Easy to Build Push-Pull Amplifier using Plitron Output and Power Transformers with Vanderveen Design Circuit Board (With a comment on Negative Feedback)

By Menno van der Veen

In my book "Transformers and Tubes" there is a detailed description about the construction of special tube amplifiers with toroidal transformers (both output and power). Amplifiers are described with output powers ranging from 10 to 100 Watt.

Two of these designs, the 70 Watt and 100 Watt amplifiers with 4 x EL34 power tubes, can be build using a special PCB that I have designed. This is the ideal starting point for any one who intends to build his/her own tube amplifier.

All components are placed on a nice single PCB, including tubes, rectifier section, pre amplifier and driver sections, trim pots for the quiescent current of the power tubes, and so on. Only the power and output transformers are mounted outside this PCB and their wires can be easily connected directly to the soldering points on the PCB.

This construction makes it extremely simple to build an attractive, high performance tube amplifier. For complete support and explanation of all the specialities of this design, you should obtain and read the book "Transformers and Tubes" available from Plitron.

Following is a short introduction in the specialities of the BBB70100 design, while the following pages show all the details of the schematics, component lay outs plus several hints for the optimal construction of this special amplifier.

This special tube amp design is based on the concept that "using as fes components as possible" always will give the nicest sound quality. "Keep it simple! but dot compromise on sound quality" was my guide line in this design.

It is not difficult to design very complex amplifiers, but the possibility increases that something will go wrong if the DIY-er might make a very small mistake. Therefore, the simpler, the better.

Here are some highlights of the circuit. Use of one tube for the pre-amp and driver section, directly followed by four tubes in a push-pull configuration. And no feedback: keep your hands off the precious audio signal! The design is constructed in such a way that the internal distortion is low. The frequency bandwidth is large due to the ultra wide bandwidth toroidal output transformer. In such a concept, every component should be of excellent quality, selected for optimal sound reproduction.

In designing the PCB, I considered all the currents, signal voltages, mutual influence of components, and PCB traces. This examination resulted in a unique "LEP" -PCB design. LEP means: "Logistic Earth Patterns." That means "the PCB should behave as if no PCB is present at all; as if the components are placed in the air, directly between soldering points." In this short introduction I shall not explain how LEP works, read my book, but I am sure that when you buy this PCB, that you will recognise the careful lay-out and placement of components. It all results in an easy to build (and to repair, and to modify) amplifier.

In my book, I explain how to change an amp from Pentode push-pull, into an Ultra Linear design and even into a Triode push-pull design. The only thing you have to do is to replace some transformer connections. This PCB makes all those changes extremely easy, just some minutes soldering and the job is done. And what about the tuning of the design, the balancing of currents and so on? Each Power tube has its own trim pot for the trimming of the quiescent current. You only need a digital multimeter to do the trimming correctly.

What about the sound quality and characteristics? The bandwidth of the design is very large, surpassing 100 kHz without the need for any (nasty) negative feedback. See my comments on negative feedback below!

At the low frequency side the large inductance of the output transformer delivers an undistorted strong low frequency response. For more details read my study about low frequencies in OPTs in the Glass Audio reprints in this book. What is the result of all this? Clean, very clean and warm and friendly sound, with lots of power, lots of details and a very open sound stage. That's what I was looking for when designing this amplifier. And I believe it is successful.

There is one performance factor of this amplifier that could present a problem with certain loudspeakers: low damping factor. Also, electrostatic loudspeakers do not work well with this design. The damping factor of this amplifier is low due to the absence of negative feedback.. Damping factor determines how well an amplifier controls the loudspeaker, which is most important at low frequencies. Transistor amps normally have damping factors larger than 50 and even numbers of 1000 are not uncommon. This BBB70100 amp however has a damping factor in the environment of .5 (UL-mode) or 2 (Triode mode). The amplifier does NOT control the loudspeaker and not every loudspeaker is happy with that! In general, high efficiency loudspeakers like horns or Lowther design, with efficiencies up to 100 dB/W,m, don't need any control and damping of the amplifier. But standard loudspeakers with efficiencies below 88 dB/W,m totally rely on the damping of the amplifier. I use 90 dB/W,m loudspeakers which are low frequency critically damped and easily can handle amplifiers with low damping factors. In the Netherlands, I did a lot of testing with a lot of brands, and concluded that when speakers with efficiencies equal or larger than 90 dB/W are used, the marriage between my amp and the speakers is a happy one. What I am saying is this: in the mid-range and high-range, no problems are to be expected. In the low range, depending on your speakers, the damping of the bass sounds could be too weak. How to find out before buying any stuff from us? Please borrow a tube amp from a good friend: most tube amps have low damping. Test the low frequency response with your speakers; no problems, well then you have a good speaker which can live with a low damping amplifier. If the bass is inadequate, a tube amplifier may not be suitable for use with those loudspeakers. If you have your heart set on this tube amplifier, and want to keep those speakers, then follow the guidelines in my book how to implement negative feedback. But remember, it is not the first choice!

