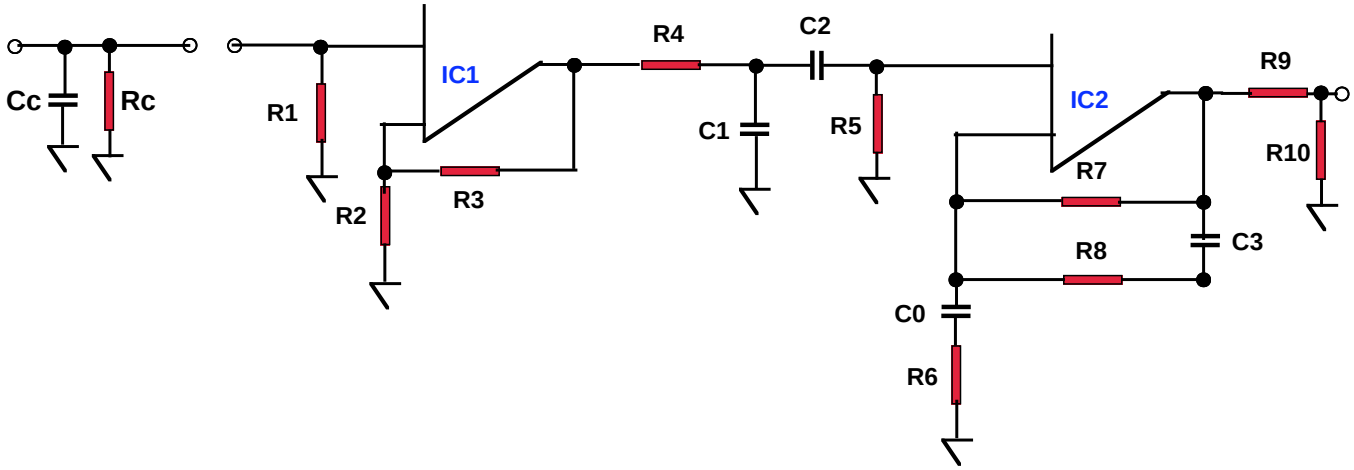
Phono Preamp based on ETI 478MM



Parts List:

Cc (here 220pF) and Rc (here 56k); these values are cartridge dependent and are mounted on the input socket.

R1 = 470k – provides a DC current path for the input of the differential pair of the IC1.
R2 = 120 ohm;
R3 = 1.2k ohm now, (original1k) ;
Both R1 and R2 must be low enough to minimize noise: e_n {e_n = \/(4*k*T*R*df),
Transformed gives the ratio: e_n / \/df (nV / \/Hz);

Where:
k = Boltzman's constant =$1.37*10^{-23}$
T = operating temperature in degrees K;
R = resistors (here R1, R2 and MM coil resistance – for most around 500ohm);
df = noise bandwidth ('brickwall bandwidth' – here 20kHz);
\/ denotes square root;

Gain of the first stage = R3 / R1 + 1;

R4 and C1 form a first order filter set to 75us;
Eg.: R4 = 4.9k;
C1 = 22 nF;

R5 and C2 form another first order filter set to 7950us to reduce gain at frequencies below 20Hz;
Eg.: R5 = 8k;
C2 = 1uF (original), now 1.5uF ;
The value of R5 affects the noise performance of the second stage and should be low but choosing a value too low would require C2 to be increased by the same factor and that implies larger size as C2 must be high quality fast metalised polypropylene; Currently the value of C2 is 1.5uF to allow for somewhat slower roll off al frequencies below 20Hz; I think one can safely reduce R5 to 5.6k and increase C2 to 2.2-2.7uF;

R7, R8 and C3 form 318us and 3150us;
EG.: R7 = 47k;
R8 = 5k6;
C3 = 56nF;

R6, with other components, sets the gain of the IC2; here R6 = 470 ohm;
R6, R7, R8 and C3 set the minimum gain at all frequencies to be not less than 10;

The value of R6 must be large enough not to degrade IC2 input impedance in relation to the previous section and at the same time low enough not to degrade the noise performance the second stage build around IC2; Component configuration around IC2

is such that capacitors are separated by resistors which makes life somewhat easier for those sensitive to direct capacitor interactions.

C_0 = 1/ (2*Pi*f0*R6) =220uF (is the low frequency –3dB corner for the IC2 – choose the frequency well below the audible range eg.1Hz);

R9 = 100 ohm;
R10 = 1M.

The original design had large input and output capacitors but these have been removed. ICs were NE5534AN. Currently these are: IC1 OP37 and IC2 OP176; In my latest preamp (still under design) I will probably use LT1028 and for the second stage OPA637BP (as I have a few of these lying around) plus best NICHICON caps and low noise / minimum inductance resistors.

Power supply is +/-15V.

The advantage of this two stage design is that it minimizes the impedance interaction between IC1 (and preamp) and the cartridge – hence the first IC is a linear amplifier only. The passive section and the second IC ensure proper RIAA equalization (with components chosen measured performance is within +/- 0.2dB of the prescribed RIAA equalization within 2Hz to 20kHz range) and as its output is connected with buffered input to the control unit the interaction of this section with the next stage is again minimized.

Signal to noise ratio at 5mV input with NE5534AN was measured to be 87dB un-weighted (weighted 92dB), THD @1kHz around 0.001% at 10mV input.

The overall (sonic) performance of this design is really good but certainly would benefit from some further tweaking. The best choice of RIAA components is not so easy as each section loads on all the other and each choice has its advantages and drawbacks. One needs not only good ears but most of all the proper test equipment which I do not have (only the necessary stuff).