Designer's casebook

Tunable notch filter suppresses hum

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Close-tolerance components are not necessary in a hum filter if its rejection frequency can be adjusted to the frequency of the line-current hum. Such a filter is cheap and easy to build.

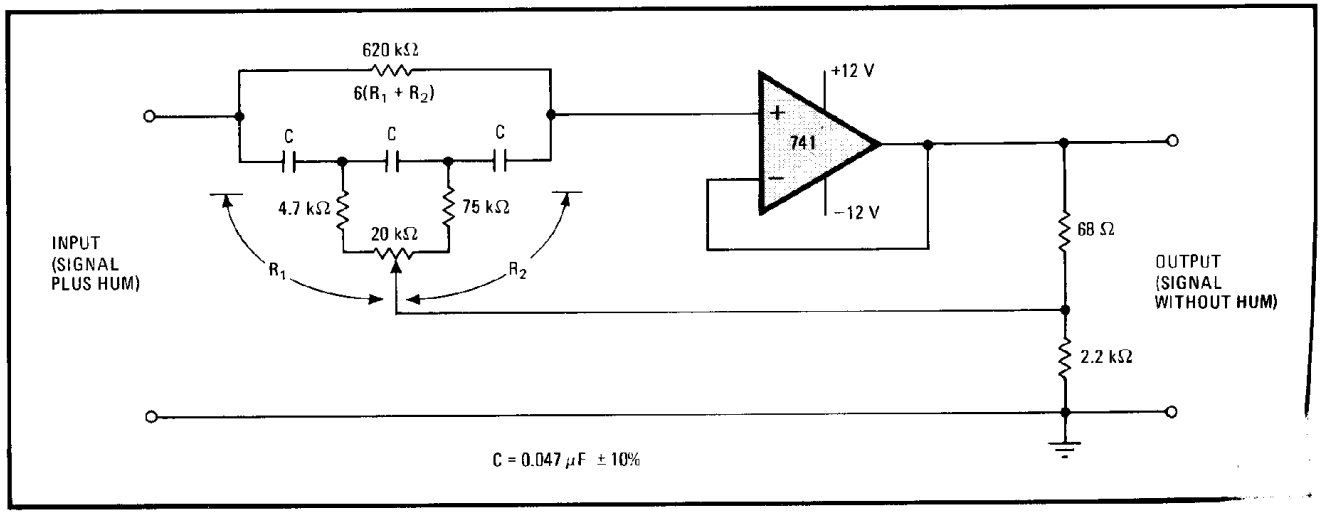
Notch filters are often designed into audio and instrumentation systems to eliminate unwanted signals or pickup such as 60-hertz line-frequency hum. For a given rejection frequency, close-tolerance components are usually required to guarantee repeatable design. An inexpensive, reproducible, narrow-stop-band circuit that can be built with wide-tolerance parts and can be tuned from 50 Hz to 60 Hz with 30-decibel minimum notch depth satisfies most hum-rejection requirements.

The illustrated circuit employs a bridge-differentiator RC network with active feedback. The notch frequency in hertz is given by:

$$f_o = 1/2\pi C(3R_1R_2)^{0.5}$$

where C is the farad value of the capacitors in the circuit; R_1 is the sum of the 4,700-ohm fixed resistor and the left-hand portion of the potentiometer, expressed in ohms, and R_2 is the sum of the right-hand portion of the pot and the fixed 75,000-ohm resistor. Although the operational amplifier can be of almost any sort, the 741 shown is typical. The notch bandwidth is set by the feedback gain of the noninverting amplifier, so replacing the 68-ohm resistor with a lower value narrows the rejection band.

With the given component values, this circuit can be tuned to reject the U. S. 60-Hz or the European 50-Hz power-line frequency. With 10%-tolerance capacitors, the minimum notch depth is 30 dB and the total 3-dB bandwidth is 14 Hz for 50 Hz and 18 Hz for 60-Hz center frequency. The insertion loss outside of the stopband is a negligible fraction of a decibel. □



Tuning a hum. This narrow-stop-band filter can be tuned by the pot to place the notch at any frequency from 45 to 90 Hz. It attenuates power-line hum or other unwanted signals by at least 30 dB. Because the circuit uses wide-tolerance parts, it is inexpensive to build.