PRINCESS

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Part 2

High Power Single Ended Amplifier

Small clarifications

In the process of setting up several boards, of course, minor troubles surfaced. Well, that's all they were eliminated with little bloodshed. Below I will give fragments of schemes *(changed and added elements are highlighted in color),* in which changes were made, and I will give short explanations. In the output stage, the stabilization circuit was slightly modified.

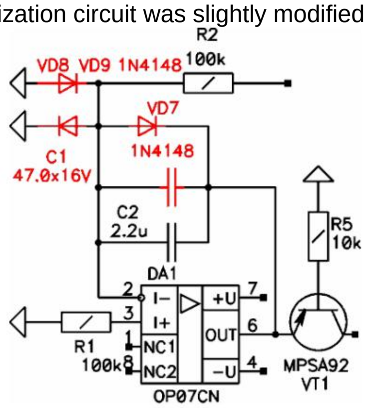

Figure 7

zero (Figure 7). To completely eliminate the influence of this circuit on the sound in the low frequency region (15÷20Hz), the time constant was increased by an order of magnitude. A diode was added to reduce the transient time VD7. Changing the ratio of the time constants of the stabilization circuit when led to a change in the duration and nature of the transient process, as a result, when the amplifier was turned on, a rather large ejection. This required a change in the acoustics connection delay scheme. In addition, connecting the output autotransformer after the end of the transient at the output significantly reduces the stress load on the power supply of the output stage. The new version of the delay system is shown in Figure 8. In fact, the delay has become two-stage. The first stage (DA1) works as before. triggered

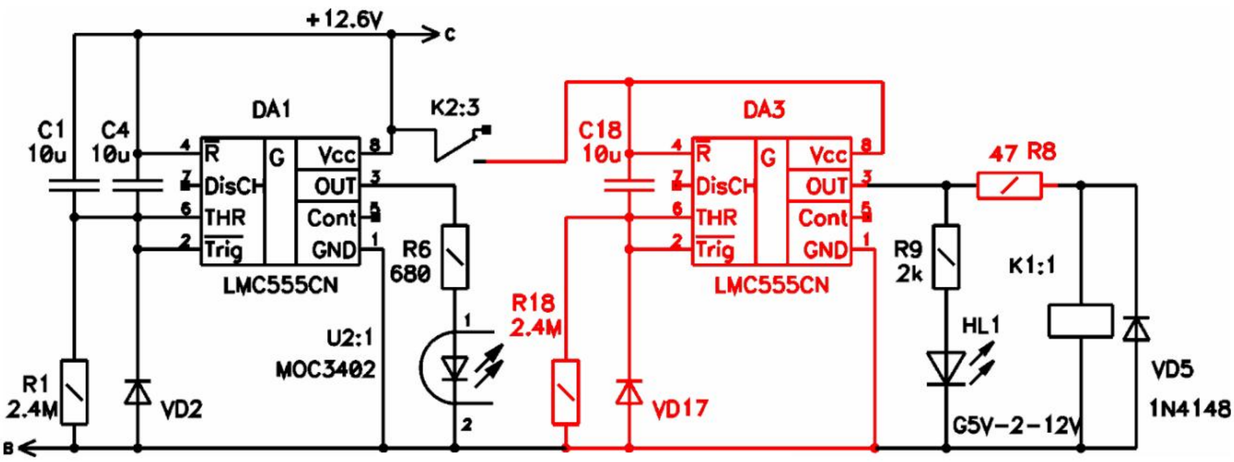

Figure 8

The first stage feeds the supply voltage to the output stage and to the second delay stage (DA3), which, after the end of the delay, connects the load.

Amplifier parameters

Maximum output power Rated output power
Sensitivity Input impedance Rated load
impedance Output impedance Noise level
(not weighted) Harmonic distortion

30W
25W
ÿ 170mV
47kOhm
8 Ohm
ÿ1 Ohm
-91dB

25W
10W
1W

3.3%
2.1%
0.6%

Power band Bandwidth
(max) Channel mismatch (max) Supply voltage
Power consumption (max) Dimensions Weight

20Hz÷100kHz
1.5 dB 0.2 dB
220 V ±10%
550 WA
330x400x480 mm
29 kg

The objective parameters of the amplifier are measured at nominal supply voltage and at nominal active load resistance. Dependences of the level of non-linear distortion (THD) and the level of individual harmonics on the output power shown in figures 9 and 10, respectively.

