Dynamic Response Measurements

Trend Plots Measure Phase Locked Loop Dynamics

LeCroy oscilloscopes offer optional local (cycle to cycle) parameter measurements and trend graphs which can be combined to produce detailed plots of instantaneous changes of frequency or period. These plots are ideal for characterizing the dynamic tracking response of phase locked loop (PLL) based circuits. Figure 1 shows an example of the response of a PLL based synthesized signal generator to a step change in the 10 MHz reference input frequency. This a trend graph based on 10,000 individual period measurements taken over 1 ms on an acquired waveform containing 500,000 sample points. The reciprocal of the local period trend is the cycle to cycle frequency and is shown in the figure. The vertical axis for this graph is frequency with a scale factor of 25 kHz/div. The parameter readouts, below the trace, include measurements of the step amplitude, minimum value, maximum value, and overshoot.

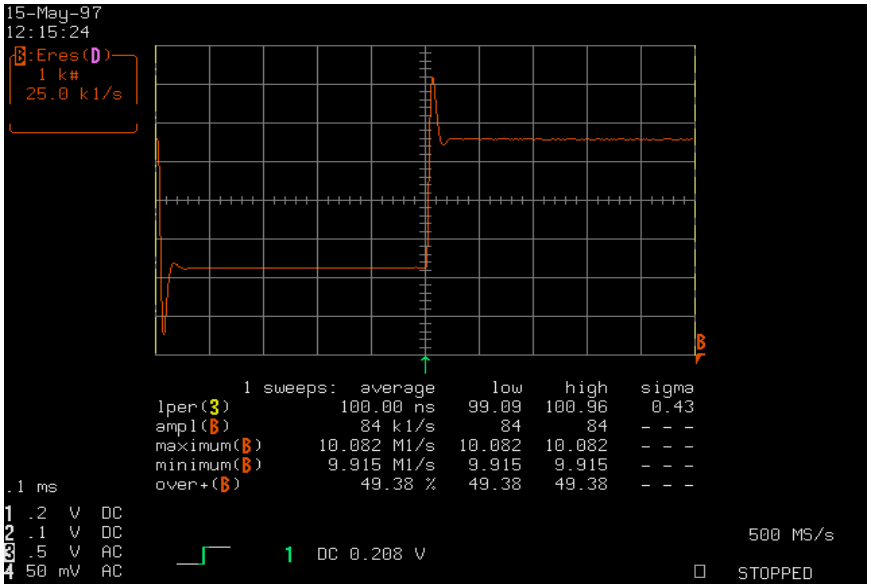

Figure 1 Trend graph of instantaneous frequency showing response of a synthesized generator to a step change in 10 MHz reference frequency input.

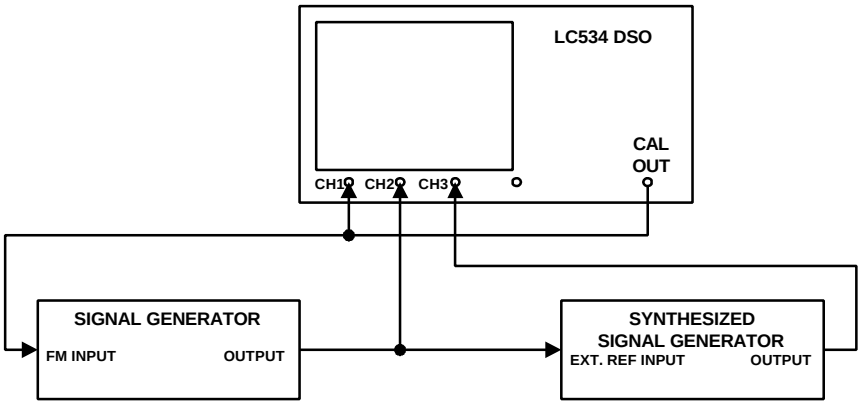

Figure 2 - The equipment setup for measuring PLL dynamic response in the synthesized signal generator.

Figure 2 shows the equipment setup for making this measurement. The programmable calibration output of the oscilloscope is used to frequency modulate the 10 MHz output of a signal generator. The signal generator output provides a frequency deviation of 86 kHz. The generator supplies the 10 MHz reference to the synthesized signal generator. The synthesized signal generator is set to output a 10 MHz square wave which is used to view the effect of the step change in the external reference input. The oscilloscope acquires 1 ms of data on each channel at a sampling rate of 500 MS/s. The analysis steps are shown in figure 3.

The operations are stacked vertically within the octal grid display in the order they are performed. Color coded trace annotation labels document the function and scale factors for each trace. The top trace, ch1, shows the 1 kHz square wave used to frequency modulate the 10 MHz carrier.

