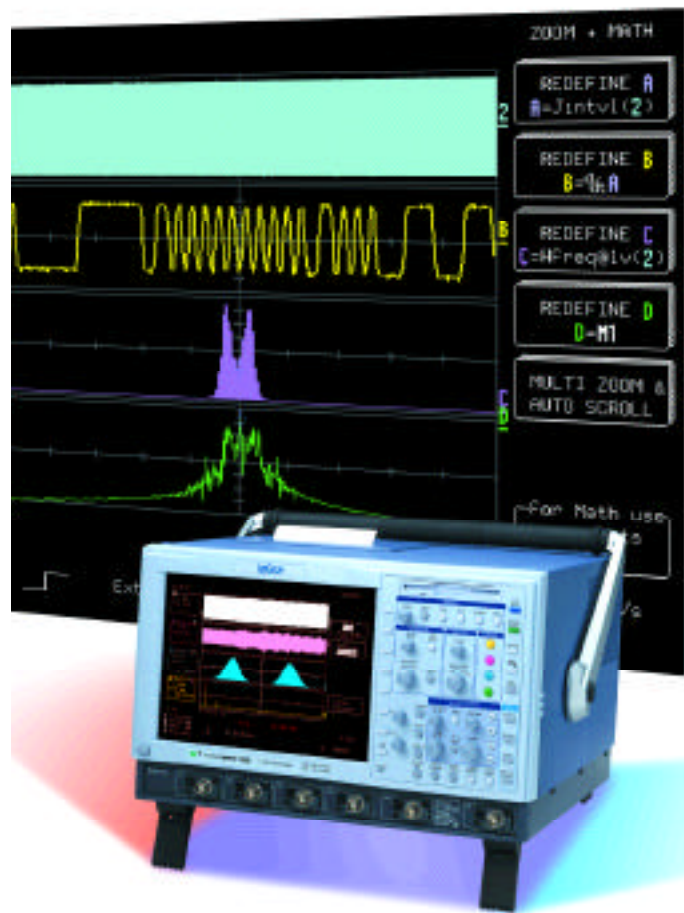


JitterPro™ and JTA

The Most Complete
Jitter and Timing Solutions



THREE VIEWS OF JITTER

Statistical, Time, and Spectral

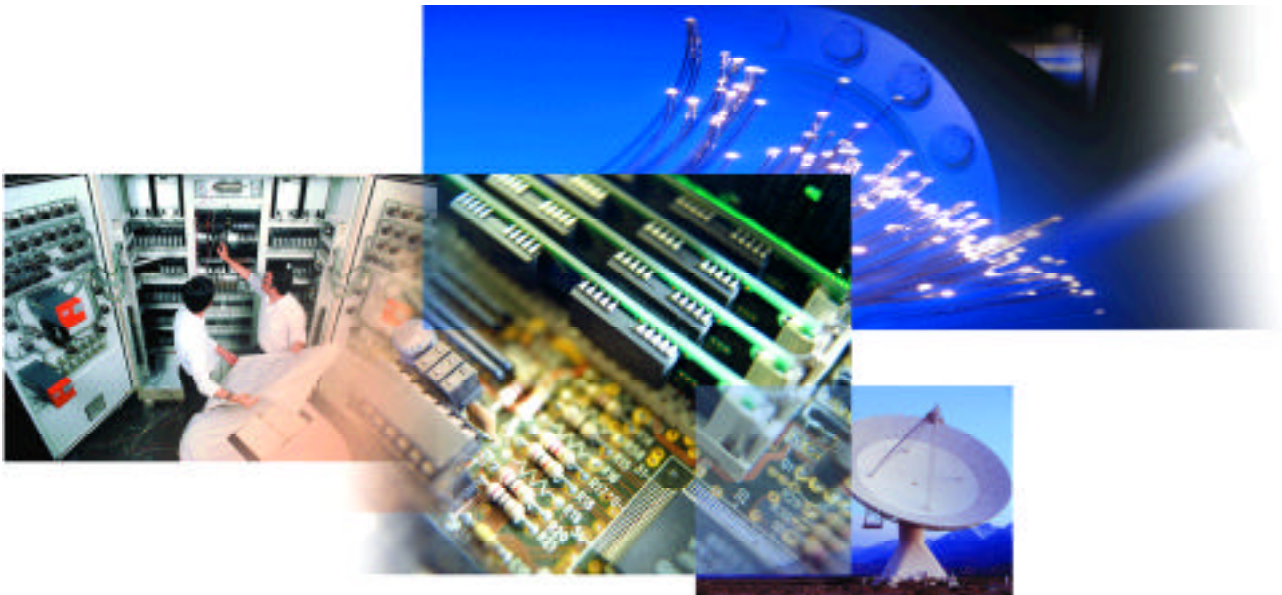
LeCroy

Timing is Everything!

