PLL Loop Bandwidth

Measuring Jitter Transfer Function In Phase Locked Loops

The propagation of jitter in phase locked loop based timing systems can be determined by measuring the jitter transfer function of the system components. This test characterizes the jitter amplitude response of the device under test as a function of jitter frequency. Figure 1 shows the result of a typical jitter transfer function test made using a LeCroy LW420 arbitrary waveform generator and a LeCroy WaveMaster™ digital oscilloscope with the XMAP extended math option. XMAP includes the jitter and timing (JTA) measurement parameters used in this example.

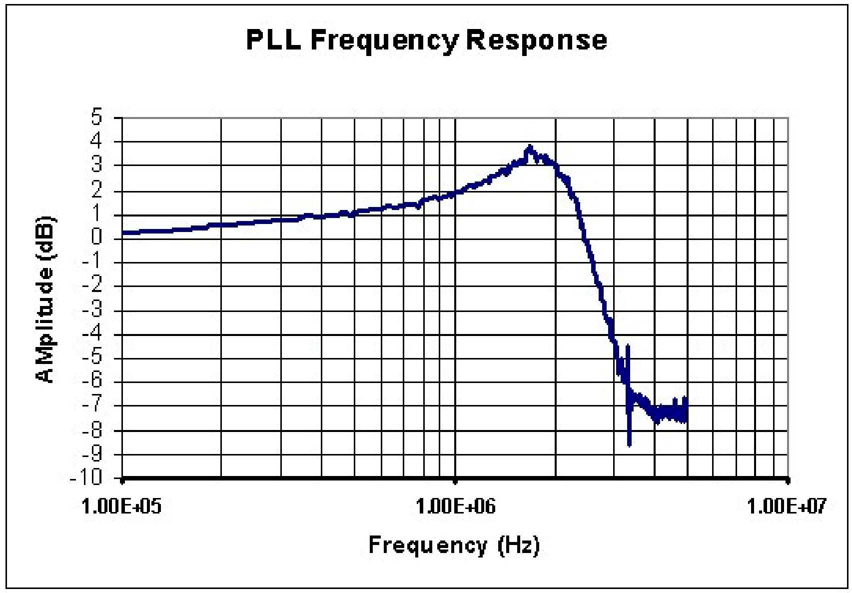

Figure 1 Loop bandwidth measurement for a PLL based zero delay clock buffer

The test can be performed using a signal source capable of generating a phase modulated signal with controlled phase deviation and sufficient modulation bandwidth to cover the desired range of frequencies. The LeCroy LW420 allows the generation of phase modulated signals with modulation bandwidths sufficient for testing out to 10's of MHz. Tests were performed using stepped frequency sine modulation and also with a broadband step modulation function. In both cases the modulation bandwidth was flat out to greater than 10 MHz.

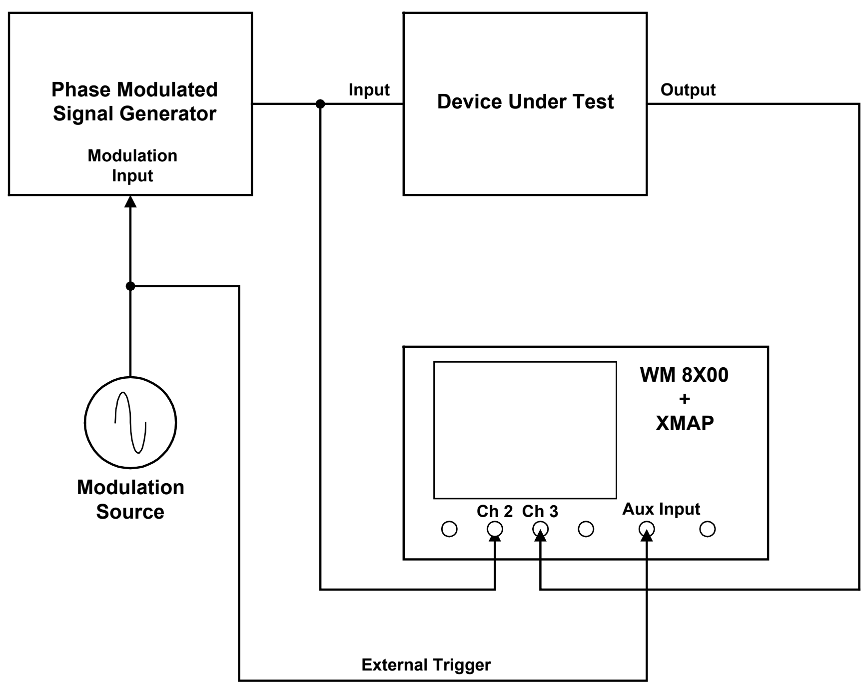

Figure 2 The test setup for measuring jitter transfer function

A step function was used to modulate the phase of the 66.67 MHz carrier of the input signal. In figure 3 the step response for both the input and output of the device under test were detected (trace F2 and F5) using a track of the time interval error (TIE) parameter. The TIE parameter measures the time difference between a signal edge and an ideal reference clock. In practical terms , TIE measures the instantaneous phase of the signal. The track function plots the TIE parameter on a cycle by cycle basis against time and demodulates the phase modulated signal. The demodulated step function is differentiated to obtain the impulse response (traces F3 and F6). The averaged Fast Fourier Transform (FFT) converts the impulse response functions into the frequency response of the PLL input and outputs, traces F4 and F7 respectively. The final step is to normalize the output response spectrum to the input response spectrum. Figure 4 shows the normalized frequency response displayed in a Log-Lin format. To convert to the usual Log-Log format the data is transferred to Excel in ASCII spreadsheet format. This result was shown previously in figure 1.