The ch2 trace is the modulated 10 MHz output of the signal generator. Trace A is the trend of local period, a record of 10,000 cycle by cycle period measurements. Enhanced resolution is used to filter the trend waveform and the result is displayed in trace B. This shows that the period of the signal generator output changes cleanly, by about 800 ps, without any significant overshoot or ringing. It is important to verify the quality of the signal generator output waveform because it will be used as the reference input to the synthesized signal generator.

The waveform in ch3 is the output (10 MHz square wave) of the synthesized signal generator. Trace C is the trend of local period of the waveform in ch3. This shows the tracking response of the synthesizer's PLL in terms of a change in period. Since most PLL measurements are made in terms of instantaneous frequency we apply the reciprocal function to convert the trend of period to frequency in trace D. The dynamic range of this signal can be improved by using enhanced resolution as shown in figure 4. Comparing the pre- and post-processed data assures that the processing is not distorting the underlying information.

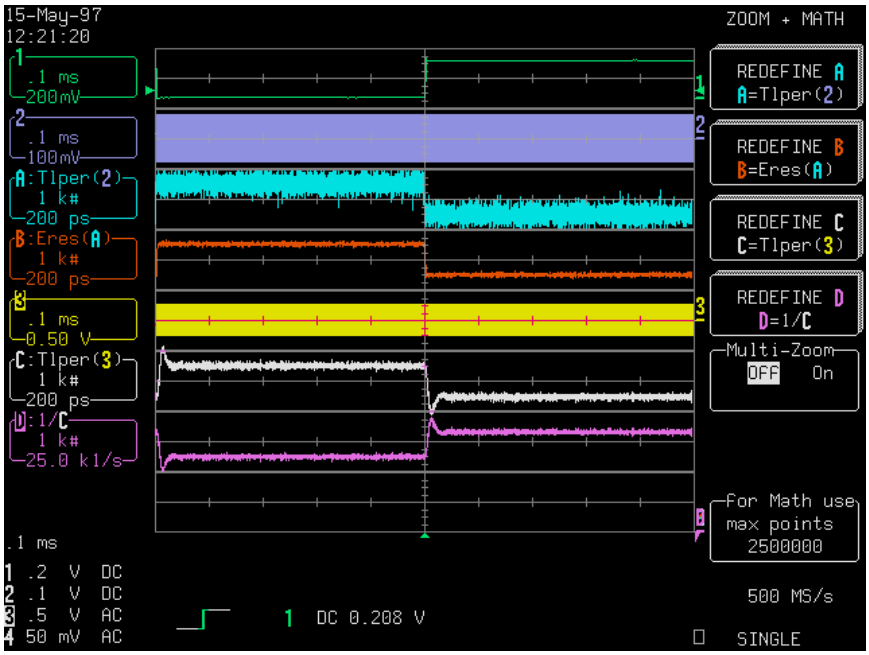

Figure 3 Acquisition and processing setup for measuring PLL tracking response to a step change in reference frequency

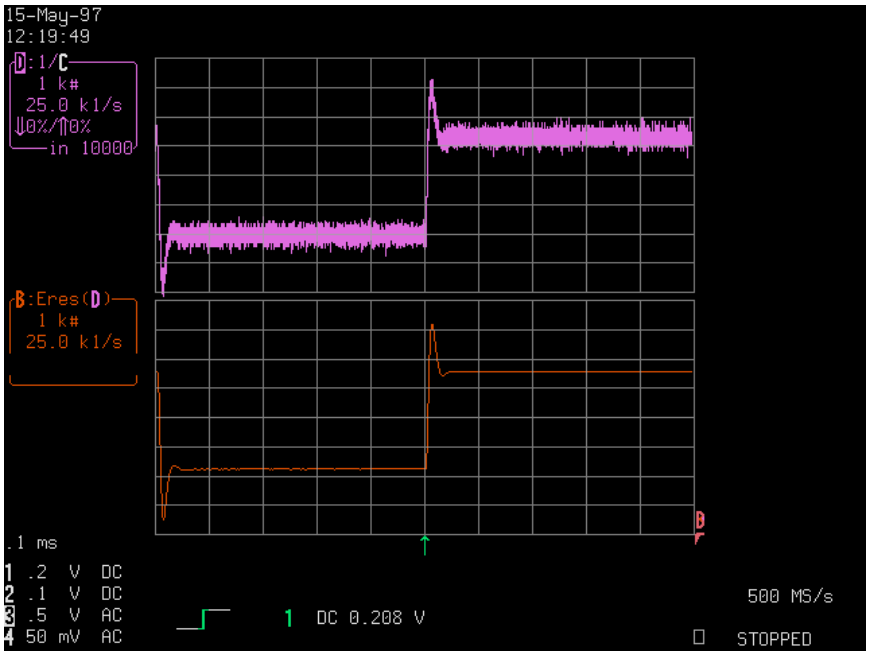

Figure 4 - Increasing the dynamic range of the measured tracking response using enhanced resolution