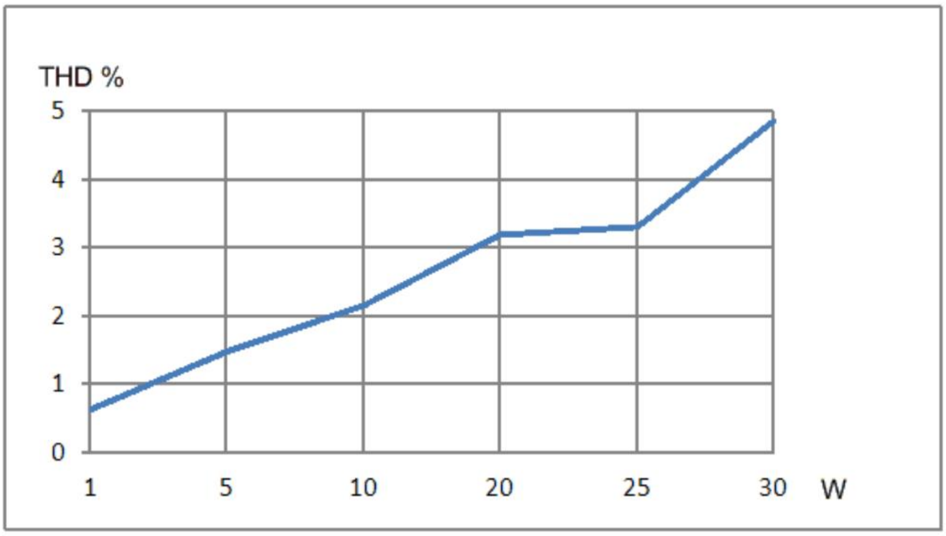

Figure 9

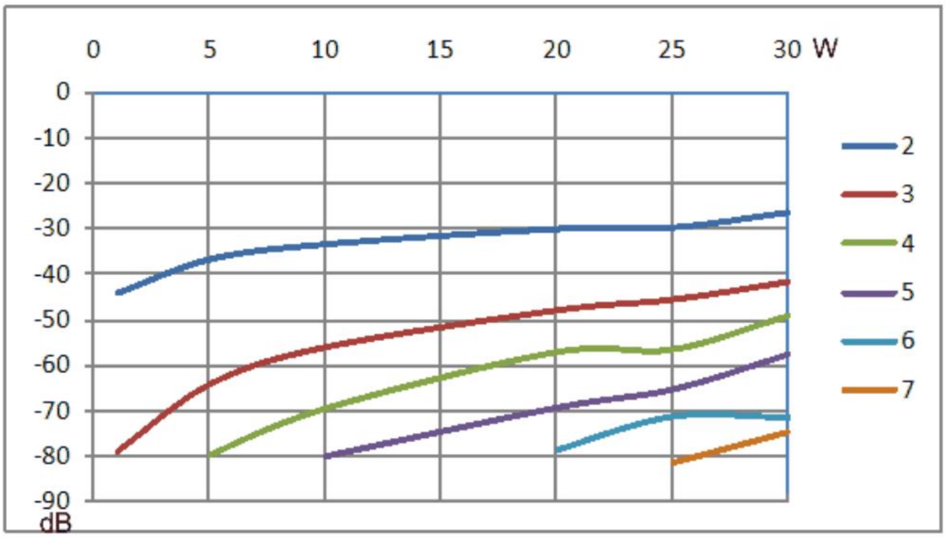

Figure 10

To evaluate the nature of the distortion introduced by the amplifier, below are the spectrograms of the output signal at output power levels of 1, 10 and 25 watts (Figures 11÷13).

