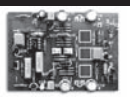

Loading Step-Up Transformers for MC Cartridges

Here is an easy way to load a moving-coil step-up transformer to match your cartridge load requirements.

By Cornelius R. Morton

For this project, all you need are two RCA f/m/f adaptors, mono to mono plug adaptor at Radio Shack, a handful of solder on RCA plugs (insulated), and a selection of resistors. **Photo 1** shows an adaptor and plugs for reference. The load resistor is soldered between the center pin and the ground of the RCA plug.

The adaptor is plugged into the MM phono input, the load plug (with the desired load resistor) into one of the female sockets on the adaptor, and the appropriate left or right cable from the MC transformer into the other. Then repeat for the other channel. Oh, that desired load resistor!

THE REST OF THE STORY

MC cartridges have loading requirements varying from 100Ω to 30Ω or less, while the standard MM input stage has an input impedance of 47kΩ. The MC step-up transformer has two functions. The first, and most obvious, is to step-up the output of the MC cartridge, between 0.5 and 0.05mV or less, to the 3 to 5mV level of a typical MM cartridge.

The second function is to transform the high input impedance of the MM input to the relatively low impedance required by the MC cartridge. MC step-up transformers are usually rated in dBs of gain. Unless you get a transformer designed for your cartridge or one of the few expensive ones that incorporate a load select switch, how do you match everything up?

A look at an MC transformer will help you find an answer. The ratio of primary to secondary turns determines the voltage step-up of the transformer and is identified as "n." If the secondary has ten turns for every turn on the primary, then n = 10 and 1mV in results in 10mV out. When you take the voltages across the same impedance—in this case the preamp output—the power gain is equal to the square of the voltage gain, or n^2, which is also the impedance ratio of the transformer. Thus the transformer with a turns ratio, n, of 10 has an impedance ratio of 100, so 1Ω across the primary looks like 100Ω across the output or, conversely, 100Ω across the output looks like 1Ω across the input.

If the cartridge requires a load of 100Ω, then the resistance required across the secondary is 100 × 100Ω = 10kΩ. This is great, but the transformer is rated in dBs of gain! Well, the gain in dB is equal to 10×log(power gain) for the transformer with a power gain of 100, which is equal to 10×log(100) or 10 × 2 = 20dB.

To obtain the power gain or, more important, the impedance ratio of the transformer from the gain in dB, you simply divide the gain in dB by 10 (20/10 = 2) and use the resulting number as a power of 10, 10^2 = 100. For a gain of 26dB the impedance ratio is $10^{2.6}$ = 398.1. To properly load a MC cartridge, the resistance across the secondary must equal the desired cartridge load multiplied by the impedance ratio of the transformer.

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PHOTO 1: Adaptor and plugs.

TABLE 1.

Transformer	Transformer	Phono in	Load Resistance for Desired Input Z		
			Z in	*Z in*	*Z in*
Gain/db	Z ratio	47k	100Ω	50Ω	32Ω
21	125.9	373Ω	17.2kΩ	7.27kΩ	4.4kΩ
22	158.5	296.5	23.9k	9.53k	5.69k
23	199.5	236.6	34.7k	12.7k	7.39k
24	251.2	187.1	53.96k	17.1k	9.7k
25	316.2	148.6	96.2k	23.8k	12.9k
26	398	118	259.8k	34.5k	17.5k
27	501	93.8	——	53.6k	24.3k
28	631	74.5	——	96k	35.4k
29	794	59	——	340k	55.3k
30	1000	47	——	——	100k

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The typical input impedance for a MM preamp stage is 47kΩ. Generally, inserting a resistance in parallel with the preamplifier input so that the resulting parallel combination equals the desired load times the impedance ratio will provide the desired results. **Table 1** lists gain in dB, impedance gain, the reflected load of the 47k input resistance, and load resistors required for cartridge loads of 100, 50, and 32Ω, for gains of 21 to 30dB in 1dB steps.

The raw input impedance of the MM input stage needs help until the transformer gain reaches 26dB, where the transformer input impedance is 118Ω and 93.8Ω at 27dB gain. Many MC cartridges list 100Ω or less, so the 118Ω may be a little high.

Table 1 lists gains in whole values; fractional values such as 21.3dB are easily interpolated. For example, 21.3 is 0.3 of the value between 21 and 22. For the Z ratio then, it would be 0.3×(158.5 – 125.9) + 125.9 = 9.78 + 125.9 = 135.68; the calculated value is 134.9 and the error is less than 1%.

Interpolation of loading resistor values for Z in values between those given will be fair up to a gain value of 24dB. You can determine accurate values by the following:

$$R_{load} = (1/(Z_{ratio} \times Z_{in}) - 1/47000)^{-1}$$

for example, if the desired Zin = 70Ω and the Zratio = 398, gain = 26dB

then

$$R_{load} = (1/(70 \times 398) - 1/47000)^{-1} = 68.413k\Omega$$

This is easier to do on a calculator than it is to write.

LOAD VALUES AND RESISTORS

• MC cartridges tend to have a slight high-frequency peak; therefore, a load slightly on the low side may provide better high-frequency control.

• 1% metal film resistors are recommended to maintain channel balance and noise floors.

• ¼W resistors are fine and easily fit the solder type RCA plugs. **Photo 1** shows a ½W in my plug, which was handy. *aX*

PARTS LIST

Gold Plated MonoAdaptor, Radio Shack 274-881, $4.99 ea., two required.

Insulated phono plugs (8), color-coded (red, blue, yellow and white), Radio Shack 274-321, $3.99 per package.

1% metal film resistors are available from Antique Electronics, Digi-Key, Mouser Electronics, and other suppliers. The gold-plated connectors look nice and do not tarnish. Gold does have a higher contact resistance than some of the standard platings, thus there is no electrical gain. So my connectors look nice.