How does this amp behave with electrostatic loudspeakers? Don't! The low damping factor ESL's and this amp makes this an uncomfortable marriage.

You might ask me: “Why did you design such an amp with such a low damping factor? Make the damping factor higher, and then the amp can be used everywhere”. So right you are. But I had good reasons. It has to do with the use of negative feedback. When you apply negative feedback, you lose much musical information and character. The sense of space , the ease of reproduction, its natural character are reduced. I did not want to lose such very important characters of the sound. Therefore I decided to design for natural quality, needing for a search for an optimal marriage between speakers and amplifier, however gaining so much in true sound quality, that the higher damping with extra NFB, right from the start was not acceptable.

Let me conclude with this: as guitar player my ears listen to natural sounds and exactly that is what I am looking for when designing amps. Are you searching for the same?

The Netherlands, July 1999, Menno van der Veen

Specifications:

	BBB70	BBB100
Tubes	4 x EL34, ECC82	4 x EL34, ECC82
power transformer	654708	754709
output transformer	PAT-4004	PAT-4006
quiescent current per EL34	60 mA	50 mA
output Power	70 W Pentode	100 W Pentode
	57 W Ultra Lin	93 W Ultra Lin
	27 W Triode	46 W Triode
Optimal Loudspeaker impedance	5 ohm	5 ohm
output impedance (Ultra Lin)	7.1 ohm	9.8 ohm
hum and noise	< 5 mV_{pp}	< 5 mV_{pp}
input sensitivity	1.6 V_{rms}	1.7 V_{rms}
input impedance	100 k ohms	100 k ohms
-3dB frequency range	24 Hz – 140 kHz	24 Hz – 140 kHz
-3dB power bandwidth	25 Hz – 120 kHz	24 Hz – 120 kHz
stability	unconditional	unconditional
optimal loudspeaker efficiency	>90 dB/W,m	> 90 dB/W,m

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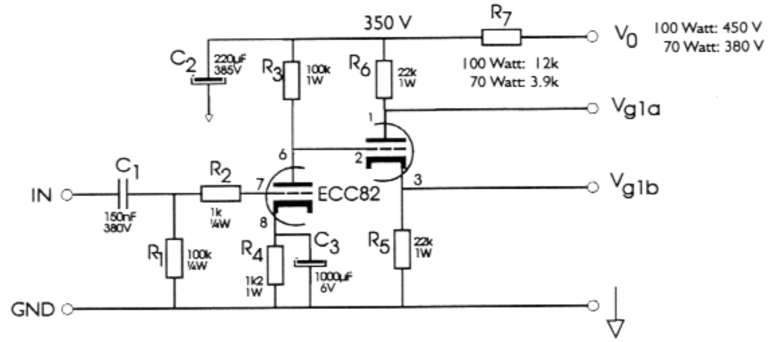
Component List 70 & 100 Watt Tube Amplifiers

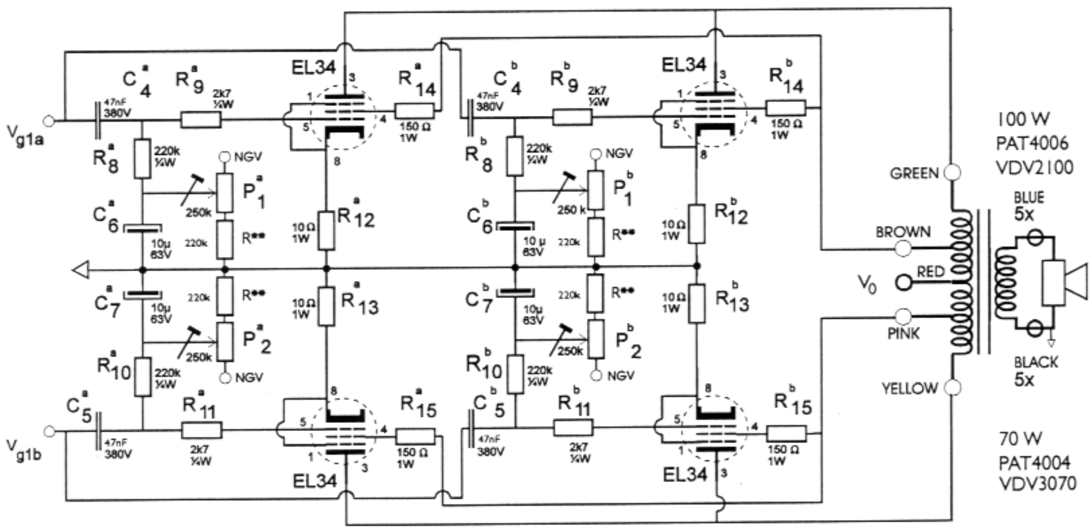
(ref. "Transformers and Tubes in Power Amplifiers" by Menno van der Veen)

