# Hi-Fi Phono Preamp (RIAA Equalisation)

**Rod Elliott - ESP (Original Design)**

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**Update - 15 Aug 2003 ...** For some unknown reason, some constructors have had difficulty sourcing the 82nF cap for the high frequency equalisation. There is an answer, and it actually improves the EQ accuracy (albeit marginally).

R8 (L&R) may be changed to 750 ohms (a standard E24 value), and C4 (L&R) changed to 100nF. If 750 ohms is not available from your supplier, use 2 x 1k5 resistors in parallel.

## Introduction

The phono preamp shown has an accurate RIAA equalisation curve, is very quiet, and offers far better sonic performance than the vast majority of those seen in magazines and application notes. Like most other ESP projects, it is very tolerant of opamps but the NE5532 dual op-amp is a good choice. This is a low noise, high speed device with excellent characteristics, and is inexpensive. It is ideally suited to this sort of application. Noise is extremely low, since any amplifier stage noise is rolled off above 2kHz with the passive filter. Another excellent opamp is the OPA2134, and these are used in my own units.

One factor often overlooked with phono preamps is the capacitive loading on the opamp output at high frequencies. This is all but eliminated in this design, and since the NE5532 and OPA2134 can both drive a 600 ohm load with ease, the 820 ohm output resistor isolates the output stage from any capacitive loading at all. The first stage has 10k in series with the cap, so capacitive loading is not an issue.

Note that if a moving-coil phono cartridge is to be used, a step-up transformer or ultra low-noise preamplifier circuit is needed before the phono preamp. This circuit is intended for use with the standard moving magnet type phono pickup.

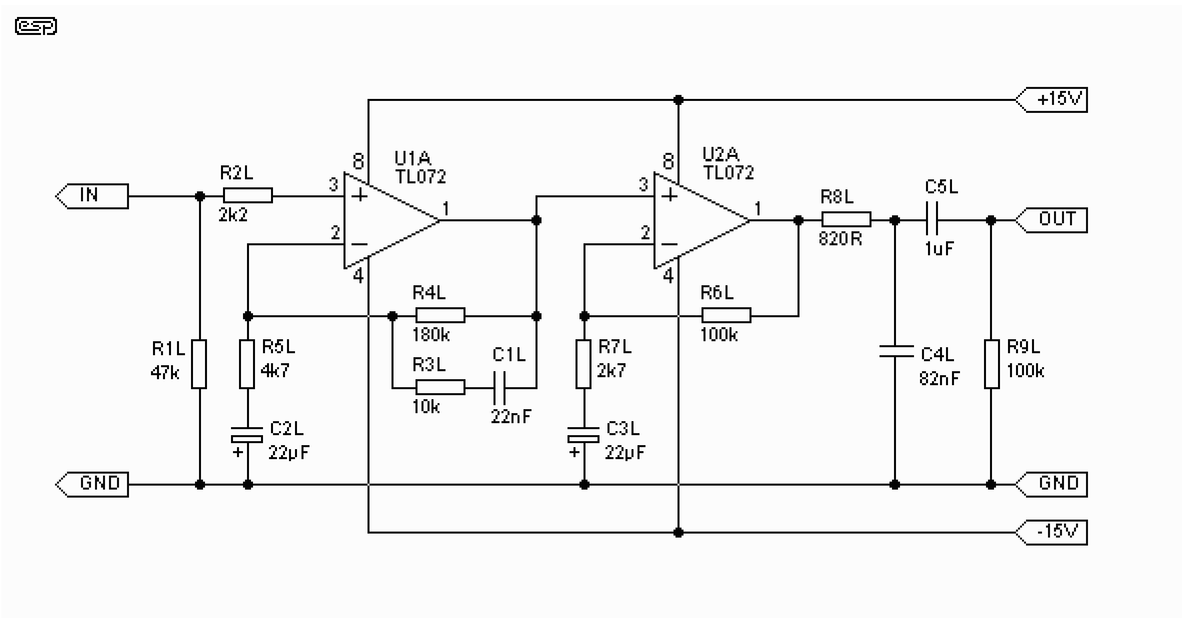


**Figure 1 - Phono Preamplifier (RIAA Equalisation)**

The high value capacitors should preferably be non-polarised electrolytic types, since they will have no DC voltage across them. However, these are quite large, and standard electrolytics or even tantalum capacitors may be used instead. Tantalum caps will function more or less normally without DC bias, but are one of my least favourite capacitor types.

