

OPENAMP1

Assembly instructions and manual

1. Introduction

OPENAMP1 is a preamplifier for MM phono cartridge.

It uses operational amplifiers, a monolithic buffer and a feedback RIAA correction.

DC servo is used to remove DC voltage from the output.

Output stage/buffer of the OPANAMP1 works at 20mA idle current. It remains in class A for all amplitudes of output voltage for loads 600 ohm and more.

High quality parts are recommended in the bill of materials. This applies especially for operational amplifiers and polypropylene capacitors for feedback correction.

2. Circuit design

Schematics may be found in appended drawings „openamp1“.

Let us speak about left channel only, the right channel is identical and its part numbers are same as in the left channel +100.

X1 terminal block is an input of phono cartridge signal. It is followed by load resistor R1 (47k) and C1 capacitor, that may serve for optimization of cartridge capacitive load. Leave C1 unconnected, you may make experiments later. R2 and C2 are an input RF filter.

Input opamp IC1 is OPA627. To obtain lowest possible noise and lowest distortion, please keep this type, though it is expensive. Please buy OPA627 at reliable suppliers like Farnell. The possible substitute is OPA134, but results in higher noise and higher distortion. Leave C3 unconnected for both types of opamps.

IC1 is followed by IC2 buffer, LT1010CT type. The buffer is used for two reasons. It easily drives feedback capacitive network of 7,5nF resulting capacitance even at highest frequencies and steepest signals. It also increases immunity of output stage to different signal output cables and their length. Last, it enables to use low impedance feedback network, to obtain lowest noise.

RIAA correction circuit consists of R50 – R53 resistors and C51 – C54 capacitors. With R54 = 100 ohm, gain is 40dB at 1kHz.

DC servo circuit is in the sheet 2 of the schematics drawing. It is possible to use OP07, OP177 or OPA134 for the DC servo.

3. Assembly and setup instructions and comments

The PCB board is to be assembled by components listed in the BOM. The file „open1_parts.pdf“ can be downloaded from my website.

WAGO 255 terminal blocks can be replaced by screw terminal blocks with 5mm pin distance. For IC1, IC101, IC3 and IC103 one may use 8-pin sockets.

The preamplifier circuit works properly immediately after assembly, if proper (recommended) parts are used and no mistakes in soldering have been done. Without DC servo opamps, the DC output offset would be $< \pm 200\text{mV}$, with DC servo it should fall below $\pm 1\text{mV}$. There is no need to adjust anything in the preamplifier.

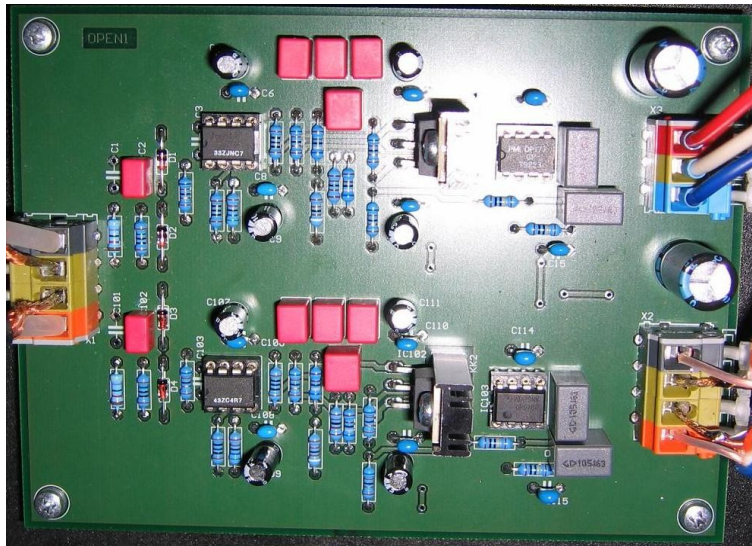
4. Further comments

Heatsinks (KK1 – KK2)

Heatsinks used for LT1010CT buffers are SK 95 25 2 x M3 type, supplied by Fischer Elektronik. It is not absolutely necessary to use this type, but it is an optimum for mechanical fixing.

LT1010CT buffers (Linear Technology)

Recommended supplier of LT1010CT is Farnell. The buffers are in TO220-5 package (5-pins). They are supplied with both straight pins or bended 1, 3, 5 pins. The PCB is prepared for the package with bended pins. Please use pliers to bend pins no. 1, 3, 5 if they were supplied straight. One can see the bended pins in the photo below.