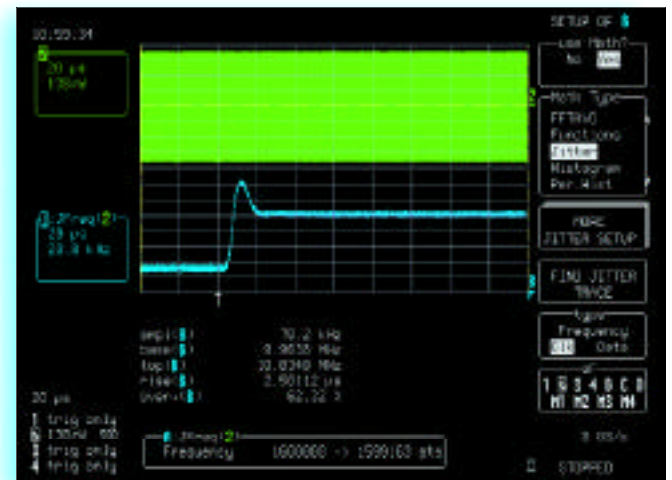
LeCroy helps you get it right! LeCroy jitter and timing analysis packages will help you spot problems before they get to the manufacturing floor or to your customer. Use these packages to find modulation effects, intermittent signal jitter, to track timing changes, and for troubleshooting in the time, frequency and statistical domains. Engineers in design or test will find great utility in these powerful packages. Industry applications include mechanical/rotational machinery, automotive, data communications, telecom, data storage, microprocessor-based designs, PLL characterization, and the testing of clock distribution circuits.

“ I thought my circuit was working fine until I looked at it with a LeCroy scope. ”

“ JTA and JitterPo are the best I found them to be great multi-purpose tools for finding all sorts of circuit problems. Sure, you can spot jitter but also modulation effects and other sorts of anomalies. ”



The Right Scopes — including the New WavePro™ 960 — Provide Acquisition Duration, Flexibility, and Accuracy



Track PLL Response



Three Views of Jitter: Time, Statistical and Frequency



The Best Jitter and Timing Measurement Solution Available Today

LeCroy provides the most complete and useful solutions available today for characterizing, validating, and debugging signal jitter and timing.

Jitter and Timing Analysis Package (JTA)

- High-speed clock and data jitter analysis package
- Spot modulation effects, frequency drift and other timing problems
- Three views of jitter, including JitterTrack
- A rich set of timing measurements for clock, clock-to-data, and datastream analysis
- High-accuracy, peak-to-peak jitter measurements
- Flexibility of operation – to do exactly what you need
- Application-specific solutions
- In combination with a LeCroy scope — get fast answers with a high confidence level

JitterPro (JPro)

- All the features of JTA
- Ease of operation – through JitterWizard™
- Jitter measurements of set-up and hold times
- Clock Certification and Test Module (CCTM option)*

*CCTM is Rambus specified for DRCG clock validation

Three Views Of Jitter

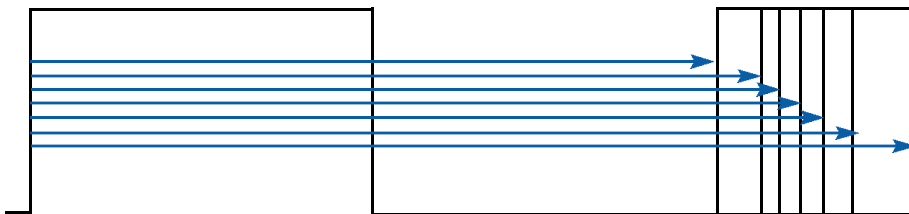
1 – Statistical View

The Key to Measurement Accuracy

More measurements
mean more accuracy!

