Keysight DSOX6JITTER
Jitter Analysis Option
For InfiniiVision 6000 X-Series Oscilloscopes

Data Sheet

KEYSIGHT TECHNOLOGIES

Introduction

As data rates continue to increase in today's state-of-the-art high-speed digital designs, timing budgets are decreasing. Ensuring that high-speed clocks and serial data signals are valid and stable when receivers sample data often requires an understanding of the effects of the various components of jitter that may contribute to decreased valid data windows. With the DSOX6JITTER jitter analysis option, the InfiniiVision 6000 X-Series oscilloscope can perform various types of jitter analysis measurements with multiple views and quantization of jitter to provide you with valuable insight into the source of unwanted timing errors. The Keysight Technologies, Inc. InfiniiVision 6000 X-Series oscilloscope with the DSOX6JITTER jitter analysis option is the lowest priced oscilloscope jitter analysis test solution in the market today.

Features

- Serial data TIE jitter measurements
- Clock jitter measurements including: clock TIE, N period, period to period, +width to +width, -width to -width, and duty cycle
- Various clock recovery algorithms including: constant/fixed clock, 1st order phase-locked loop (PLL) with loop bandwidth, and 2nd order PLL with loop bandwidth and damping factor
- Various views/plots of jitter including: jitter histogram, jitter trend, jitter spectrum, and jitter statistics
- Color-graded real-time eye with automatic eye-opening measurements

Types of Jitter Analysis

There are various types of jitter analysis measurements that can be selected and performed using the DSOX6JITTER jitter analysis option. Jitter on clock signals can be measured either relative to a software-based recovered ideal clock or relative to selected cycles of the clock signal itself. Jitter measurements on serial data signals, which are sometimes referred to as Time Interval Error (TIE), can be performed relative to either an explicit reference clock or software-based recovered clock.

Figure 1 shows the InfiniiVision 6000 X-Series oscilloscope jitter analysis selection/setup menu. The following table summarizes the various types of jitter analysis that can be selected and performed using the DSOX6JITTER option licensed on an InfiniiVision 6000 X-Series oscilloscope.

Figure 1. InfiniiVision 6000 X-Series oscilloscope jitter analysis setup menu.

Clock jitter measurements	
Clock TIE	Measures timing error of selected edges (rising, falling, or both) of the input clock signal relative to a recovered ideal clock.
N period	Measures the time-span of N consecutive periods of the clock based on the selected edge (rising or falling). Then, it shifts ahead by one period and measures the time-span of the next N consecutive periods, and so on. For example, if N = 3, then jitter = $(T_1 + T_2 + T_3)$, $(T_2 + T_3 + T_4)$, $(T_3 + T_4 + T_5)$, etc.
Period to period	Measures the time difference of successive periods (or groups of periods if N > 1) of the input clock signal on the selected edge (rising or falling). If N = 1, which is sometimes referred to as cycle-to-cycle jitter, then jitter = $T_2 - T_1$, $T_3 - T_2$, $T_4 - T_3$, etc. If N = 3, then jitter = $(T_4 + T_5 + T_6) - (T_1 + T_2 + T_3)$, $(T_5 + T_6 + T_7) - (T_2 + T_3 + T_4)$, etc.
+Width to +width	Measures the time difference of successive positive pulse widths of the input clock signal $({}^{+}PW_{n+1} - {}^{+}PW_n)$.
-Width to -width	Measures the time difference of successive negative pulse widths of the input clock signal $({}^{-}PW_{n+1} - {}^{-}PW_n)$.
+Duty cycle	Measures the duty cycle of every cycle of the input clock signal.

Serial data jitter measurements	
Data TIE	Measures timing error of all edges of the input serial data signal relative to either a recovered ideal clock or an explicit input clock signal.

Views/Plots of Jitter Measurements

Various views/plots of jitter, as well as statistical results of jitter measurements, can be selected to help provide insight into the distribution and source of timing errors including the following:

- Jitter histogram
- Jitter trend
- Jitter spectrum
- Jitter statistics
- Real-time eye

Figure 2 shows an example of a serial data TIE measurement with a jitter histogram plot and jitter trend plot. The histogram shows the probability distribution function (PDF) of accumulated timing errors along with numerical statistics of measured jitter. The jitter trend plot shows timing error of each serial data edge time-correlated to the input data signal (yellow trace) that is under test. In other words, the jitter trend waveform plots timing error on the vertical axis (sec/div) versus time on the horizontal axis.

Figure 3 shows an example of a serial data TIE measurement with the jitter spectrum view along with a jitter trend plot. The jitter spectrum is actually a Fast Fourier Transform (FFT) waveform math operation performed on the jitter trend waveform data. This view of jitter can often times help identify periodic components of jitter as illustrated in this jitter measurement example. Also available are frequency-domain search features to automatically identify peak frequencies. Note that although they not shown, all three views of jitter analysis (histogram, trend, and spectrum) and can be selected and viewed simultaneously.

Figure 2. Jitter analysis with the jitter histogram and jitter trend views of timing errors.

