Magnetic Pickup Amplifier

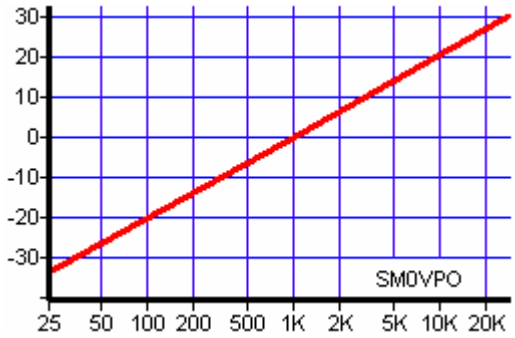
by Harry Lythall - SM0VPO

Introduction

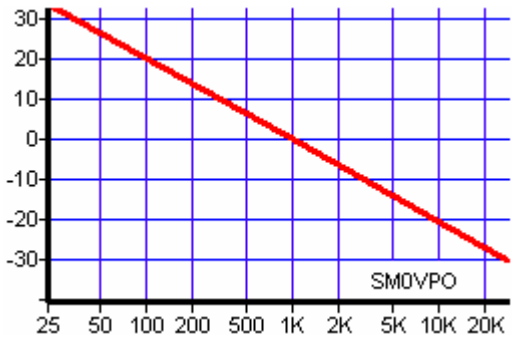
I don't know about you, but I seem to aquire loads of old technology, and I keep them. I still have my trusty 80286 computer, and I quite often listen to my old "vinyl" records. With modern technology I do play my vinyl records via the LINE-IN on my computer, and I make MP3s from them (only for personal use). But therein lays a problem. My Garrard AP76 belt-driven turntable is fitted with a Goldring magnetic cartridge. The magnetic cartridge has a low output level and does not have a flat frequency response. The output level is also very low - about 5mV at 1KHz.

I used to use a ceramic pickup cartridge and these have a high output level, flat frequency response, but with a very high impedance load. If you load a ceramic or "crystal" record deck cartridge with a medium impedance then the output level drops and the response becomes the same as a magnetic cartridge. This means I can make one pre-amplifier that can be used to amplify either ceramic, crystal or magnetic cartridges and deliver a 1v Peak-to-Peak LINE-IN level. The remaining description now applies to the magnetic pickups.

Basics



When a track is recorded on vinyl, a groove is cut into the plastic and this groove has 2 planes at 90-degrees to each-other; +45 and -45. The depth of movement in each plane is converted to electrical signals in the left and right-hand stereo channels. Unfortunately, a 20Hz signal and 20KHz signal cannot be allowed to have the same amplitude. The rate of change of 20Hz is so slow that to achieve a full amplitude, the walls of the track would be broken. If not, then the 20KHz signal would be so low that the grains of the plastic would cause an unacceptable level of noise. So the frequency response is so adjusted that 20KHz and 20Hz deviate by the same physical amount. It is therefore apparent that there is much more energy recovered from the 20KHz signal: the rate of change is 1000 times faster. The amplitude of the recorded signal therefore rises at a rate of 6dB/octave, or 20dB per decade, as shown below.

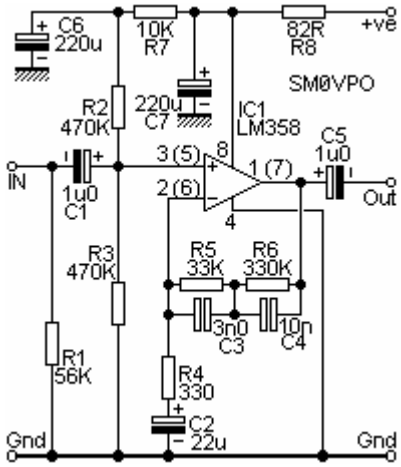


To correct this state of affairs, the record player must have an equal and opposite curve. A simple RC time-constant will give the required slope, but not over a full 60dB range. Two time-constants are commonly used so that as one "flattens off" so the other one comes into action. This I did using negative feedback in a simple Op-Amp circuit. The target response is shown to the side of this text.

This is commonly refered to as the RIAA response curve. RIAA, by the way, stands for Recording Industry Association of America, even though records were sold in many other countries and the response curve was exactly the same since they all used the same "pre-emphasis" during recording.

The Circuit

Refer to the circuit below. R7 and C6 decouple the supply quite dramatically since the audio level is so low, in the order of 5mV, that we do not want even small traces of PSU ripple here. R1 and C1 couple the magnetic cartridge into the amplifier but R1 also provides a low impedance load on the cartridge. Most magnetic cartridges need a 50K load.



R2 and R3 set the input DC bias to about 1/2 the supply voltage and R4/C2 set the gain of the complete amplifier. R5/C3 and R6/C4 are the two time-constants that give the "RIAA frequency response curve". C5 is an output blocking capacitor. C1 and C5 can be any value from about 0.1uf to 10,000uf or more. Only R5/C3 and R6/C4 values are critical in order to preserve that RIAA response curve. Numbers in brackets refer to alternative pins on the Op-Amp IC. If you build a stereo version then you will need two identical circuits, but the LM358 chip contains two seperate Op-Amps.

The PCB that is on my download page is designed for the stereo version. The supply voltage can be as little as 9v DC but I strongly suggest 18 volts or more. Incidentally, if you do not mind stuffing a wire inside your computer then you can find a good stable 12v DC. It is one of the wires connected to every hard disk and CD-ROM drive.

If you de decide to use my own PCB then be aware that most components appear on PCB twice, once for each channel. The components that are common to both channels (and therefore only appear once) are C6, C7, R7 and R8. Another thing, if you need to wire the signal cables in your turntable, do NOT Earth (Ground) them to the Earth point in the turntable. The turntable shall be grounded at the mains, but the cartridge is grounded from the amplifier, otherwise you will never be able to get rid of the "hum". It's call an "Earth loop".

Conclusion

So I hope that you can now so something to play all those old LPs, 45s and 78s you have stored in the attic. By the way, this project makes a good driver for my V7(b) FM Transmitter project! (not that I would actually ever transmit music, you understand, of course!). If you should come across an old copy of Jerry Lewis's "*Murder Mystery*" (reverse side = "*I keep her picture hanging upside down 'cause I can't stand the sight of her face*") then please bear me in mind before you dispose of the record. That was the first and best 78 I ever had, but it was broken by an ex-wife. If you should have any old LPs you don't like then place them on a tin of baked beans in the oven. Remove the heat when the a plant-pot has formed. I have a great Cliff Richards plant pot. Old LPs can also be used to make a simple SSTV camera, but more about that in another project.

Have fun with the circuit. Very best regards from Harry - SM0VPO