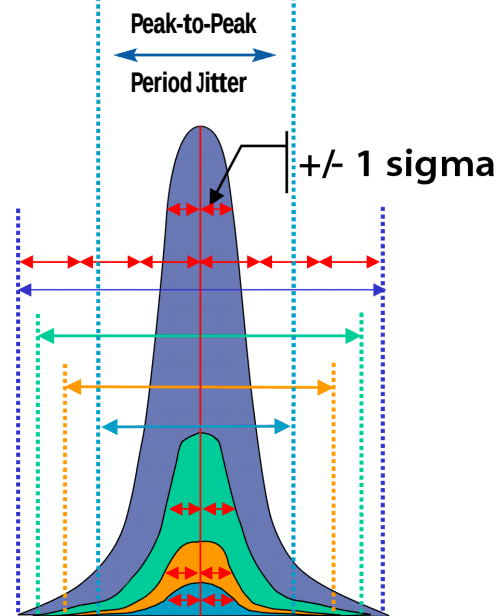
LeCroy's statistical view of jitter gives insight by providing a view of the distribution of jitter. As with any noise-based phenomena, the peak-to-peak value grows as more values are measured. Therefore, anyone interested in determining worst-case timing and jitter values needs to consider the number of measurements taken in making this determination. More is better.

One type of jitter commonly measured is the variation in a clock period as diagrammed below. Consider each arrow as one measurement of period and the difference between the shortest and longest durations as the peak-to-peak jitter. In most designs, it is the worst case jitter occurrences that cause problems. So finding them is crucial.



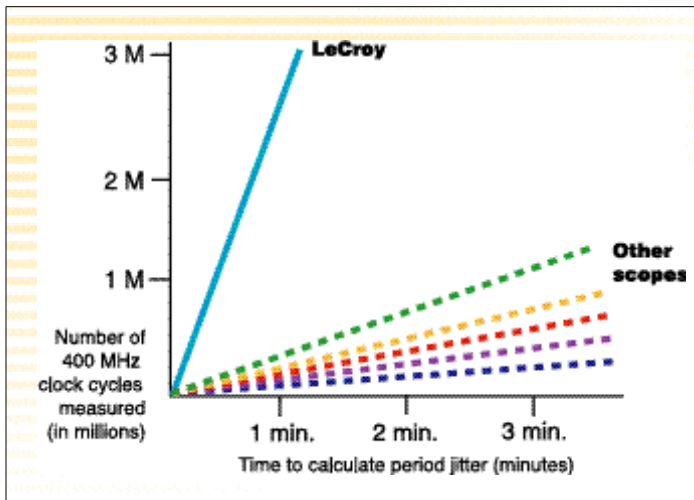
# of Measured Values Measured	Typical Peak-to-Peak (# sigma)
100	+/- 2.58
1,000	+/- 3.29
5,000	+/- 3.72
10,000	+/- 3.89
100,000	+/- 4.42
1,000,000	+/- 4.89
5,000,000	+/- 5.33

Hundreds of thousands — even millions — of timing values are necessary for accurate peak-to-peak measurements. More measurements mean more accuracy!



As more individual measurements are accumulated, their distribution can be displayed in a histogram. The peak-to-peak value grows statistically as more measurements are made.

Processing Performance and Accuracy

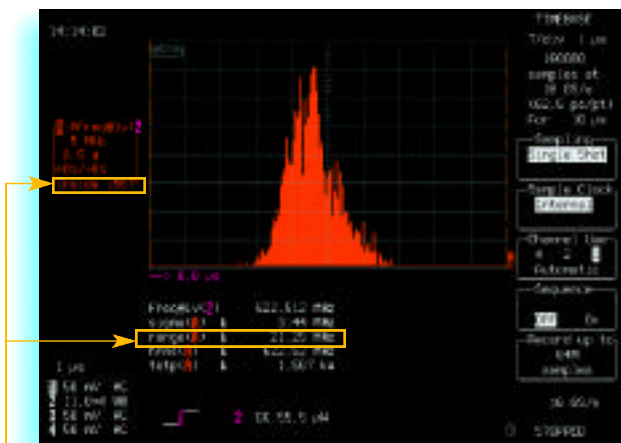


Component selection and clock system validation require that tens of thousands — if not hundreds of thousands — of peak-to-peak jitter measurements be made. LeCroy's ultra-fast processing can provide statistically meaningful measurements of the peak-to-peak range of jitter in seconds, unlike other oscilloscopes that are orders-of-magnitude slower.

