



## [Cascade bandpass filters for higher Q](#)

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Switched-capacitor filters that are preset for a given bandwidth sometimes do not deliver the bandwidth or Q an application requires. By inverting the clock between two switched-capacitor bandpass filters, such as the MSFS1 from Mixed Signal Integration Corp, you can configure a high-Q filter ([Figure 1](#)). The MSFS1 is a selectable, seventh-order, lowpass/bandpass, switched-capacitor filter. Using the FSEL pin, you can select either a lowpass or a bandpass response. With the TYPE pin, you can select a Butterworth, a Bessel, or an elliptic response if FSEL is low. When FSEL is high, you can select full-, third-, or sixth-octave bandpass response. The circuit in [Figure 1](#) shows both ICs set for sixth-octave bandpass response.

The clock-to-corner ratio of the MSFS1 is 50-to-1. With switched-capacitor filters, changing the clock frequency moves the center or corner frequency of the response by the same amount. For example, if the input clock to the MSFS1 is 1 MHz, the corner frequency is 20 kHz. Cutting the clock frequency to 500 kHz results in a corner frequency of 10 kHz. By inverting the clock between the two filter ICs, you obtain a 10th-octave filter. If you simply cascade the filters, without the clock inversion, the signal has a delay to the second filter equal to the clock period. The result is an increase in passband ripple and no change in the Q of the filter..