An alternative Volume Controller for the Bruno Putzeys balanced Pre Amp.

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In Linear Audio Vol 5, Bruno Putzeys published an excellent article, called “The G Word”, explaining the importance of carefully treating the signal and its reference as a complementary pair of signals and how to prevent uncontrolled connections to (dirty) ground reference, from input through output.
Balanced circuitry can help a great deal in achieving this goal.

A PCB was included, complementary to the article, to turn all theory into a practical project.
I was very impressed with the sound of this balanced preamp.

Especially the implementation of the level control with a linear potentiometer cleverly circumvents the non-linear properties of such a device. However matching errors between the two channels of a stereo potentiometer may still lead to audible volume differences

Remaining issues still are that at one extreme of the rotation, the gain of the preamp rises to infinity. Although no one would deliberately do this, in practice it cannot be ruled out that it might happen unintendedly and this might spell death for your speakers. Another potential recipe for disaster could occur if the pot’s wiper would lose contact with the track.
Placing resistors in series and in parallel could have cured these problems, but that would negate the cancellation of the pot’s non linearity issues.

To make a very good preamp even better, I decided to design a replacement circuit for the pot that retains all the advantages and solves the remaining issues mentioned above.

I do not need a gain from zero to infinity. A 30 dB range or in terms of power 1 : 1000 should be enough. After some experimenting, gain steps of 2dB proved to be more than adequate for a volume controller. This led me to the decision to use a 4 bit binary rotary encoder, potentially enabling 16 steps of 2dB each, controlled through 4 relays. **Figure 1** shows the overall circuit.
The LSB relay allows a change in volume by 2dB, the second and third relay have steps of respectively 4dB and 8dB and the MSB relay causes a gain step of 16 dB, the combination of all 4 relays giving the desired 16 steps of 2dB each.

Gain can never be more than +6dB and never be less than -24 dB and no disaster of whatever nature can ever happen, solving some of the issue’s mentioned above.
With the resistors as shown, this circuit has a constant input resistance of 2K Ohm. The fixed feedback resistor R12/R22 of 4K Ohm attached to the output amp determines the maximum gain of 6dB, but can easily be adapted to one’s need.
When using 1% resistors, gain difference between L / R will be in the order of 0.1dB, and by using E96 resistors, deviation from the 2dB steps will be below 0.1 dB.

To reduce thermal modulation as much as possible for the specified resistors, the use of 10ppm tempco versions is advised , especially for the eight 1K resistors around U2/U7 on the PreAmp PCB.

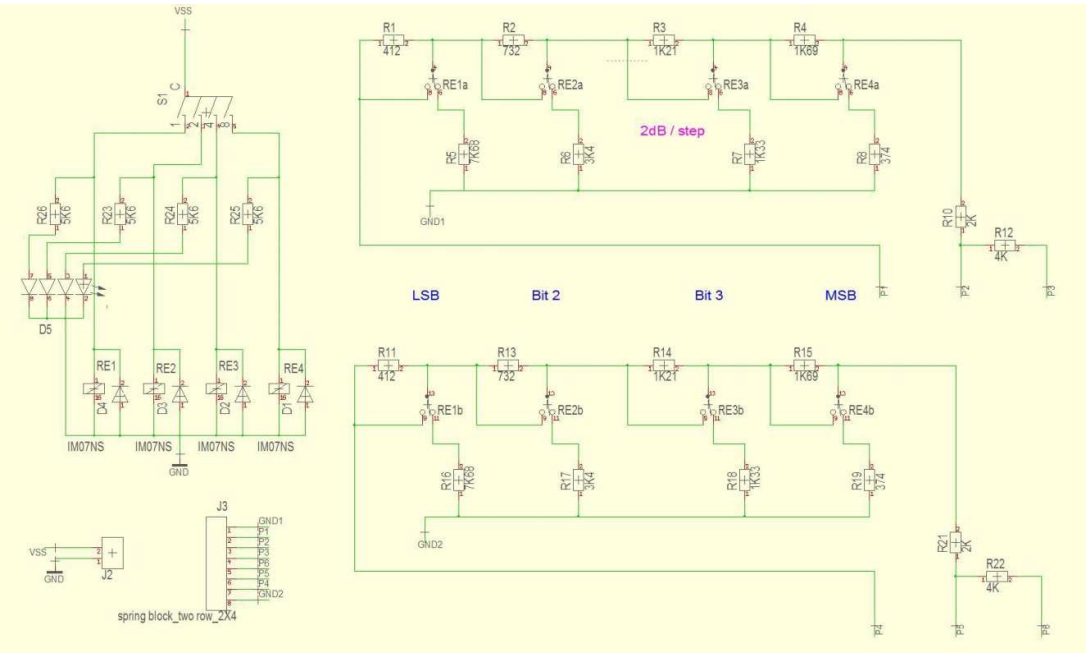
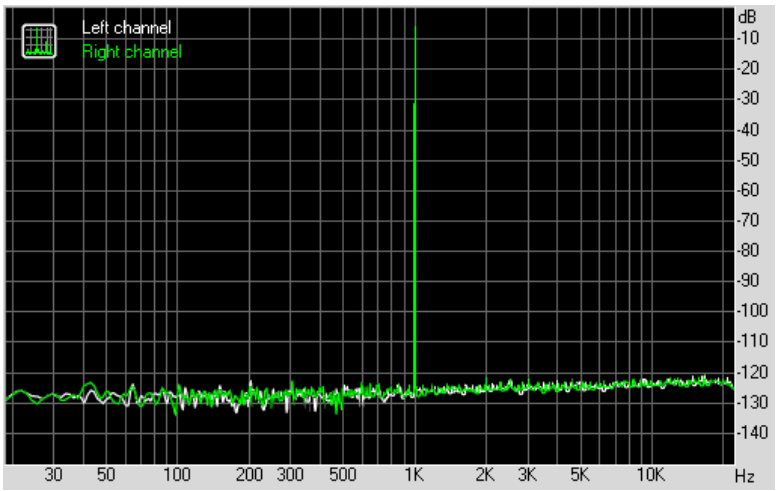


Figure 1. 30dB volume controller.

P1 to P3 and P4 to P6 are connected to the Pre amp just as the potentiometer this unit replaces. Extra connections are Gnd1 and Gnd2, to be connected to resp. Net Tie J4/J10 on the board. And of course the relays will need an 18Volt supply; this can be obtained from VRAW and GND.

All this circuitry replacing the potentiometer is mounted on a small PCB, measuring 4.6 cm by 2.7 cm. Four LEDs show in binary code the position of the volume setting, 0000 meaning -24 dB and 1111 +6dB.

And what, you say, about audible clicks in the sound when changing the gain? I can hear none at all, not even when going from 0111 to 1000 where all 4 relays are changing position. Mandatory is that no DC is entering P1 and P4, but Op Amp U3 on Bruno's PCB should take care of that.



Finally, here is the output spectrum of a 1kHz 1V signal in 0dB gain mode.

A limited amount of PCB's are available at request from the author at hapolak@me.com.