The low value capacitors should be 2.5% tolerance if obtainable, otherwise you may be able to measure a selection of standard tolerance caps to find those which are closest to the required value. Some deviation from the ideal RIAA equalisation curve will occur if these caps are too far from the designated values. More important is matching between channels - this should be as accurate as possible.

Resistors (as always) should be 1% metal film for close tolerance and low noise. This design differs from most in that the low and high frequency equalisation are performed separately, with the LF being active and the HF passive. Because of the low value of the output resistor, a following stage input impedance down to 22k will cause little degradation of the EQ curve.

The customary "flattening" of the curve at 50Hz has not been fully incorporated, since many listeners found that the bass sounded far more natural without this. In this respect it can be said that accuracy is lacking, but I am still using this arrangement, and have not found rumble or other low frequency "noise" to be a problem.

Based on the RIAA specification, the table shows the performance with frequency - below 50Hz there is a marked deviation, and "accuracy" figures are not quoted.

Note that there is no provision for a "rumble" filter, and the circuit as shown has a low frequency -3dB point of about 3Hz. A low rumble turntable is essential - especially if you use a subwoofer. A well damped and isolated turntable platform is an excellent idea, and I have had great success with a large concrete paving slab, neatly covered with speaker carpet or other material, and isolated using foam rubber. Some experimentation will be needed to get this exactly right. Usually, good results will be obtained when the foam support is compressed to 70% of its normal thickness with the weight of the concrete slab and turntable.

| **Freq - Hz** | **Gain - dB** | **Ideal - dB** | **Error - dB** |
|---|---|---|---|
| 20 | 62.25 | N/A | N/A |
| 50 | 59.16 | 58.42 | 0.74 |
| 500 | 43.87 | 44.42 | -0.55 |
| 1000 | 41.42 | Reference | |
| 2100 | 38.88 | 38.42 | 0.46 |
| 21 k | 22.17 | 21.42 | 0.75 |

As can be seen from the table, accuracy is better than 1dB, and gain at 1kHz is about 40dB (100) so a nominal 5mV cartridge output will give 500mV output. This may be increased if necessary, by increasing the value of the 100k resistor in the second stage. Care is needed to ensure that the gain is not increased so far as to cause clipping of the signal - allowing for the worst possible case. As it stands, stage 2 has a gain of 38 (31dB).

If the 100k resistor were to be increased to 220k, the gain will be slightly more than doubled, at 38dB, so an input signal to stage 2 at 100mV (50mV phono cartridge output) above 1kHz stage 2 is on the verge of clipping. This is a highly unlikely possibility, due to the nature of music, since there are very few fundamental frequencies of any instrument (other than a synthesiser) above 1kHz, and most harmonics roll off naturally at approximately 3 to 6dB per octave above about 2kHz.

Only one channel is shown, the other channel uses the remaining half of each op-amp, the pinouts of which are shown on the diagram. Remember that the +ve supply connects to pin 8, and the -ve supply to pin 4.

Op-amps should be bypassed from each supply line to ground with a 10uF electrolytic and a 100nF polyester or ceramic capacitor to ensure stability.