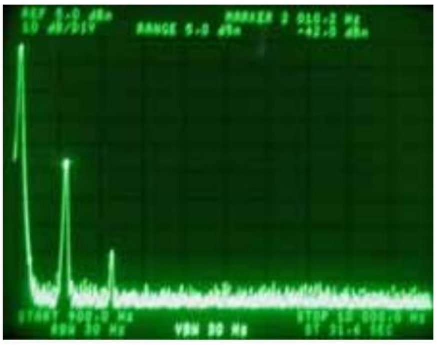

Figure 11

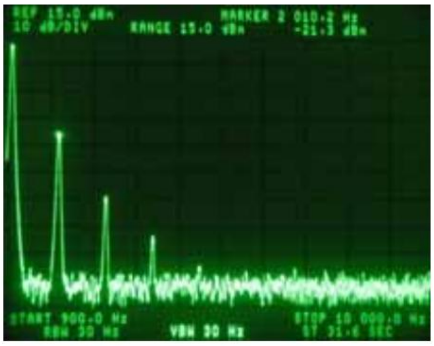

Figure 12

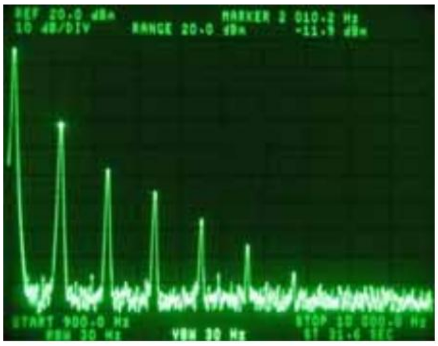

Figure 13

It should be noted that the amplifier introduces distortions that are characteristic of single-ended cascades on vacuum triodes. Compared to Cinderella, the rate of decline in the level of harmonic distortion turned out to be even somewhat faster, and with a shorter "tail". Subjectively, this amplifier sounds noticeably better and more dynamic, both due to better frequency and transient response, and due to large power reserve. From a formal point of view, this amplifier is up to the HI-FI level, oh, how far, but what is interesting, according to the subjective perception of music, 95% of the amplifiers belonging to this class are not suitable for the Princess.

Amplifier design

The design of the amplifier was chosen somewhat unusual, this is a floor-standing design without pretensions. for a special decorative effect (strictly and not conspicuously). Firstly, the amplifier is designed to play music, not to decorate the interior, so the issues of optimal layout, cooling, convenience and safety of operation were put at the forefront. Secondly, the amplifier has a lot of weight, and not every bedside table can withstand it. Thirdly, the amplifier emits a lot of heat and must be freely flowed around by air from all sides. As already mentioned, all components of one channel are placed on one board. It was originally assumed

horizontal placement of the board in the case, but for a number of reasons the layout had to be changed, and "Princess" has become taller and thicker. The large dimensions of the case are mainly determined by the need for effective cooling of the components. As previous experience has shown, it is not very good to leave exposed components that have a high temperature (the temperature of the bulb of the output lamp reaches 250 ° C, coolers - 70 ÷ 80 ° C), especially if there are small children. And, despite my lengthy calculations of thermal regimes, I still made a little mistake. The maximum calculated temperature of the cooler should not exceed 70°C, it actually turned out to be 80°C.

straight miss. The temperature of the lid rose above 100C °, as a result, the "Princess" acquired two ultra-quiet propellers (I recommend Noctua, NF-S series). Even being next to the amplifier, they are not audible, and this solved all the problems with thermal conditions. The amplifier case is conditionally divided into three zones (Fig. 14, 15).

Figure 14

Figure 15

Power transformers and mains filter elements are located in the lower part, the middle part The housing is divided by a longitudinal partition, on which the channel boards and output transformers are placed on the left and right. A massive baffle shields the channels from each other and serves as a stiffening rib for the case. The heat stabilizer transistor cooler is also located at the bottom and has no electrical contact with the case. The stabilizer transistors are also installed through insulating gaskets. Double insulation allows the amplifier to be used without a ground connection. Mounted on the rear panel

two terminals, one of them is connected to the body of the amplifier (at the connection point of the grounds of the channels and screens power transformers), and the second - to the ground wire of the power cord. If necessary, depending on the interference situation, the terminals are connected with a jumper.

Power regulator transistor coolers and output stage transistor cooler raised to the board level. This reduces the length of the connecting wires and ensures free air flow around the coolers. Propellers (not shown in the figures) are installed approximately under the output lamps at a height (from the pallet) of 35÷40mm. What the amplifier looks like with coolers installed and with the lid closed is shown in Figures 16 and 17.

