Programmable Notch Filter Using the ispPAC®10

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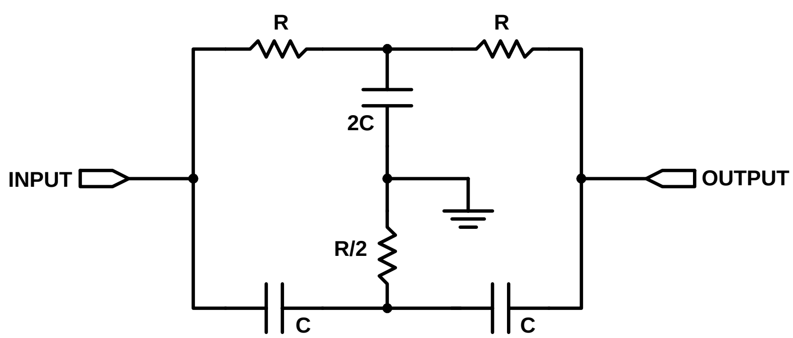
Band-stop, or 'notch' filters are used to attenuate unwanted signals occurring within a specific band of frequencies. One common application for notch filters in signal conditioning circuits is to remove narrow-band interference, such as that generated by switching power supplies.

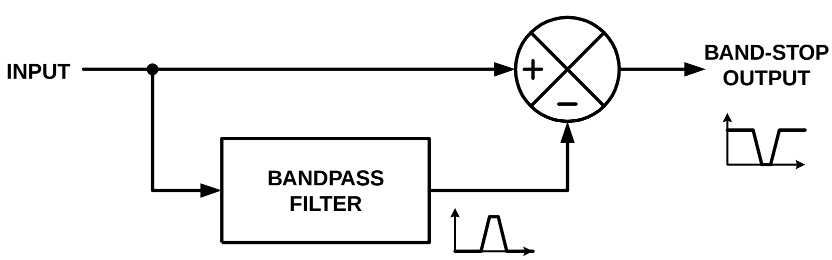
Popular circuits for implementing notch filters include those such as the 'twin-T' filter shown in Figure 1. In this circuit, an incoming signal is split into two parts, phase shifted, and the two phase-shifted versions summed. To implement a notch filter in this manner, however, requires that passive components be matched very precisely. While resistors can be easily matched, precisely matching capacitors can be more difficult. Component mismatches severely limit the maximum amount of signal rejection (the depth of the 'notch') that can be achieved in practice.

Figure 1. 'Twin-T' RC Notch Filter



An alternative method of building notch filters is by band-pass filtering the input signal and subtracting it from the input, as shown in Figure 2. In this case, in-band attenuation is limited by the matching of gains in the filtered and unfiltered signal paths.

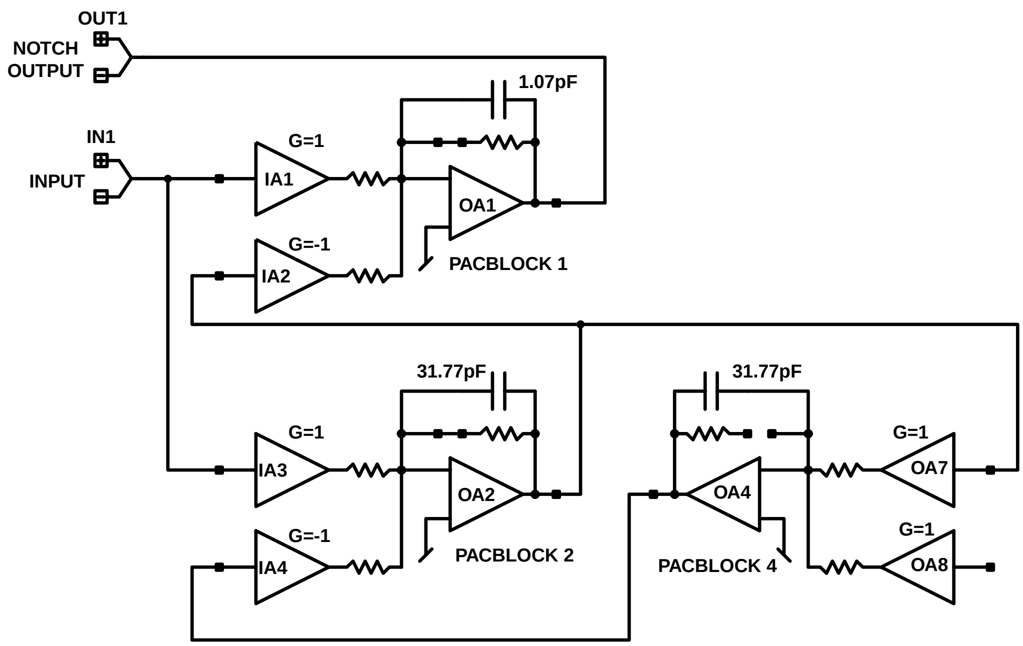
Figure 2. Implementing a Band-stop Filter with a Band-pass Filter and Subtractor



While there are many ways to build high quality band-pass filters, the 'biquad' configuration provides well-defined pass-band gain, and well-controlled center frequency and 'Q' parameters. By using two of the four available PACblocks in an ispPAC10, it is possible to implement a biquad band-pass filter with a center frequency adjustable from 10kHz to 200kHz.

Figure 3 shows how a notch filter can be implemented with an ispPAC10. The signal to be filtered is input on IN1, and the notch-filtered signal is output on OUT1. The bandpass filter is composed of PACblocks 2 and 4, where the center is set by the values of the capacitors. PACblock 1 is used as the subtractor, taking the difference of the input signal and the band-passed signal (output of PACblock 2).

Figure 3. 20kHz Notch Filter Implemented in ispPAC10



By using PACblocks 2 and 4 to implement the biquad, it is possible to do all the necessary signal routing within the ispPAC10. By reducing the need for external signal routing, this design also decreases the filter's susceptibility to external noise.

Figure 4. Simulated Response of Notch Filter

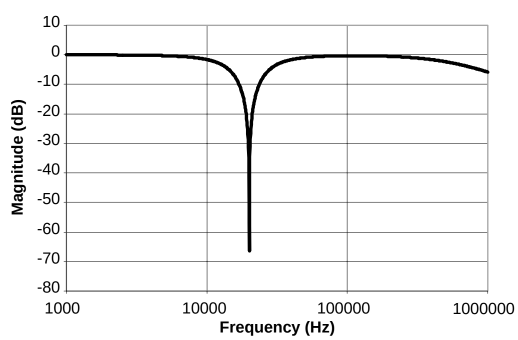


Figure 3 shows a simulated response curve for the above filter. The response curve can be adjusted by varying the characteristics of the band-pass filter. In the case shown above, with all the biquad gains set to '1' and the capacitor values equal, the center frequency will be that given by OA2 capacitor selection-list in PAC-Designer®.

Because of slight gain mismatches between the 'straight-through' signal path and the band-pass filtered signal path, the actual maximum notch rejection for a given filter using this design will be on the order of -40 dB.

Technical Support Assistance

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