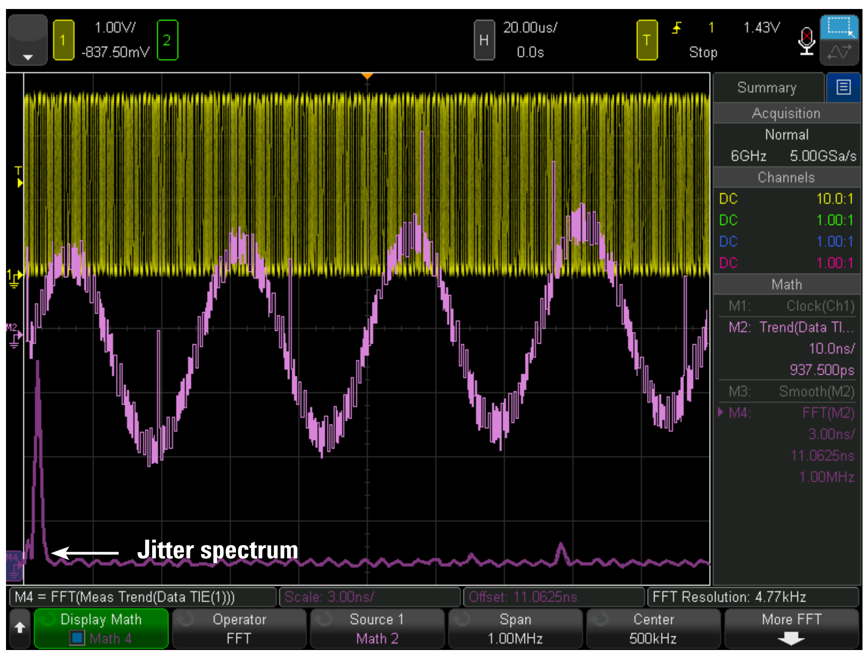


Figure 3. Jitter analysis with the jitter spectrum and jitter trend views of timing errors.

Views/Plots of Jitter Measurements (continued)

In addition to viewing jitter in histogram, trend, and spectrum views, the InfiniiVision 6000 X-Series oscilloscopes can also display a color-graded Real-Time Eye (RTE) of serial data signals as shown in Figure 4. A real-time eye is an overlay of all bits to show worst-case timing (jitter) and worst-case noise relative to a recovered or explicit clock. With a real-time eye display, it is easy to observe the valid data window present at the input of receivers, along with automatic eye opening measurements (eye height and eye width).

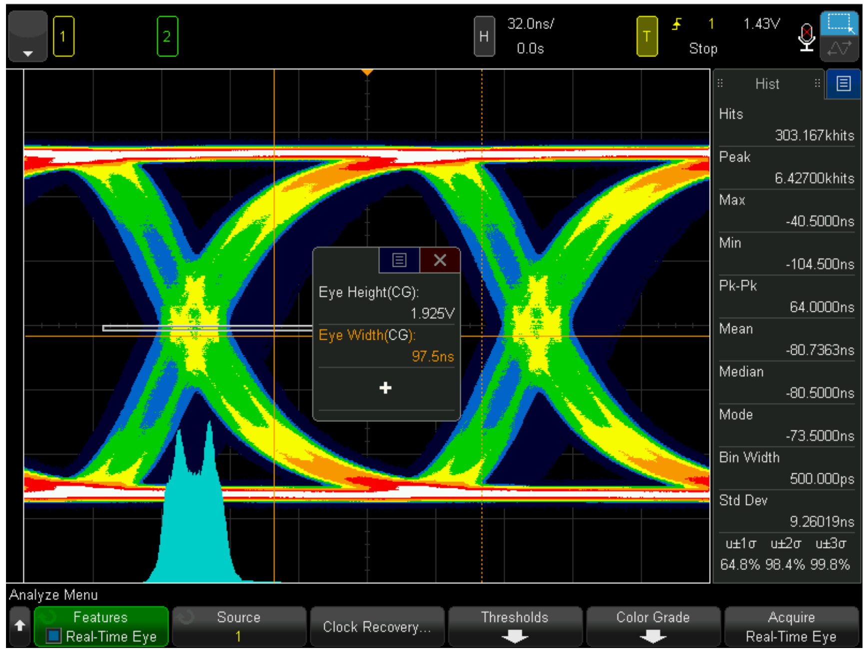


Figure 4. The color-graded real-time eye waveform shows worst-case data valid window (eye-opening).

Clock recovery for jitter measurements

Clock and serial data TIE jitter measurements are performed on all captured edges based on the selected transition(s) relative to either an explicit input reference clock signal or a software-based recovered clock (sometimes referred to as clock data recovery (CDR)). Creating real-time eye displays also requires a recovered clock to use as a reference for slicing the captured serial data waveform into individual Unit Internals (UIs) for overlapping/folding. Since most of today's serial bus signals don't have explicit clocks (clocks are typically embedded in the data signal), software-based clock recovery is required to extract the clock from the data. Figure 5 shows a zoomed-in view of a serial data input (yellow trace), a recovered clock waveform (upper purple trace), and a TIE trend waveform (lower purple trace). TIE (jitter) measurements are performed on each transition of the serial data signal relative to the mid-point of the closest recovered clock, and then these measurement results are plotted as the TIE (jitter) trend waveform.