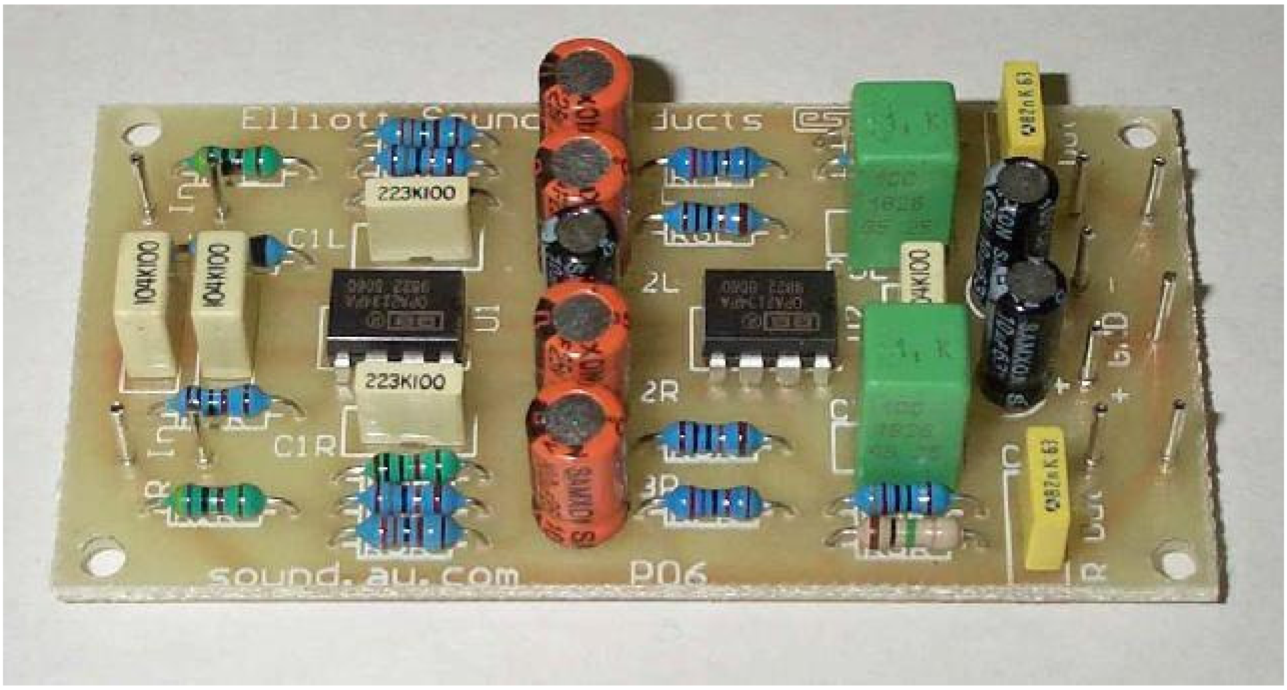


**Photo of Completed Unit**

The photograph above shows a complete phono preamp using the PCB. This is as shown in Figure 1. Click here to have a look at a reader's experience with this preamp (and some other stuff, too).

**Update 02 Oct 00**
From Tom Windelinckx ... I've adapted one of your projects, Project 06: the Phono Preamp with RIAA Equalisation. Since the amp it's going to be put in works on a single power supply, I adapted the preamp for a single power line. Another small thing I changed is the pinning of the opamps, for no particular reason - just seemed more logical, one dual opamp per channel.

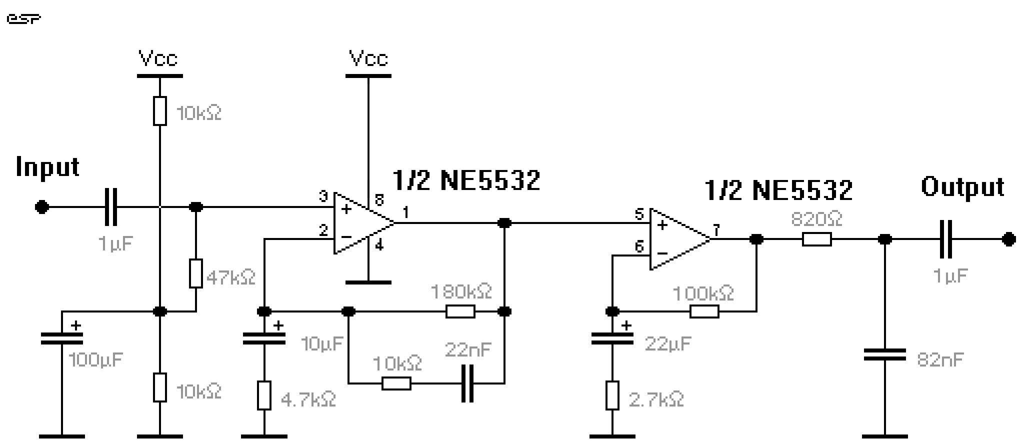


**Figure 2 - Single Supply Version (Modified Pinouts)**

Maybe it could be interesting for some who visit your site. So maybe you could add my version to your site? I could add it to mine, but since your site is more known and popular by far, I think it would be more useful to put it on yours.

> I have modified Tom's original circuit to simplify it slightly, and reduce the possibility of supply noise getting into the signal path. The amended drawing is shown. [ESP]