The use of 8 math traces, available with the WaveMaster XMAP option, facilitates the simultaneous computation of all the components of the measurement. This is further enhanced by the direct link with third party Windows applications like Excel which provides extensive analysis and plotting functions of its own. The result is a measurement instrument with superior productivity and ease of use.

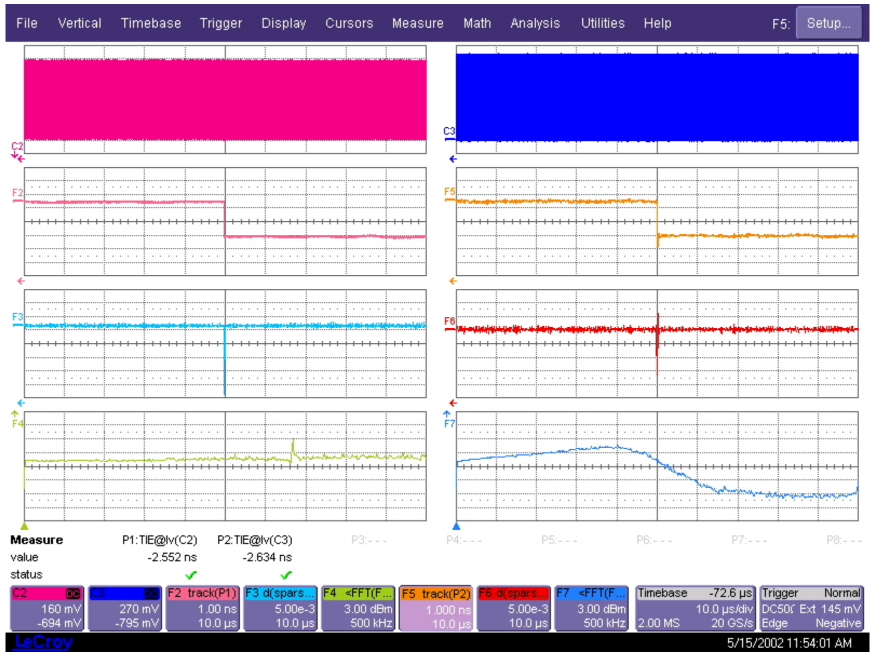

Figure 3 Calculating the impulse response for the input and output signals of the PLL.

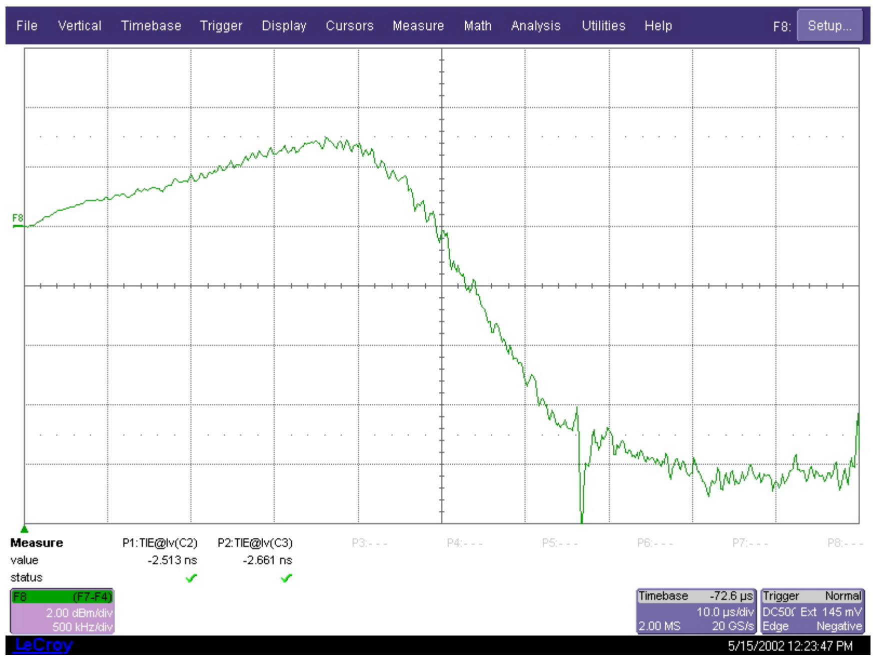

Figure 4 The normalized PLL loop magnitude impulse response