Digital Filter Applications

Useful Applications Of The Digital Filter Package 2 (DFP2)

Filters are circuits or devices in which the output gain and phase vary as a function of the frequency of the input. This frequency sensitivity makes them useful in removing undesirable elements of a signal or compensating for some frequency dependent distortion within the signal. LeCroy's Digital Filter Package 2 (DFP2) option, for the WaveMaster™ series oscilloscopes, offers a selection of several standard (infinite impulse response or finite impulse response) filters or a user defined, custom digital filter configuration. These can be applied in the analysis and measurement of waveforms as illustrated in the examples, which follow.

The first class of applications to be shown is the removal of undesirable spectral components of a signal. Figure 1 contains an example of a waveform which consists of a 2 MHz square wave combined with an unwanted 5 MHz sinusoidal component. The time domain view of this signal is shown in trace C2 and the frequency spectrum is shown in trace F2. By applying a band stop filter with band limits of 2.5and 5.5 MHz the unwanted 5 MHz component is attenuated and the 2 MHz square wave is evident at the filter output (Trace F3). The spectrum of the filter

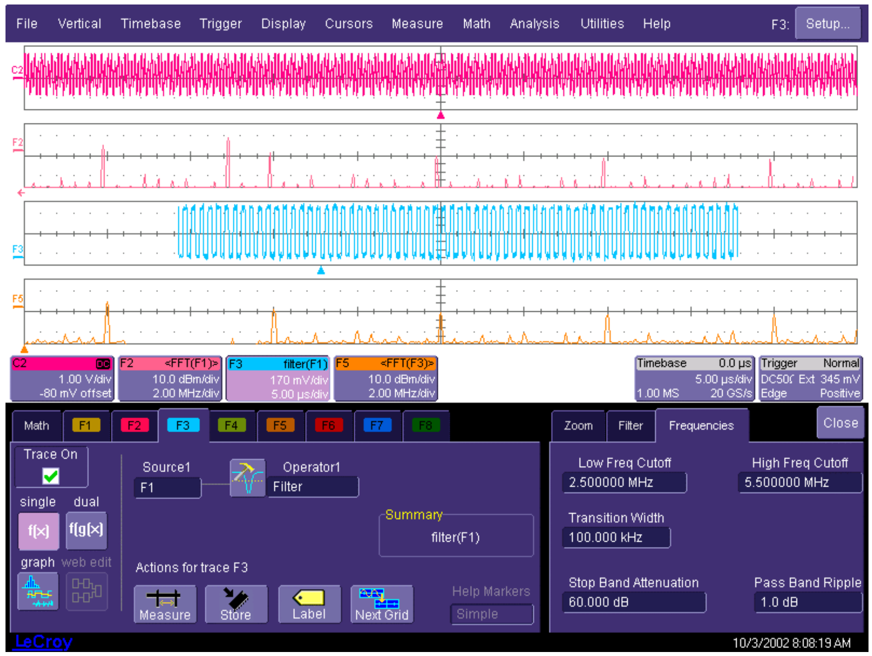

Figure 1 Using a band stop filter to remove a 5 MHz sinusoidal signal from a 2 MHz square wave.

Figure 2 Using a high pass filter to eliminate 60 Hz pickup.

output (Trace F5) shows the reduction in the 5 MHz component.

Figure 2 shows how a high pass filter is used to eliminate 60 Hz pickup from a 25 kHz pulse width modulated signal. The high pass filter is set to attenuate signals lower than 1 kHz thereby removing the 60 Hz signal.

If the acquired signal has a shaped baseline, as shown in figure 3, it is possible to use a low pass filter to separate the baseline and then subtract it from the acquired waveform. In this example a low pass filter (Trace F1) is used to extract the baseline which is then subtracted from the acquired signal in trace F2.

The last of our spectral separation examples, figure 4, shows the use of a low pass filter in a detector simulation. Modulation from an amplitude modulated signal is extracted by peak detection and filtering. The absolute value function performs full wave peak detection and the DFP provides the necessary low pass filtering.

The next set of applications uses filters to help recover signals from noise and control channel bandwidth. These types of situations arise in communications systems and echo ranging systems.