Power supply

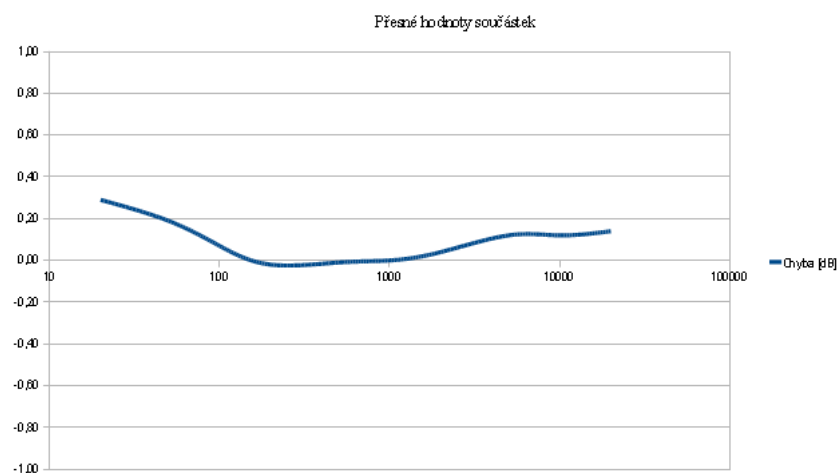
The preamplifier should be supplied from 2 x 15V to 2 x 18V regulated power supply. The ZT15VA power supply (please visit my webpage) set at 2x17V is suitable for this preamplifier. Or you can use any regulated power supply within

recommended voltage range that is capable to deliver at least 2 x 100mA output current.

To obtain the best possible signal to noise ratio, it is absolutely necessary to place preamplifier board as far from power supply board as possible. Or use external power supply. One of the possibilities is to use 19" case, 1U, 280mm deep. Place the preamplifier board near to right side panel and power supply near to left side panel. The transformer should be as far from preamplifier board input terminals as possible.

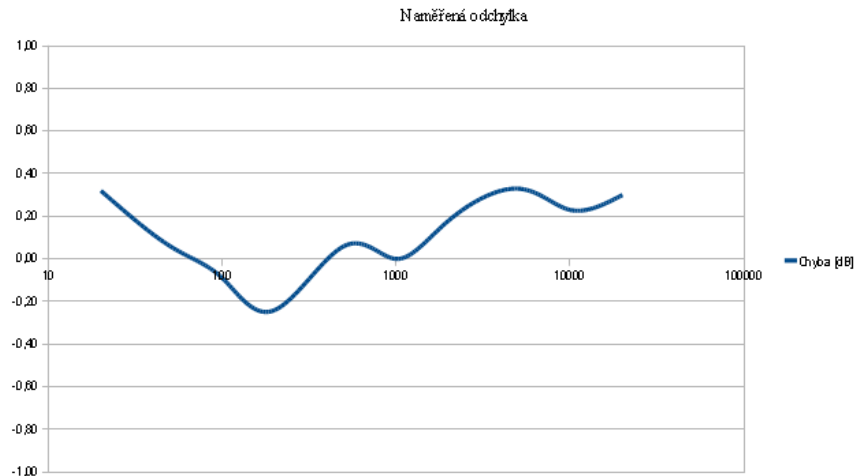
Parts for correction circuit

Feedback correction circuit is constituted by R50 – R53 and C51 – C54, with R54 as a low side feedback resistor. All the capacitors are 10nF, polypropylene. Resistors are 91k, 6k8, 1k1 and 100R, 1%, metalized. With absolutely precise component values, the deviation from RIAA curve is as follows:



RIAA error with precise component values

With parts directly from the supplier, no additional selection for precise values, I measured the following deviation:



measured error with parts directly from supplier, no additional choice

Description of terminal block's pins and signals

Input

- X1-4 left channel (live)
- X1-3 left channel ground (shield)
- X1-2 right channel ground (shield)
- X1-1 right channel (live)

Output

- X2-1 left channel out (live)
- X2-2 left channel out ground (shield)
- X2-3 right channel out ground (shield)
- X2-4 right channel out (live)

Supply

- X3-1 +15V
- X3-2 0V (ground)
- X3-3 -15V

Please avoid any possible ground loops inside the preamplifier case. Put the signal cables close to each other. Use **shielded** cables like RG-179. Never use unshielded cables. RCA-CINCH connectors must be isolated from metal case. Connect preamplifier PCB board analog ground with metal case in only one point, preferably at X1-3 or X1-2. Please make the preamplifier in class II, that means that metal case would not be connected with PE. **Provide the case with socket connected with PCB analog ground.** You will connect a cartridge/turtable grounding wire to this socket.

