Measuring Clock Stability

Jitter And Timing Analysis Measures Clock Stability

The Jitter and Timing Analysis (JTA) option provides all the parameters and functions to measure long term, short term, and environmental stability of clock oscillators. The JitterTrack functions include period, frequency, cycle to cycle, duty cycle, events, and time interval error. Each of these functions is plotted as a function of time. In addition, the matching parameters provide data for histograms and trend plots of these measurements.

Figure 1 shows the use of JitterTrack of time interval error (Jintvl) to characterize the stability of a 20 MHz oscillator over a 1 ms measurement window. This oscillator is very stable and over the measurement window we are measuring an error from an ideal period of under 100 ps. In other words the phase of the oscillator is drifting. Time interval error essentially measures the phase error of the input signal. JitterTrack of frequency or period would be more appropriate for measuring oscillators where there is a change in frequency over the measurement interval.

Characterizing short term stability as period jitter is demonstrated in figure 2 for a 400 MHz SAW oscillator. In

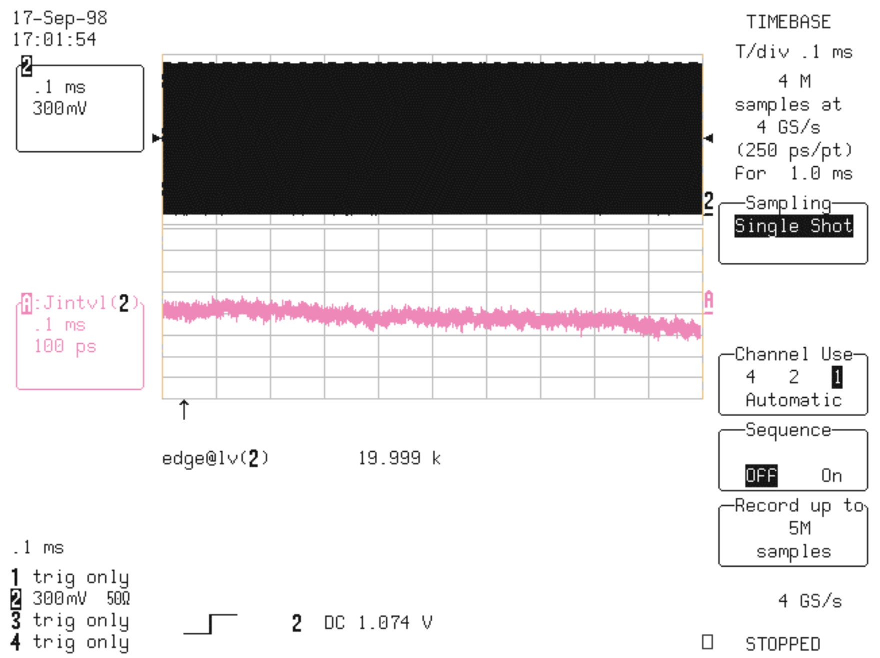

Figure 1 – Using time interval error at level to measure long term clock stability of a high accuracy clock

