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What about Impedance?

Impedance: There are 2 types of impedance to be concerned about with Moving coil Cartridges: Internal Impedance and Loaded Impedance.

Cartridge Manufacturers are not consistent with how they specify loaded impedance.

With Step up transformers, we boost the voltage, since transformers are voltage changing devices. There is also a secondary effect of the internal impedance being the square of the step-up ratio. So, for example, if a transformer has a step up ratio of 1:10, then the internal impedance of the transformer would be 100 (10 x 10). So the reflected impedance back to the cartridge would be 47,000 ohms (using the RIAA standard for a standard MM phono input), divided by the internal impedance of the transformer. So for this example, you take 47,000/100 = 470 ohms impedance at the cartridge. So, the manufacturer sometimes advertises 470 and sometimes advertises less than that, if they choose to use a multiplier.

But it is not that simple. The voltage ratio and impedance ratio changes depending on the input voltage, which is why I spec the units I build using an input signal of 0.5mV and the standard of 1kHz frequency, and measure them myself. Usually the step up ratios at that voltage are lower than what the manufacturer specifies, which means that the impedance is higher than advertised for the input. We are talking about extremely low voltages.

There is a lot of confusion about how the loading is specified. Some cartridge manufacturers try to take the guess work out of it and put in some kind of multiplier, while others base their loading assuming a head amplifier will be used to boost the signal. For example, Koetsu recommends anything between 5 and 100k. Other manufacturers just specify a minimum, like >100 Ohms. The problem is that we don't really know whether the manufacturer has provided loading information based on the internal impedance or the loaded impedance of the cartridge, or considered whether we would be using a SUT or head amp. We do know from considerable testing, that you don't want to load a MC cartridge using a SUT to match the internal impedance, or you will "choke-out" the cartridge and it will sound muddy.

Just how close do you want to approach the internal impedance before this happens, and what happens as you approach this ratio? Is resistor loading necessary?

The deal on impedance is that it is not that important with SUTs. Voltage match

is what is critical. Having said that, once you make the voltage match, you should look at the reflected impedance. You want it to be about 10-times the internal impedance of the cartridge. Now that is not a hard number, it could be 8-times and be fine, and sometimes 4-times can sound great. The important part is that more headroom is better. A lot depends on the characteristics of the phono preamp. Typically if you have enough headroom with impedance, the natural characteristics of the cartridge will be apparent. So, if you have a "bright" sounding cartridge, you may want to have a lower impedance at the cartridge, but if you have the impedance too low, it may sound muddy and flat.

The only time I would consider adding resistors is with a high output mc cartridge with a low internal impedance, and only if the cartridge sounds too bright. If you insist on adding resistance, the best way to dial in resistance is to add a little at a time and when it sounds bad, then go back a step. The interesting part is that when you add resistors, it is extremely hard to tell that you are doing anything, then it becomes instantly obvious that you put too much in. Personally, I prefer to not use resistors at all. The signal is so low coming from the MC cartridge, that is the one place I would not want to waste any signal. I work really hard to ensure that the output of the transformer has as short of a signal path as possible. That is the most critical part of the setup, where you have already reduced the current coming from the cartridge to gain extra voltage.

I have read several articles that discuss loading of cartridges. I took it a step further and experimented with different loads on several different test cartridges. I both measured the response using a signal generator and dual trace oscilloscope and also conducted many listening tests. What I found was really interesting. Basically if you are just looking at the test equipment, you can tune it pretty accurately, but the real test is in the listening. The biggest challenge is in gathering the correct information on the cartridge you are using. The manufacturer can tell you the impedance and the output voltage, but is frequently wrong with telling you what loading impedance is required. To test that, I used several of my transformers with different cartridges and instead of hard wiring resistors to the output of the transformer (yes - the output is definitely the best place to mount them) I built a set of resistor tees (2 female to 1 male) and inserted them on the outputs of the transformers. I then wired several resistors onto male plugs and inserted them into the tee on the output to try different resistances. Starting with high output values and changing them to lower and lower values, I found that there was a very slight improvement as the resistance came down until there was a major change for the worse when it reached a certain point. This point usually turns out to be about 8-12 times the output of the cartridges I tested. Now, I am a purist and don't really want to put anything into a circuit unless it improves it. So adding a resistor to decrease the reflected impedance is not something I like to do, however, I have done it for those situations where the output of the cartridge has a high voltage with a low impedance, and where the user wanted to make the cartridge less bright at the high frequency end of the spectrum. Ortofon SPUs and Koetsu Blacks are two of the cartridges that I have put loading on. Now, mind you, there is a very minor, almost imperceptible improvement by doing that. I have also mounted lugs on the outputs where you can attach resistors as an after-market thing, but they introduce noise, so I stopped doing it. The output of a transformer is the most critical part of the circuit and you have to be very careful with wiring between

there and the preamp to eliminate noise.

In most cases where I have tried to load using resistors and tuned them in, I tried an A-B test afterwards both with and without any resistors and did not notice the difference. In my opinion, you usually do not gain anything by adding resistors, and only stand to degrade the sound if not done properly.

So, to make a long story short, I don't recommend messing with the output side of transformers unless there is a clear reason to do so.