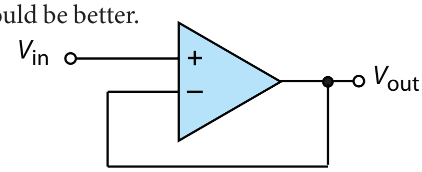
Inverting signals

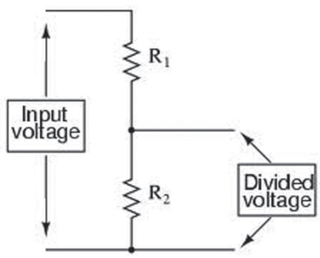
In an otherwise fine article on using a sound card for data acquisition,[1] the authors offer an inverting op-amp circuit in Fig. 3 as an example of a high input impedance circuit that attenuates the voltage of an input signal. They correctly state the voltage gain function of the circuit as $V_{out} = -(R_2/R_1) \times V_{in}$, but then call the ratio (R_1/R_2) the attenuation.

It would be easier for the user had they kept to the conventional language and called $(-R_2/R_1)$ the voltage gain, where the minus sign indicates inversion of the input signal. Now in order to protect the input circuits of the sound card, the magnitude of the voltage gain must be less than 1 if the input signals are greater than the sound card's limits. Choosing resistor values of, say, $R_2 = 1000\ \Omega$ and $R_1 = 10\ \mathrm{k}\Omega$ would yield a voltage gain of 0.1, and input voltages of up to 10 V would never exceed 1 V into the sound card.

But the circuit's input impedance is determined by R_1, or $10\ \mathrm{k}\Omega$ in the example above. Unless this value is chosen to be much larger than the source impedance (typically 10 times greater), this particular circuit is not generally a high input impedance configuration. Use of a noninverting voltage follower would be better.



Of course, one could just build a two-resistor voltage divider, and keep the sum of the resistance 10 times higher than the source impedance. The "divided voltage" is $[R_2/(R_1+R_2)] \times$ "input voltage." This would work just as well for many applications in the introductory lab and be much simpler than using op-amps, which require their own (often bipolar) power supply.



1. Umer Hassan, Saad Pervaiz, and Muhammad Sabieh Anwar, "Inexpensive data acquisition with a sound card," *Phys. Teach.* **49,** 537–539 (Dec. 2011).

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Author response

Dr. Karlow has proposed a voltage follower circuit with a much higher input impedance. However the follower provides unity gain, and for purposes of protecting the sound card against excessive voltages, some means of attenuation would be required on top of it. Indeed, the resistive divider circuit Dr. Karlow proposes will also work, especially since it is simpler and cheaper to set up, avoiding the need of multiple power supplies to power up the op-amp.

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(Over)simplified Science

We enjoyed the article "Pepper's Ghost" by Thomas B. Greenslade Jr. in the September issue of *TPT* (p. 338), but we think that Fig. 3 from *Cyclopaedic Science Simplified* is oversimplified. Even with a naked eye one can see that angle α does not equal β. The green ray follows the correct path from the nose of the hidden lady to the eye of the spectator. The lower part of her robe cannot even be seen (blue).

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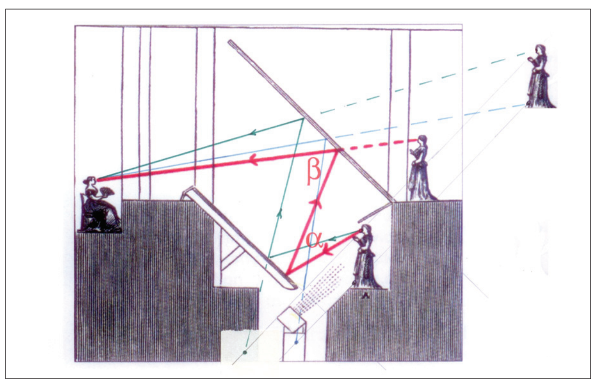

Correction: John Cordell, "Non-Mathematical Explanation of Precession," *Phys. Teach.* 49, 572 (Dec. 2011)

(Pointed out to the author by Al Friebe):

In paragraph 7, "The tilting axis will now lie beneath line segment AB" should read "The tilting axis will now lie beneath line segment AC."