Simple AC-stop, DC-pass circuit uses four op amps

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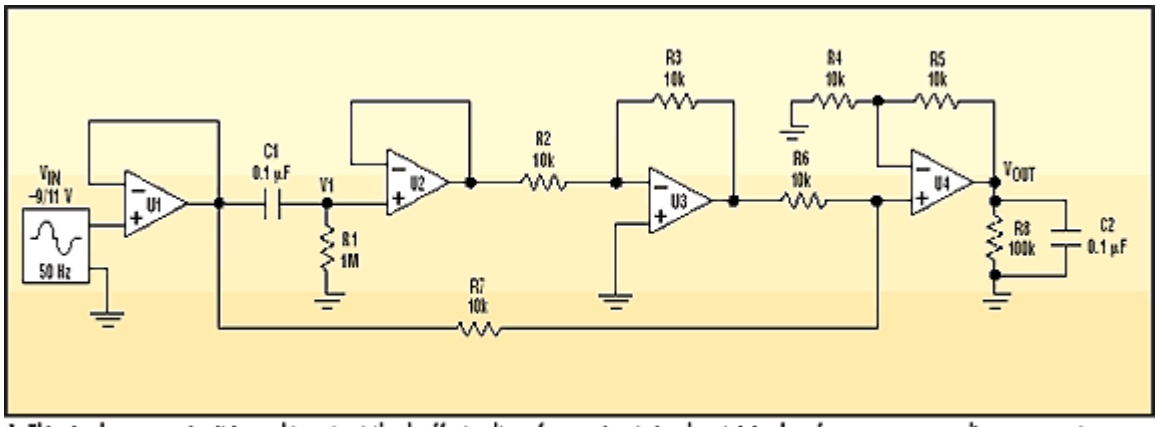
The circuit presented can be helpful in applications where the desired output is a dc offset voltage of an ac signal. Such an application would be the design of an electronic watt/watthour meter. For example, when calculating active ac power, VP*sin(ωt) (proportional to voltage across the load) and VC*sin(ωt + ψ) (proportional to the current through the load) are multiplied, resulting in K*VP*VC*cos(ψ) [dc offset] and K*VP*VC*cos(2ωt + ψ) [ac harmonic].

Because the required output signal is just the dc term, the ac term must be eliminated. This type of function can't be performed by conventional low-pass filters. However, the simple and inexpensive circuit shown accomplishes the job (Fig. 1).



1. This simple op-amp circuit is used to extract the dc offset voltage from an input signal containing low-frequency ac powerline components.

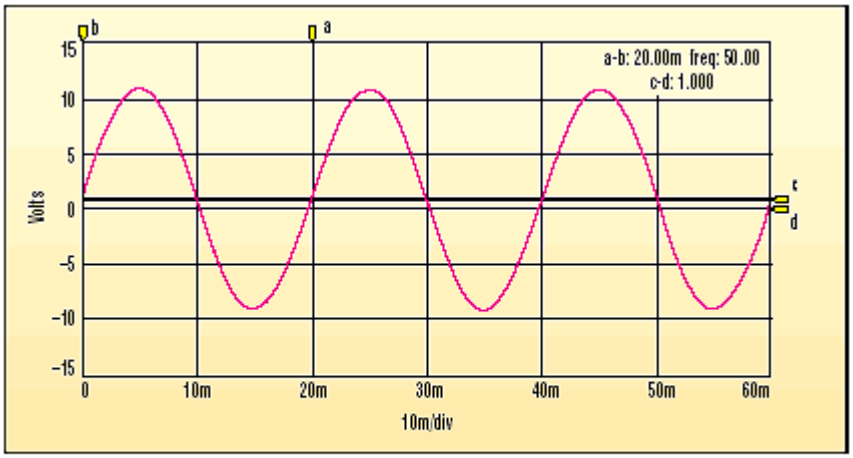
In this arrangement, the input signal is buffered and two outputs are derived. One of the outputs is ac-coupled, inverted, and then added to the original input signal.

Op-amp U1 buffers the input signal. The buffered voltage is then passed through a capacitor to obtain a pure ac waveform at V1. U2 buffers V1 and U3 is a unity-gain inverter that provides an output of -V1. Then, at U4, V_{IN} (i.e., V1 + V2) is added to the output from U3. Therefore,

$V_{OUT} = V_{IN} + (-V1) = (V1 + V2) - V1 = V2$

which is the desired dc signal.

This circuit works very effectively even for very small input signals. It's been implemented in the field at a frequency of 50 Hz, and excellent results were observed for voltage offsets as low as 0.1 mV (Fig. 2). Its accuracy depends on the matching of resistors and the performance of the op amps.



2. Tests show that the ac-stop, dc-pass circuit is very effective, even for very small input signals. The circuit operates at a frequency of 50 Hz and excellent results were observed with voltage offsets as low as 0.1 mV. Accuracy depends on the matching of resistors and the performance of the op amps.

The TL084 op amp, a high-performance quad op amp, is recommended for low-frequency applications. A 5k resistance may be inserted between the non-inverting input of U3 and ground to nullify errors due to biasing currents of the op amp.