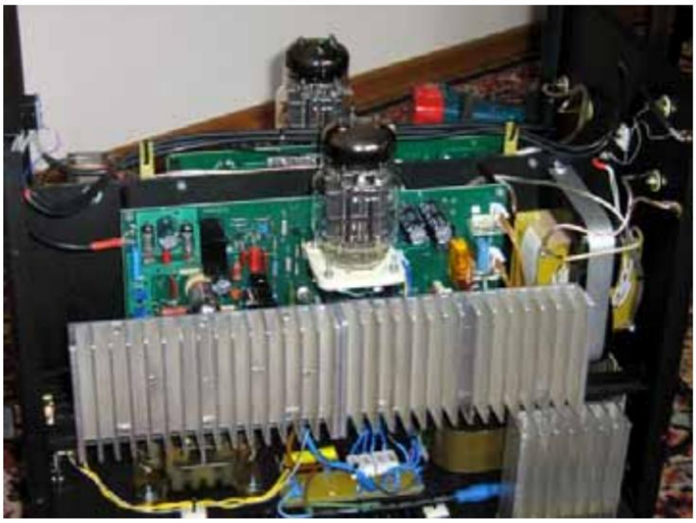

Figure 16

Figure 17

Such a design is completely optional, but when designing your own version, you should pay attention to special attention to the cooling of the elements.

transformers

Both power transformers operate with reduced inductance. The overall power of the filament transformer is chosen somewhat larger than necessary, this is due to a large number of windings and, accordingly, a low fill factor. Used for filament transformer
core and fittings from the industrial transformer OSM1-0.25 (table 1), and for the transformer
The power source uses a core and fittings from the OSM1-0.63 transformer (Table 2). Transformers are wound in the usual way. For interlayer insulation (for thin wire), 0.03mm thick capacitor paper is used, for interwinding insulation, PET-E film with a thickness of
0.1mm. To isolate the network winding from the screen, it is necessary to put three layers of film. cores transformers are glued together with an epoxy compound with low magnetic resistance, and the transformers are impregnated with ML-92 varnish, followed by drying at a temperature of 120°C. Winding - ordinary, the windings are wound in the same order as they are listed in the table. Table 1 Winding Number of turns W1 440 Screen 1 W2 870 W3 64 W4 870 W5 64 W6 13 W61 13 W7 13 W71 13 W8 13 W81 13 W9 13 W91 13

		Wire	Voltage (Volt) ÿ 180	Note
		PEV-2 Ø 0.72mm		
		Copper foil PEV-2		Thickness - 0.1 - 0.15 mm
		Ø 0.17mm PEV-2	390	
		Ø 0.19mm PEV-2	29	
		Ø 0.17mm PEV-2	390	
		Ø 0.19mm PEV-2	29	
		Ø 1.2mm PEV-2	5.8	Windings W6, W7 are wound simultaneously (in two wires)
		Ø 1.0mm PEV-2	5.8	
		Ø 1.2 mm PEV-2	5.8	
		Ø 1.0mm PEV-2	5.8	
		Ø 1.2mm PEV-2	5.8	Windings W8, W9 are wound simultaneously (in two wires)
		Ø 1.0mm PEV-2	5.8	
		Ø 1.2mm PEV-2	5.8	
		Ø 1.0mm	5.8	

The winding of the filament transformer must be done very carefully, otherwise there is a chance that the windings will not fit in the window. Close attention should be paid to the quality of the joining of the halves of the magnetic circuits. and be sure to check the no-load current of the transformers before impregnation.

The output transformer is wound on a W-shaped core, made up of two magnetic cores.
water pipes PLM22x32x58 from steel 3414 (tape thickness 0.35mm). Winding W1:1 consists of 9 sections of 64 turns wound with PET-155 wire Ø 0754mm. Sections are connected in series according to.