Figure 5. Software-based clock recovery provides a reference waveform for performing TIE jitter measurements.

The DSOX6JITTER jitter analysis option provides the following software-based clock recovery algorithms:

- Constant/fixed clock
- 1st order PLL clock with user-specified loop bandwidth/cut-off frequency
- 2nd order PLL clock with user-specified loop bandwidth and damping factor
- Explicit clock (captured/not recovered)

Probing Differential Clock and Serial Bus Data Signals

Most of today's higher-speed digital designs are based on differential signaling. If direct 50-Ω cabling from the measurement source to the oscilloscope is not possible, then a differential probe must be used. Keysight recommends the N2750A InfiniiMode Series differential active probes (1.5 to 6 GHz bandwidth models) shown in Figure 6.

The InfiniiMode Series probe allows you to view not only the differential signal, but you can also select to view each side of a differential signal (high-side and low-side) bus relative to ground, as well as the common mode of the bus — without ever moving probe connections.

The InfiniiMode differential active probe comes standard with multiple probe heads for various probing use-models including solder-in, socketed, and browser. This probe also has a high-intensity LED headlight to make it easier to connect to fine-pitch devices.

Figure 6. Keysight's InfiniiMode N2750A Series differential active probe.

Features and characteristics	
Data jitter measurements	Data TIE
Clock jitter measurements	Clock TIE N period Period to period +Width to +width -Width to –width Duty cycle
Jitter views	Histogram Trend Spectrum Statistics Real time eye (color-graded)
Clock recovery	Explicit Constant/fixed 1st order PLL with user-specified loop bandwidth/cut-off frequency 2nd order PLL with user-specified loop bandwidth/cut-off frequency and damping factor

Ordering Information

The DSOX6JITTER jitter analysis option is compatible on all InfiniiVision 6000 X-Series oscilloscope models with bandwidths ranging from 1 to 6 GHz and real-time sampling up to 20 GSa/s. Refer to the InfiniiVision 6000 X-Series oscilloscope data sheet for ordering information about specific oscilloscope models and other licensed options.

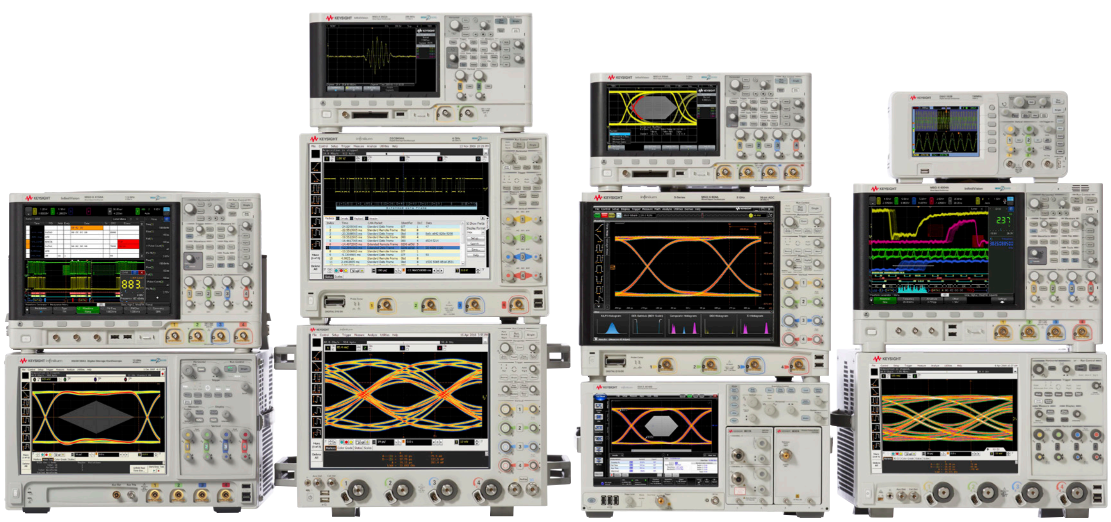
Related Literature

Publication title	Publication type	Publication number
InfiniiVision 6000 X-Series Oscilloscopes	Data sheet	5991-4087EN
N2750A InfiniiMode Series Differential Active Probe	Data sheet	5991-0560EN
Jitter Analysis using Keysight's InfiniiVision 6000 X-Series and Infiniium Series Oscilloscopes	Application note	5991-4000EN
Finding Sources of Jitter with Real Time Jitter Analysis	Application note	5988-9740EN

To download these documents, insert the publication number in the URL: http://literature.cdn.keysight.com/litweb/pdf/xxxx-xxxxEN.pdf

Product web site

For the most up-to-date and complete application and product information, please visit our product Web site at:
www.keysight.com/find/6000X-Series



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