Multirate Filters

DESCRIPTION

In many of today's development environments, digital filter design has become most challenging. Specifications typically require higher order filters, implying increased storage capacity for filter coefficients and higher processing power. Moreover, high-order filters can be difficult, if not impossible, to design. In applications such as 3G wireless systems, for example, at the receiver end data must be filtered in large magnitude in order to be processed.

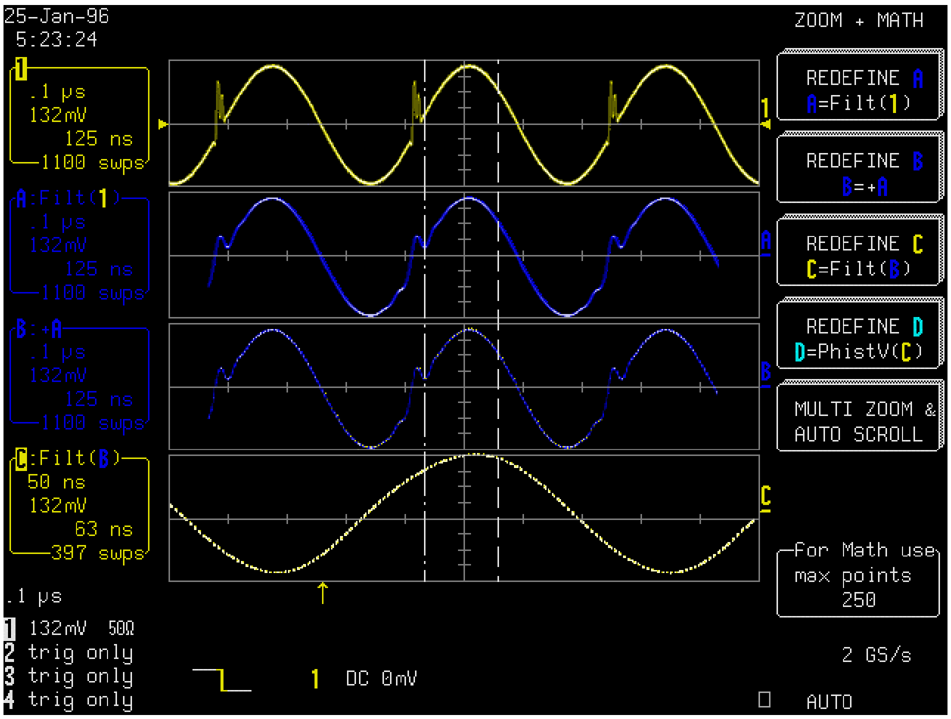
Although the LeCroy DFP option provides many filter types, the correlation between edge frequencies and sample rate may be a limiting factor: edge frequencies are limited from 1% to 49.5% of the sample rate, while the minimum transition width region is 1% of the sample rate.

Multirate, multistage filters are a practical solution for the design and implementation of FIR filters with narrow spectral constraints. Multirate filters change the input data rate at one or more intermediate points within the filter itself, while maintaining an output rate that is identical to the input rate. This approach provides a solution with greatly reduced filter lengths, as compared to standard single-rate filters.

This can be achieved in two or more simple steps. First, a filter (with a relative limited edge frequency) is applied and the results are decimated. Then, a second filter is applied to the decimated waveform, substantially reducing the lower edge frequency limit.

EXAMPLE

A sine wave with a frequency of 3 MHz has a higher frequency noise component. A low-pass filter is required to remove the noise component. The sample rate of the scope is 2 GS/s. The minimum edge frequency of the low-pass filter for this sample rate is 20 MHz. While this filter is sufficient for removing part of the noise, it cannot remove the high frequency component completely. In such a case, the problem can be solved in two stages.



1. Channel 1 represents a noisy sine wave with a frequency of 3MHz.
2. The first low-pass filter with 20 MHz edge frequency and 30MHz transition region is applied.
3. Trace B is a decimated version of trace A. This is accomplished by using the identity function and setting "for Math use" in the ZOOM & MATH menu to 250 points.
4. A second low-pass filter with an edge frequency of 5 MHz and a transition region width of 6 MHz is applied to trace B. The result is displayed in trace C.
5. Trace C shows the zoomed signal, which was filtered by a multistage filtering method. Notice that all high frequency noise components were removed.

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