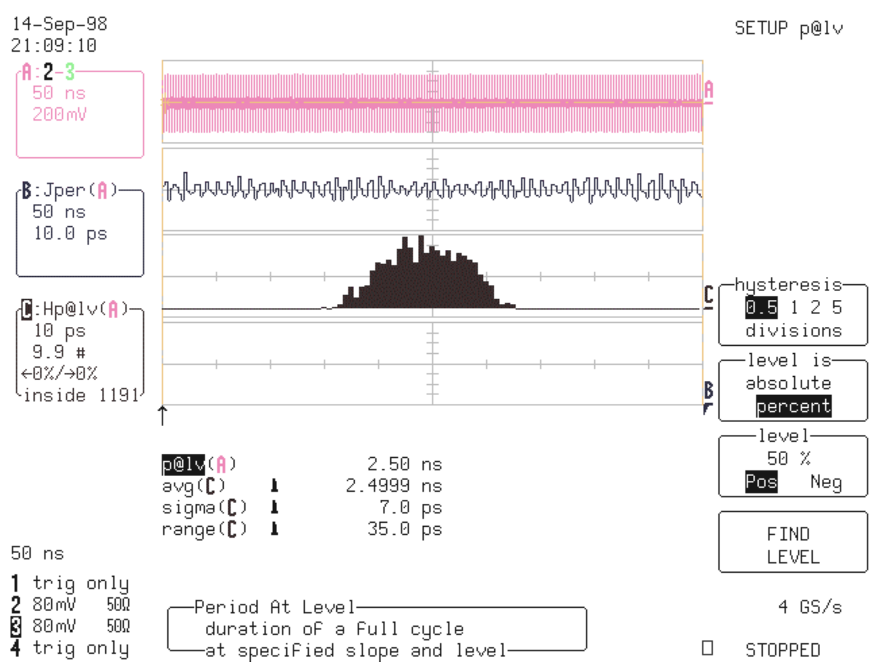

Figure 2 – Measuring short term stability of an oscillator

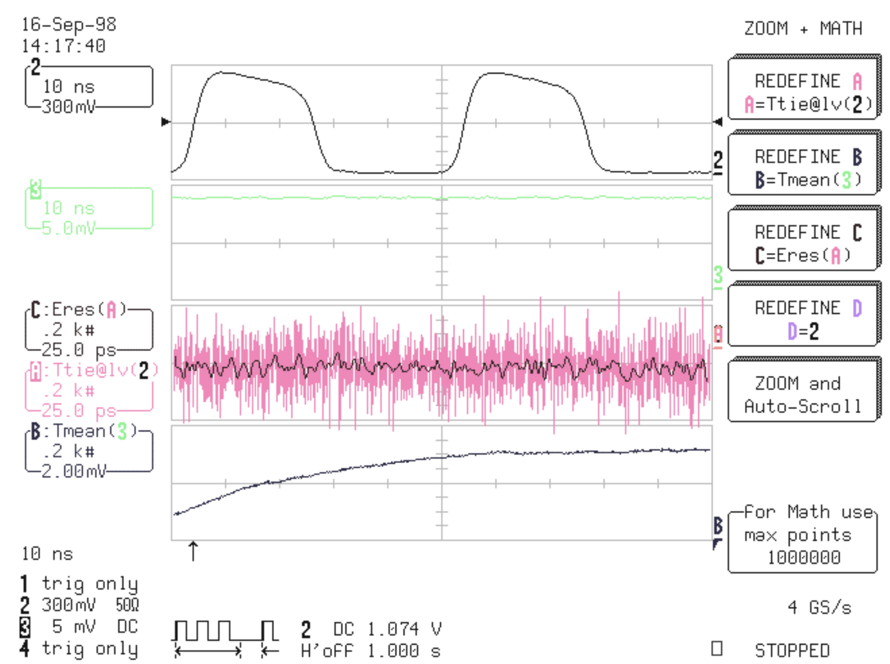

Figure 3 Measuring stability of a 20 MHz oscillator with changes in temperature

this measurement the histogram of the JTA parameter period at level (p@lv) is used to determine period jitter. The histogram parameters avg, sigma, and range read the mean period, rms jitter (standard deviation of period) and peak to peak jitter (range of period values).

By selecting other JitterTrack parameters the width, time interval error, duty cycle, frequency, or cycle to cycle period jitter can be determined.

Environmental stability can be studied with the same tools. Figure 3 illustrates this type of measurement. The lower trace is a trend plot of temperature within the enclosure containing the oscillator. The temperature probe is calibrated to produce 1 mV per degree C.

Trace A is a trend of time interval error at level. A smoothed version of trace A is overlaid on top of it to show the mean variation of time interval error. All of these trend plots contain 2000 measured values. Trigger holdoff is used to take one measurement per second. The trends contain 2000 seconds of data showing the warmup of the oscillator.

The trend of time interval error shows a peak to peak variation of about +/- 100 ps while the temperature changes by about 8 degrees C. Note that there is no apparent relationship between the temperature and time interval error.

These measurements show how the measurement and analysis capabilities of the LeCroy JTA package, complemented by long memory, can be used to characterize oscillator long term, short term and environmental stability.