SUNTSU FREQUENCY CONTROL, INC.

JITTER NOTES

CLOCK JITTER

Clock jitter is defined as the deviations in a clock's output transitions from their ideal positions. The deviations can either lead or lag the ideal position, measured at a specified voltage level, and hence jitter is often specified as an absolute value in picoseconds.

For a crystal-controlled oscillator, jitter is associated with random noise and is always uniformly distributed, i.e., any of the period width deviations within the range are equally probable. In other words, jitter has a Gaussian distribution.

To arrive at the rated values, measurements are taken on an oscilloscope and a histogram of this Gaussian distribution width is recorded and termed as the peak to peak jitter. The histogram should be comprised of measurements from at least 1,000 waveform cycles.

Gigabit-Ethernet, Fibre-channel, and SONET/SDH conventions specify total system jitter either in unit interval (UI) or in RMS units. To arrive at the RMS jitter value, simply take the peak to peak value and divide it by 6.

Please note that the jitter value measured is actually a sum of the jitter of the oscillator plus the jitter inherent in the equipment used to take the measurement. For a DSO (Digital Storage Oscilloscope) this contribution is due to several sources including trigger jitter, timebase stability, and delay jitter. When conducting measurements, minimize the oscilloscope's contribution as much as possible by setting at zero delay, using a trigger signal that is derived from the oscillator being measured itself (since it is of the highest signal to noise ratio possible), and by maximizing the measured waveform dynamic range (setting to the full scale range Volt/Div setting).

Since the oscilloscope, or any other measuring instrument jitter sources are generally uncorrelated with those of the device under test, they can generally be subtracted from the measured data using quadrature subtraction:

$$t_{DUT} = (t_{meas}^{2} - t_{instr}^{2})^{1/2}$$

Where:
- t_{DUT} - jitter of device under test
- t_{meas} - total measured jitter
- t_{instr} - jitter due to instruments

In the values published in Suntsu Frequency Control, Inc. data sheets, this subtraction has not been made. Most users are not aware of the test equipment relationship, and we therefore leave the instrument jitter in the numbers since they most likely will also.

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Cycle-to-cycle and Period Jitter:

Cycle-to-cycle jitter is defined as the deviation between periods of two adjacent cycles. The purpose of this jitter viewpoint is to detect what are called large-displacement failures. The measurement technique requires adjacent cycle capture (thus the term cycle-to-cycle) and therefore must obtain more than two successive edges to make the measurement.

Period jitter is a measurement of a non-adjacent population of periods and arriving upon the maximum difference within the sample taken. This sample is dependent upon the specific sample rate & capability of the particular equipment (oscilloscope used) and therefore can be highly variable if the measurement conditions are not known or are not similar among measurers. Period jitter is critical in detecting short-cycle failures, which is a real and very elusive failure mechanism in a given application.

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