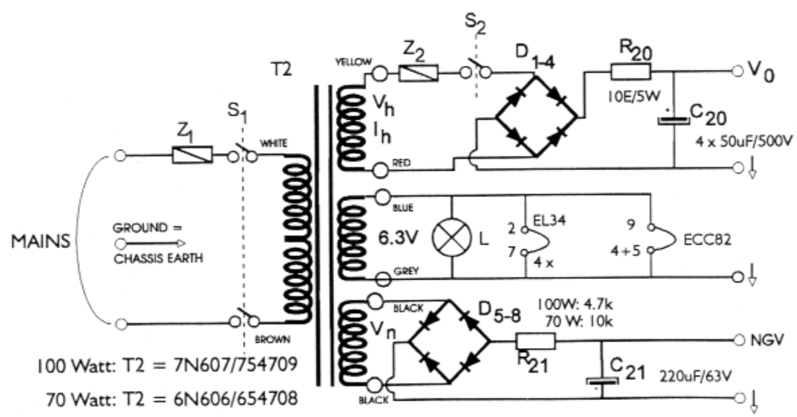
No.	70 W Amp	100 W Amp
R1	100 k	100 k
R2	1 k	1 k
R3	100 k	100 k
R4	1,2 k	1,2 k
R5	22 k	22 k
R6	22 k	22 k
R7	3,9 k	12 k
R8	220 k 2x	220 k 2x
R9	2,7 k 2x	2,7 k 2x
R10	220 k 2x	220 k 2x
R11	2,7 k 2x	2,7 k 2x
R12	10 Ω 2x	10 Ω 2x
R13	10 Ω 2x	10 Ω 2x
R14	150 Ω 2x	150 Ω 2x
R15	150 Ω 2x	150 Ω 2x
R**	220 k 4x	220 k 4x
R20	10 Ω 5 W	10 Ω 5 W
R21	10 k	4,7 k
P1,2	250 k pot. 4x	250 k pot. 4x
C1	100 nF/630 V	100 nF/630 V
C2	220 µF/385 V	220 µF/385 V
C3	1000 µF/6 V	1000 µF/6 V
C4	47 nF/630 V 2x	47 nF/630 V 2x
C5	47 nF/630 V 2x	47 nF/630 V 2x
C6	10 µF/63 V 2x	10 µF/63 V 2x
C7	10 µF/63 V 2x	10 µF/63 V 2x
C20	50 µF/500 V 4x	50 µF/500 V 4x
C21	220 µF 63 V	220 µF 63 V
D1-4	1N4007 4x	1N4007 4x
D5-8	B80C100	B80C100
T1	PAT-4004	PAT-4006
T2	654708	754709
No.	70 W Amp	100 W Amp
40 V	BLK/BLK =	BLK/BLK =
NRS	GRN/VIO (3)	GRN/VIO (3)
B1	ECC82/12AU7	ECC82/12AU7
B2-5	EL34/6CA7	EL34/6CA7
PCB	VDV-BBB70100	VDV-BBB70100
Z1	fuse 1A slow	fuse 1,6A slow
Z2	fuse 1A slow	fuse 1A slow

Remarks:

1) All resistors are 1W (Beyschlag) except R20.
2) The drawing shows the dutch type numbers. the VDV3070 is the PAT4004 while VDV2100 = PAT4006. The power supply transformer 6N606 is the Plitron 654708 and the 7N607 = Plitron 754709.
3) The indicated colours of the wires to the transformers are identical except th 40 V winding: BLK/BLK (Dutch) = GRN/VIO (Plitron).
4) The 8 pin octal tube socket is ceramic with silver plated contacts, PCB mount (1" pin circle dia.) like 55294 on page 28 "The Parts Connection Catalog 2". The 9 pin noval tube sicket has a 13/16" dia. See numbers 54965 or 52640 or 56006 on page 28.
5) C1, 4, 5 are Siemens tpe B32231. C2 is Philips 05738221 or 05758221. P1, 2 are 10mm Piher.
6) Place R7 and R20 5mm above the PCB (heat!).
7) In this design the supply voltage at the phase-splitter is set at 350V. This explains the values of R7.
8) Ground the PCB with an M3 screw and a 10mm metal spacer to case on the indicated "M3 = chassis ground" position of the PCB. Use isolated 10mm spacers on the other four M3-holes. Ground the BLK speaker output wire to case, don't ground the input.
9) **Start-up procedure:** remove Z2 and control filement glowing. Turn trimpots P1,2 completely anti-clockwise. The voltage between ground and control grids should be -42 to -50 V (measure on R9,11). Switch the power off and place fuse Z2. Switch the supply on and measure over the cathode resistors R12,13 0, 60 V (70W-Amp) or 0,50 V (100W-Amp). Slowly readjust these voltages with P1,2 and repeat.
10) This design complies with the following figures from the book "Transformers and Tubes in Power Amplifiers": 5-4, 6-6 or 6-7, 6-9 and 9-5.
11) **Follow all safety rules at all times** as mentioned in chapter 6-12 of "Transformers and Tubes in Power Amplifiers". This design is part of the "**Limits of Liabilitly and Disclaimer Warranty**", as mentioned on the first page of this book.
12) Fax: 31-38-4533178; e-mail: mennovdv@noord.bart.nl