5. Specifications

Signal/noise	>90dB/5mV (re input), over 20Hz-20kHz unweighted
Harmonic distortion	<0,002%, 20Hz – 20kHz, 1V
Output voltage swing	max. 30Vp-p at 2 x 17V supply voltage
Gain	40dB/1kHz (100x)
Accuracy of RIAA correction	+/-0,15dB, 20Hz – 20kHz (viz text)
Input impedance	47k
Output impedance	51 ohm

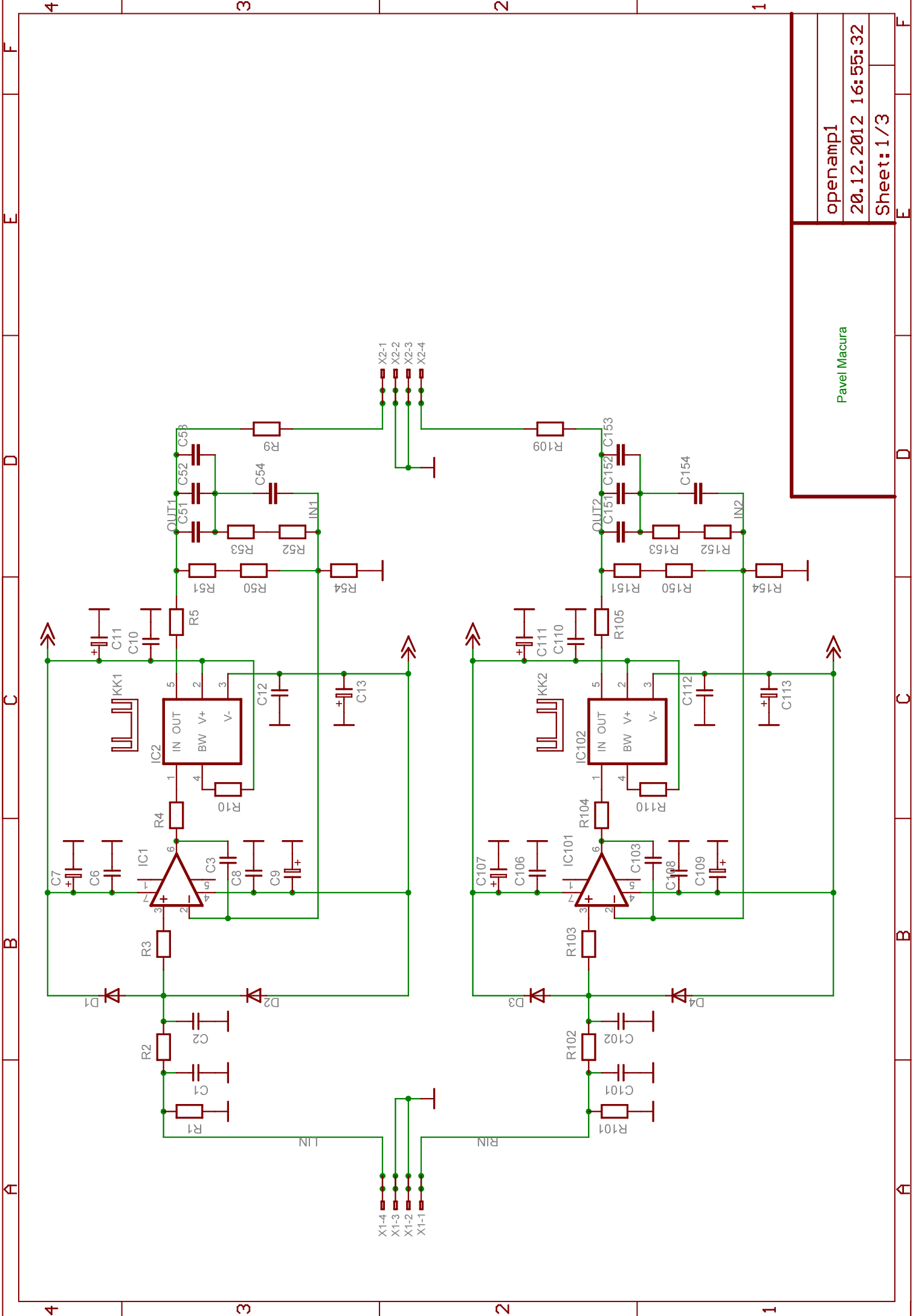
The parameters are valid in case of original PCB, recommended parts and fulfillment of design directions described here.

