side of the power bandwidth I measured 26 kHz, independent of the output power level. This is caused by the leakage inductance Lsp and the internal primary capacitance Cip inside the output transformer. These results are in total agreement with my original design goals of the special VDV-GIT80 output transformer, which should function flawlessly in our hearing range. Suppose one wishes to go up to 100 kHz bandwidth, then please use my specialist VDV4070-CFB toroidal output transformer (avaialable at Plitron).
The effective output impedance Zout (reverse with the damping factor) of the amp depends on the quiescent current and the type of power valves. See the table for details. Its value is small because (high damping) of the applied cathode feedback. Most dynamic loudspeakers will be totally happy with this damping and my listening results showed a quick and open and detailed bass character. No muddy sounds here.
The input sensitivity of the total amplifier equals 2 Vrms. Most CD-players deliver this signal level directly and then you only need a volume pot to set the desired loudness in your room. Use a stereo type when you work balanced, and use a single deck type for unbalanced application.
The total hum level at the output is remarkably small at 3 mVpp. This is caused by the magnetic leakage fields of the power transformer directly into the output transformer. By creating a larger distance between these two transformers, this level can be reduced, but I consider the present hum level negligible, so why to make the amplifier larger? The tube circuitry delivers 1 mVpp hum because of the careful grounding method as described earlier. You can hear and measure no hiss, which is explained by the careful designed amplification factor, meaning no more amplification than absolutely needed for (which is a typical Menno trick).

PR20HE-S2 specifications	**EL156**	**EL156**	**6550-C**	**unit**
Quiescent current Io per valve	40	50	40	mA
V0	726	716	728	V
V1	363	358	364	V
Va1 upper EC(C)81	199	199	199	V
Va2 lower E(C)C81	196	196	196	V
Vn	-72	-72	-72	V
Vg1 B2,3 (indicative)	-23	-22	-43	V
P-max @ 1kHz	71	73	75	W
-3dB power bandwidth	18 - 26	18 - 26	18 - 28	Hz - kHz
-3dB frequency range @ 2 W	4 - 27	4 - 27	7 - 27	Hz - kHz
Z-out at 4 Ohm tap	2,5	2,3	3,5	Ohm
V-in asymmetrical @ 70 Watt	2,0	2,0	2,5	Vrms
Hum at 4 Ohm tap 3 output	4	3	4	mVpp

Some about the case of Personal Audio Concepts
Inside the vertical left section of the case of Personal Audio Concept, a processor controls all the volume settings of each mono block, while the volume potentiometer per mono block only has a limited range of 10 dB, meant for balancing purposes. The vertical right section is empty, and can be used for any preamplifier one wishes to add. See 8) for more details. The top plate of this kit has exactly the right dimensions to fit in the nice casing of Personal Audio Concepts.

Some about your special case
Which shape or material you use, is totally left to you. But please always meet the condition of total shielding. Use Alu-foil inside the case to build a kind of metal case all around the bottom side of the amplifier. This foil with the top plate will create a Faraday shield, preventing any disturbing fields and signals to enter the sensitive electronics of the actual amplifier. All input and output connectors plus switches can be placed anywhere, but close to the terminal strip is the optimal position. An on/off light might be helpful to indicate the status of the amp. Please do not use a neon light, which causes disturbing on/off switching with the mains frequency. Use a nice filament lamp which works directly with the 6,3 V filament supply. Such a lamp does not switch on/off and causes no disturbance whatsoever.

How to build
Picture 2 shows the bottom view of my hard labor. I combined all the wires as much as possible in the middle, to make sure that especially grounding wires do not enclose a closed surface, which might cause extra hum when the leakage field of the power transformer crosses such a surface.
Picture 3 shows details of the power supply section. Make sure that the 330uF electrolytic capacitors are well isolated from the chassis.
Details of the actual valve-section are shown on picture 4.
Following 11 drawings are added which show a nice step by step way of the actual construction of the amplifier. Please follow these step to prevent any sequence conflict.
All connections to the external world are found on the 13 point mounting terminal which can be sturdy mount to the top plate with M3 screws (holes are not drilled) or with double sided glue tape. Whether you use this strip or not, is left to you. For reasons of clarity I applied it, but you might prefer direct connections to the chassis parts.
The loudspeaker connections are drawn for the 4 Ohm tap; for 8 or 16 Ohm change the red wire to the appropriate output transformer connections, as indicated.
Also the symmetrical or asymmetrical input connections are shown with remarks about the values of R3 and R7.

Subjective
Every designer is always enthusiast about his work, but I have reasons to be extra. For more than 40 years I have built valve amps and tested as reviewer the most precious amps from all over the world. I can compare, and consider this amplifier as one of my best top products. The main reasons are: so many details, such perfect translator of emotions, excellent very wide soundstage and most of all: so close to realism as I have seldom experienced. Hopefully you will join my opinion when you listen to this amplifier.

Literature and sources:

1) www.mennovanderveen.nl ; the project
2) www.aes.org ; paper 6347 Barcelona 2005
3) AudioXpress January 2006, pp. 6 - 19
4) Menno van der Veen: "High-End Buizenversterkers 2"; chapter 9
5) see 1) project 28: the challenge
6) see 1) project 8: VDV-GIT80
7) see 1) project 9: VDV-POW80
8) www.addonamp.eu (Personal Audio Concepts)
9) www.mennovanderveen.nl ; transformers
10) Questions: info@mennovanderveen.nl

figure 1: Audio schematics of the VDV PR20HE-S2
figure 2: Pin numbers of the ECC81 and the EL156/6550-C.
figure 3: Power supply

Foto-1a: VDV-PR20HE-S2 with the case of Personal Audio Concepts
Foto-1b-1c: different angels of foto-1a
Foto-2: bottom view VDV-PR20HE
Foto-3: power supply section
Foto-4: valve section

Figure-construct-1->11: details of the actual construction; please follow this step by step construction to prevent sequence conflicts.