Table 2

Winding	Number of turns	Wire	Voltage (Volt) 220	Note
W1 390	Screen 1	PEV-2 Ø 1.2mm		
		Copper foil PEV-2		Thickness - 0.1 - 0.15 mm
W2 310+310		Ø 0.64mm PEV-2	174+174	Withdrawal from the middle
W3 310+310		Ø 0.64mm	174+174	Withdrawal from the middle

Winding sections W1:2 are wound between winding sections W1:1 (eight sections). Each section contains 27 turns of PEV-2 wire Ø 0.86mm. Sections are connected in series according to. Winding parts W1:1 and W1:2 are also connected in series according to. For the convenience of switching sections, it is advisable to carry out winding so that the end of one section is near the beginning of the next (on a coil with a snake). The frame of the coil is made of fiberglass with a thickness of 1mm. Section winding ordinary, intersectional insulation - one layer of PET-E film with a thickness of 0.1mm. The total number of turns of the winding of the autotransformer is 576 + 216. The halves of the magnetic cores are glued together with a compound, but the transformer is not impregnated. The transformer is attached to the chassis with a clamp made of a steel strip 0.5÷0.8 mm thick.

Amplifier setup

Adjustment of the amplifier is carried out in several stages. In general, if there are no errors in the installation, serviceable parts are used, the installation is done correctly - the nodes start working immediately, and only adjustment of the modes is required. But we should not forget that the amplifier uses a lot of semiconductor components, and any installation error, negligence and haste - can very quickly and for a long time ruin your mood. When setting up the amplifier, it is imperative to use LATR, the first switching on of any node or part of the circuit is carried out with a smooth rise in the supply voltage. And small recommendation: when working with one channel, it is advisable to remove all anode voltages from the second (even if the channel is configured) ***Stage 1*** voltage

offset. They check the presence and magnitude of the heating voltage (resistor R6, part 1 of Fig. 3), the presence and magnitude of the negative bias voltage (permissible deviation - ± 20%). Set the preliminary value of the bias voltage (resistors R3 and R9, part 1, Fig. 2). Check system operation delays.

They are connected to the second channel of the filament and bias winding amplifier and check the filament voltage, the presence and value of the negative bias voltage, set the preliminary offset voltage value. ***Stage 2*** The winding of the anode power supply of

the driver is connected to the leading channel. Check the value of the output voltages of the anode voltage stabilizers and finally set the operating mode of the lamps VL1, VL3 (part 1, Fig. 2). Connect the anode power winding of the driver to the second channel and repeat the operations described above. **The windings of the anode power supply of the driver are disconnected from both channels.**

Stage 3

Bypassing the delay circuit, LATR is connected to the mains winding of the power supply transformer, both output lamps are removed, and the output winding of the power supply transformer is connected to the leading channel. Check the performance, the absence of self-excitation and adjust the value output voltage (resistors R3 and R11, part 1, Fig. 5) power supply stabilizers (permissible deviation - +0÷ -3%). Repeat this operation for the second channel. **Turn off the windings of the anode power from both channels.**

Stage 4

Both output lamps are inserted, the VL3 anode is shorted to a common wire with a jumper. **Turn off the output autotransformers.** The output winding of the power supply transformer is connected to the leading channel, the mains voltage is applied to the filament stabilizer. After warming up the cathode of the output lamp, the anode voltage of the output stage is gradually increased, while simultaneously controlling it quiescent current. If the quiescent current does not exceed the required one, check the absence of self-excitation and the absence of voltage at the output of the cascade (allowable value - 5÷10mV). Next, let the thermal modes of the elements settle (15÷20 minutes) and set the required quiescent current (resistor R12, part 1,

Fig.1). If the quiescent current immediately exceeds the desired value, increase the value of R12 and repeat all first. A similar operation is repeated for the second channel. ***Stage 5***

Remove jumpers, restore all connections, according to the diagram, connect all sources power supply in normal mode. The generator is connected to the input of the amplifier, and the rated load is connected to the output. Turn on the amplifier and let it warm up for 15-20 minutes. Set the value of the current feedback by the minimum level of harmonics at rated power (resistor R20, part 1, Fig. 1). Of course, it is desirable to use a spectrum analyzer, a more affordable option is to obtain a minimum signal distortion when monitoring the signal with an oscilloscope with fine tuning by ear. Check the balance of the amplifier channels and its frequency response. In order not to have problems with channel balancing, it is advisable to select paired channels before starting installation.

lamps into channels (at least in terms of gain) and paired components that can affect transfer coefficient.

Conclusion

Those who dare to repeat this design should keep two things in mind: the first is the supply scheme. definitely complex, and secondly, the cost of the amplifier turns out to be quite high. Although, if you feel enough strength in yourself, and there is an itch in your hands, then good work.