Capture Duration and Measurement Accuracy

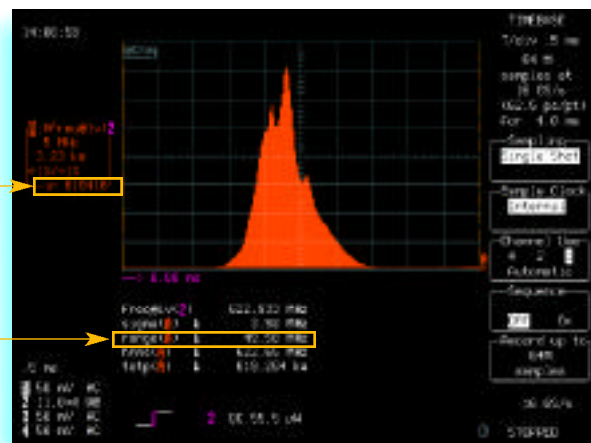
Some measurements, such as n-cycle jitter measurements, can only be performed on a single acquisition. Acquisition duration and the ability to analyze the entire acquisition are the keys to peak-to-peak measurement accuracy.

LeCroy scopes can capture and analyze hundreds of thousands — even millions — of clock cycles in a single acquisition with zero dead time!



100 kpoints Captured/Analyzed

Shown above is a frequency jitter measurement for a high-speed clock using a capture duration of 160 kpoints of acquisition memory (typically available on non-LeCroy scopes). Due to the short capture duration, the histogram has only 1,567 measurement values in its distribution. Note that the frequency jitter value range (D) is 21.25 MHz. Is this the peak-to-peak jitter your system actually sees?



64 Mpoints Captured/Analyzed

Shown above is the same measurement as on the left, using the 64 Mpoint capture duration available in LeCroy scopes. Note that the histogram distribution is now very clear. Also note that the peak-to-peak measurement range (D) is considerably higher and more accurate now because 395 times more measurement values (a total of 619,418) can be included to determine the peak-to-peak range of jitter. The more accurate range of frequency jitter is 49.5 MHz.

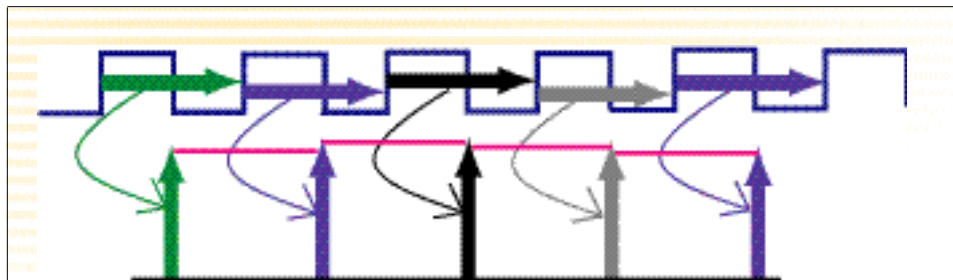
Three Views Of Jitter

2 – Time View

What is JitterTrack?

The key to understanding and debugging jitter is JitterTrack. Imagine that each clock period is represented by a horizontal arrow, as shown below. Variations in time (of the period) are not clear at all. Now imagine that each of these arrows is flipped perpendicularly and placed time-synchronized to the individual

periods they represent. The amplitude of each arrow represents the time duration of each period. By connecting the tops of those arrows, you now can see how a particular jitter measurement varies over time, perfectly synchronized to the signal being measured.

