High Pass Filtering Acquired Signals

Using Enhanced Resolution To High Pass Filter Waveforms

In some applications it is helpful to be able to high pass filter the acquired waveform . Enhanced resolution in LeCroy oscilloscopes uses digital low pass filtering to increase the amplitude resolution of the acquired waveform by up to 3 bits. A little simple signal processing allows us to create a high pass filter by subtracting the low pass filtered waveform from the original signal. The result is a waveform where the low frequency components have been removed (a good definition for a high pass filter).

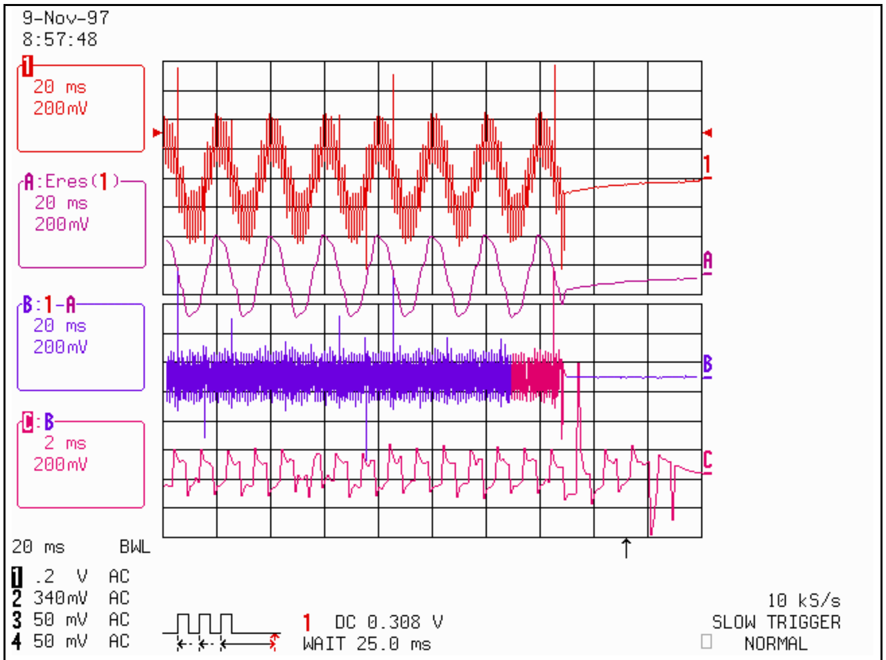

Figure 1-High pass filtering a power supply waveform to remove the 50 Hz line (mains) frequency

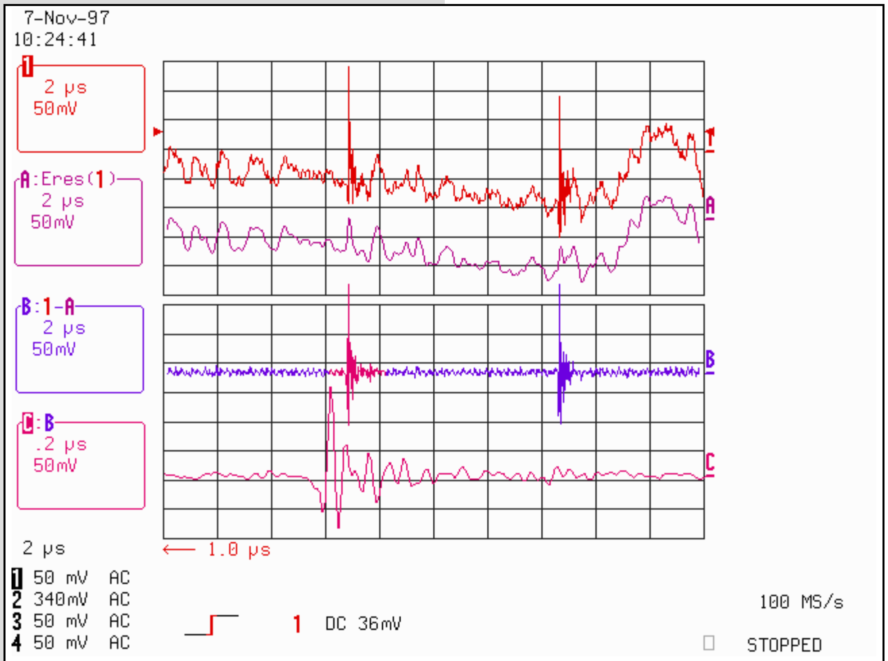

Figure 2 - Using high pass filtering to see glitches clearly

A typical application is shown in figure 1.