100 Watt: T2 = 7N607/754709

70 Watt: T2 = 6N606/654708

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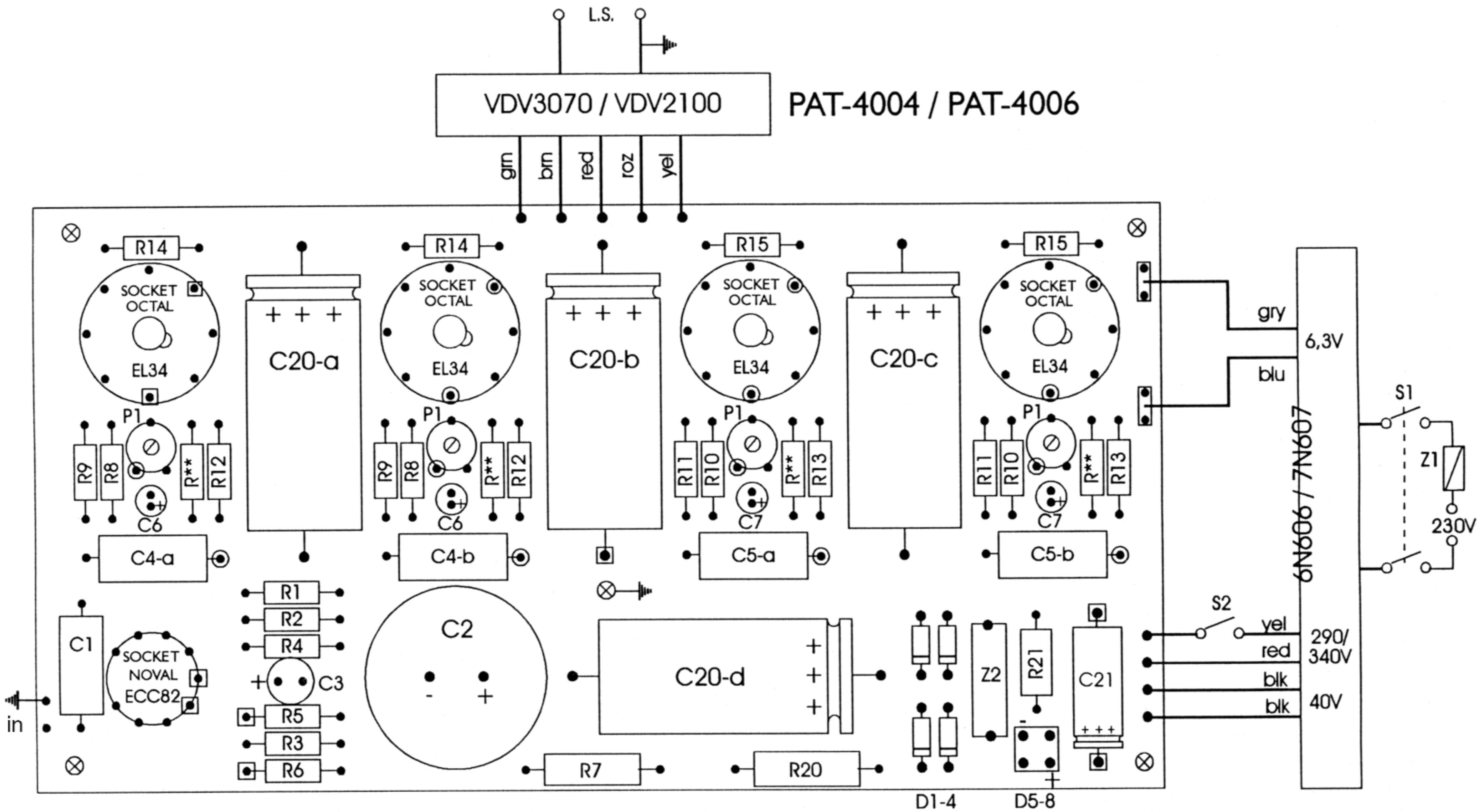

SOLDER ON:
- Solder Layer
- Component Layer
- Both sides