# Moving Coil Cartridge Step-up Transformers

It is difficult to amplify the microvolt level signals present at the output of most moving coil phono cartridges without adding audible noise. With transistor-based preamplifiers it is possible to do so using special techniques; it is even more difficult to do with tubes. However, a step-up transformer can be used to increase, or in transformer lingo, "step up", the cartridge voltage admirably without adding any perceivable noise.

The moving coil cartridge is a truly low impedance voltage generator. Because of this it is possible to use a transformer to step up the voltage by factors of 10 or more times without causing any impedance interface problems with conventional phono preamplifiers. When a transformer is used to step up a voltage, the characteristic cartridge impedance (AC resistance) is also increased. The mathematical relationship is such that a 10-fold increase in voltage results in a 100-fold increase in impedance. In general, the impedance transformation through a transformer is equal to the square of the voltage transformation. It is important to take both of these parameters into account when deciding what sort of an MC step-up transformer is required to make a given cartridge work well with the phono preamp you have.

To make the theory real, let's set up a hypothetical example. Imagine an MC cartridge that has a nominal 0.5 mV output and a phono preamplifier that has a 47K input impedance. If we desire to increase the output voltage of the MC cartridge to the "normal" 5 mV level associated with most MM phono cartridges where the phono preamp gives acceptable noise performance, then we would require a 10-fold increase in signal level. To do this, we connect the primary coils on the Lundahl LL9226 in the configuration that results in a gain of 10, or expressed in dB, 20dB, and then wire it up to our preamp and enjoy some tunes. (See the diagram below for an illustration of the hypothetical connection described here) But before we drop the stylus onto the record, we need to also consider the impedance implications of our gain decision. Because the gain we chose was 10, we have an impedance transformation of 10 squared, or 100. So, the cartridge "sees" the 47K load resistor at the input to the preamp through the transformer as being 470 ohms, which is arrived at by dividing the resistor value, 47K, by 100, the impedance ratio. Most MC cartridge manufacturers provide a recommended range for load impedance (or resistance). Because this value is usually substantially lower than 47K, the transformer is performing a valuable service on the impedance front, as well. A typical MC cartridge will sound somewhat "lightweight" when it is loaded too lightly (load impedance is too high) and will sound somewhat dull when the load impedance is too low. So, it's important to get both of these parameters, the step-up gain and the reflected load impedance, correct to get the best sound. The gain you choose generally has less effect on the sound quality than does the cartridge loading. So it's important to get the gain in the "ballpark", but then turn serious attention to adjusting the cartridge loading to get good frequency balance as described above. The discussion below will guide your efforts in this direction.

One feature of the diagram below deserves additional comment. The grounding arrangement around the transformer is appropriate for the vast majority of installations where the phono preamp has unbalanced inputs and the cabling from the turntable to the MC step-up transformer is two conductor wire terminated with an RCA plug.
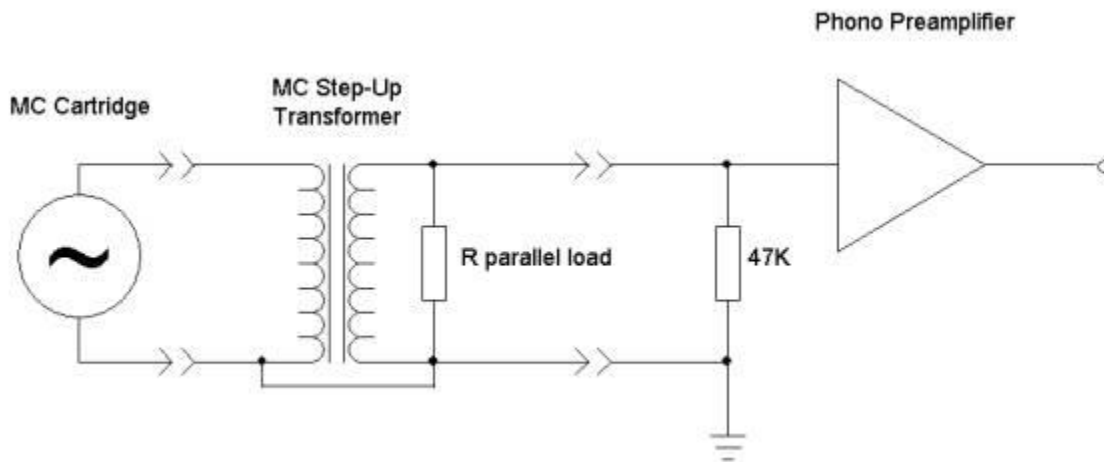
You might now ask if when you need a gain of 10, are you then "stuck" with a reflected 470ohm load for your cartridge, even if that's not optimum? To increase the load impedance above 470 ohms, you either have to remove the 47K resistor and replace it with a higher value resistor or you have to settle for a lower step-up gain. Fortunately, it's most often true that the MC cartridges that have the lowest output levels also require relatively low values of load impedance, so this is not usually a problem.

(with the PH16 input load switching, you can select 68K, 47K, or 33K)

For those of you who want to experiment with and optimize your cartridge loading (recommended!), we have provided tables of parallel resistance values that will help you achieve the best sound. As a starting point, I usually chose a load impedance value of 10 times the cartridge impedance (sometimes referred to as resistance in cartridge data sheets). The values given in the tables are referenced to the step-up gains produced by the LL9206 and the LL1678. Note that these values don't scale precisely with the square of the step-up gain. The primary and secondary resistances of the transformer also figure into the calculation.

LL9226

Desired Load Impedance (ohms)	Step-Up Gain	Phono Preamp Input Impedance	Parallel Resistor Required (ohms)
1600	5	47K	307000
800	5	47K	37200
400	5	47K	14000
200	5	47K	6570
100	5	47K	3500
50	5	47K	2100

Desired Load Impedance (ohms)	Step-Up Gain	Phono Preamp Input Impedance	Parallel Resistor Required (ohms)
400	10	47K	307000
300	10	47K	89000
200	10	47K	37200
100	10	47K	14000
60	10	47K	7900
40	10	47K	5300

Desired Load Impedance (ohms)	Step-Up Gain	Phono Preamp Input Impedance	Parallel Resistor Required (ohms)
100	20	47K	307000
80	20	47K	108000
60	20	47K	52300
40	20	47K	26000
20	20	47K	10800