Trace 1, the top trace, captured an interruption in a power supply using LeCroy's drop-out trigger. Note there is a high frequency component riding on a 50 Hz background.

Trace A, enhanced resolution applied to trace 1, shows a cleaner version of the supply voltage.

Trace B, the smoothed trace subtracted from the original, showing the high frequency component which was superimposed on the power supply voltage.

Trace C, a zoom of trace B showing details of the interfering signal.

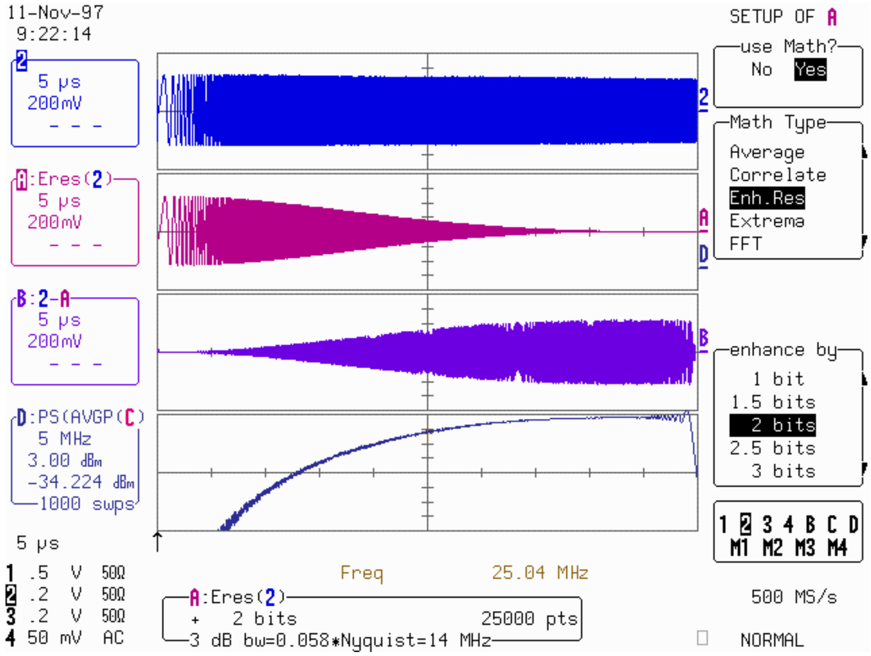

Figure 3 Characterizing the high pass filter process.

In figure 2 the signal of interest is the high frequency one, and subtraction of the enhanced resolution waveform was used to eliminate a low frequency background voltage.

Sometimes the enhanced resolution function cannot remove all the unwanted components of the waveform, because their frequencies are too close to those of the wanted signal, and then simultaneous display of all the processing steps(acquired, smoothed, and difference waveforms) can be used to discover the highest amount of smoothing which can be used without affecting the wanted signal. Another aid to evaluating the signal, along side enhanced resolution, is to do an FFT of the original signal, the smoothed signal, or the difference trace.

The next obvious question is what is the lower 3 dB frequency of the high pass filter implemented using this technique. Figure 3 shows the technique applied to a swept sinewave. The linear sweep starts at 0.1 MHz and increases to 50 MHz in 50 us (1 MHz/us). The top trace (Ch2) is the acquired waveform. 2 Bits of enhanced resolution are applied to this signal in trace A. In trace B the smoothed signal is subtracted from the original signal producing a high pass filtered version. Traces C and D are used to FFT and FFT average the high pass filtered signal. Trace D shows the frequency response of the processed signal. The absolute time cursor is used to determine the lower - 3dB point of 25 Mhz. In general, the lower -3dB frequency of the high pass filter will be approximately 1.75 times the low pass filter frequency reported in the enhanced resolution dialog box. In this example the low pass filter cutoff frequency is 14 MHz and the lower cutoff frequency of the high pass is 25 MHz.

This is another example of the implicit processing power available in LeCroy oscilloscopes. The ability to chain math operations and combine a variety of processing and analysis tools allows the user to go well beyond specified limits and to create better ways to analyze their data.