6. Headphones

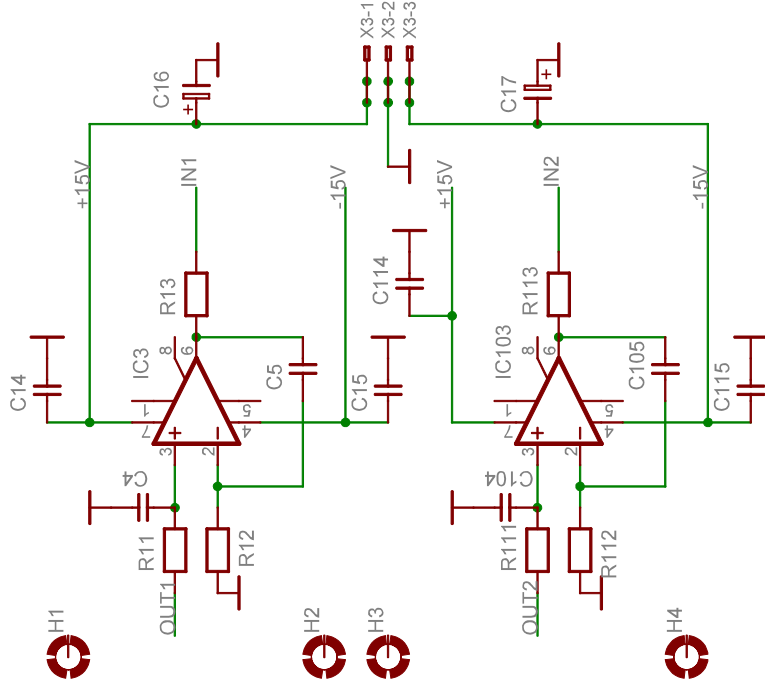
Output is capable to drive 50 ohm load, with 9.3Vp-p voltage swing at 2 x 17V supply voltage. Thus, headphones may be connected to the output, preferably via 100 – 220 ohm potentiometer. The rise of distortion into 50 ohm load is minimal.

Literature:

[1] Jung, W.: Topology Considerations for RIAA Phono Preamplifiers. Presented at 67th AES Convention, 1980, Oct.31/Nov.3, New York.



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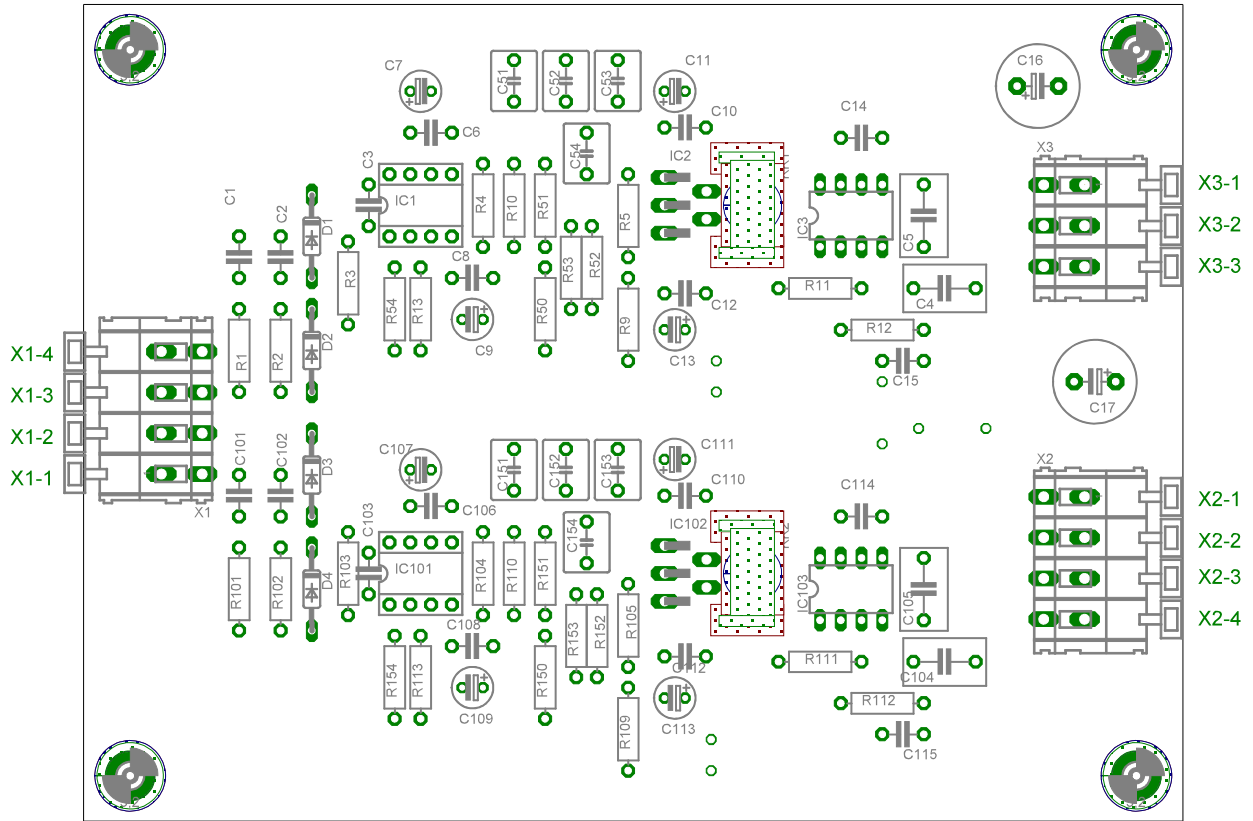


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