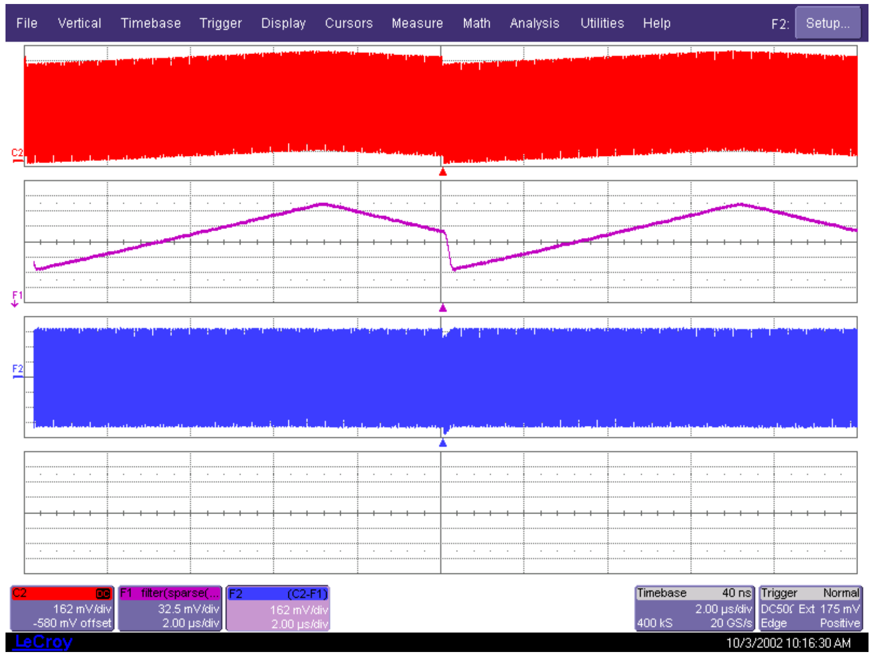

Figure 3 Removing baseline shaping by separating and subtracting the low frequency content of an acquired waveform

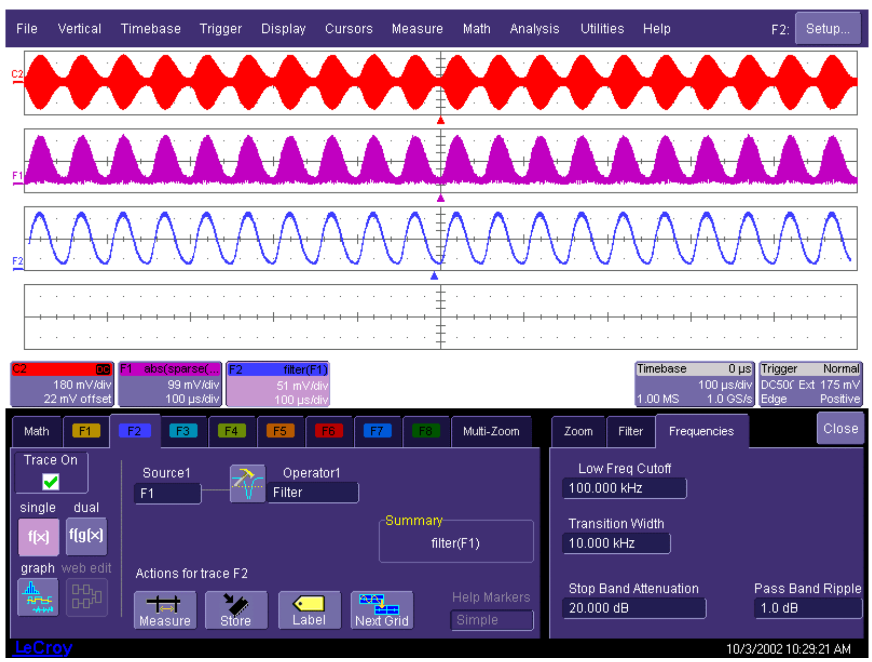

Figure 4 Using peak detection and filtering to demodulate an AM signal.

The acquired waveform in figure 5 (C 2) is a 12.5 MHz damped sine badly contaminated with noise. The judicious use of band pass filtering improves the signal to noise ratio significantly.

Note that the fast Fourier transform (FFT) displays are used to assess the effects of the filtering operation. Trace F2 shows the spectrum of the acquired signal and trace F4 shows the spectrum of the filtered signal. The band pass filter is used to reduce the acquired signal's bandwidth to 16 MHz, thereby eliminating large noise components outside the filters pass band. The recovered signal is shown in trace F3. While averaging could produce even better results it would require multiple acquisitions which are not always available.

Figure 5 Use of a band pass filter to increase signal to noise ratio and recover a signal from broadband noise.

The final example, shown in figure 6, is the evaluation of a band limiting filter for a digital communications signal. In this measurement the effects of filter selection for a North American Digital Cellular (NADC) waveform are evaluated. Comparing a normally filtered signal (raised root cosine) against an unfiltered waveform with DFP filtering shows a near exact match. The user can vary the type of filter or adjust parameters to see the effect of other types of filter configurations.

Figure 5 Using DFP to evaluate the effects of different filter types on an NADC signal

Channel 2 contains the NADC signal without filtering. Channel 3 is the same signal with the normal raised root cosine filter. The DFP raised root cosine filter is applied using trace F2. The overlapped traces F3 and F4 are used to compare the two versions of the signal.