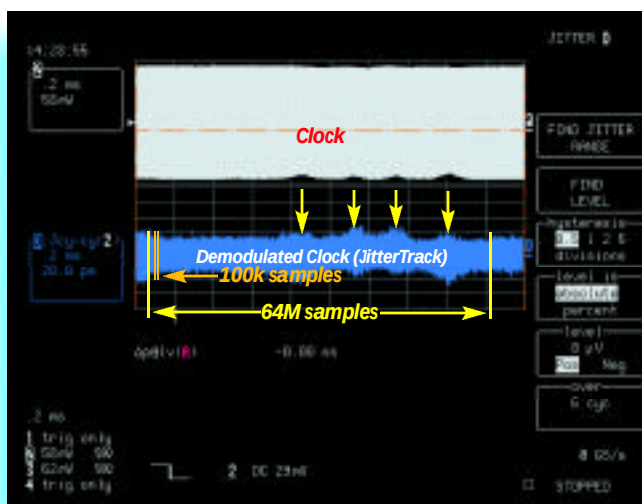


JitterTrack is a patent-pending feature from LeCroy that displays how a jitter/timing measurement varies with time.

Debugging Jitter

JitterTrack is the most useful jitter debugging tool available today. The key to debugging jitter is the ability to correlate jitter events to other device, board, or system signal events.

Only LeCroy's JitterTrack offers this capability by providing a display of jitter that is synchronized in time with the display of captured scope signals.



Jitter Bursts

Shown in the upper trace is a 2 ms capture of a 400 MHz differential clock. The lower trace is the JitterTrack of the clock's cycle-to-cycle jitter displayed synchronized in time with the clock signal. The JitterTrack signal shows clear bursts of higher jitter. The times of these bursts correspond directly to times when the clock signal has a slight reduction in amplitude. A clear relationship between the two events, amplitude variation and jitter bursts, is thereby easily determined. Also note that a scope with a short capture—duration, or limited analysis window, of only 100k samples would be incapable of identifying this phenomenon.

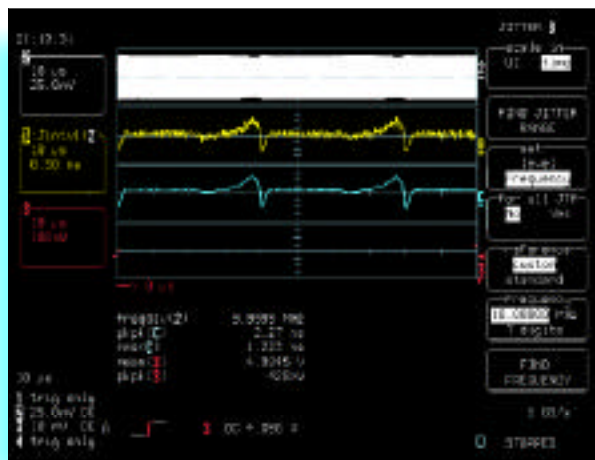
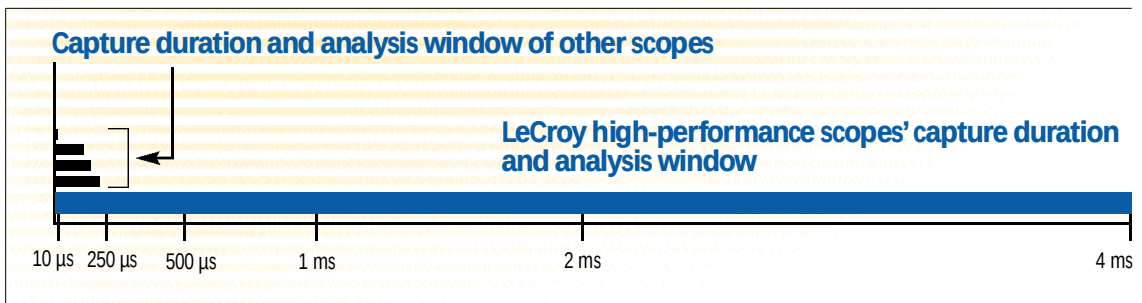
Don't get stuck without the right tools to do your job!

Acquisition Duration is Crucial to Jitter Debug and Characterization

Many phenomena that impact jitter and timing — such as power glitches, clock modulation, PLL step response, etc. — take hundreds of microseconds or even milliseconds to occur. Only with the combination of LeCroy's long

capture duration and the JitterTrack function's ability to analyze the entire waveform can these events be detected and analyzed.

Don't get stuck without the right tools to do your job!



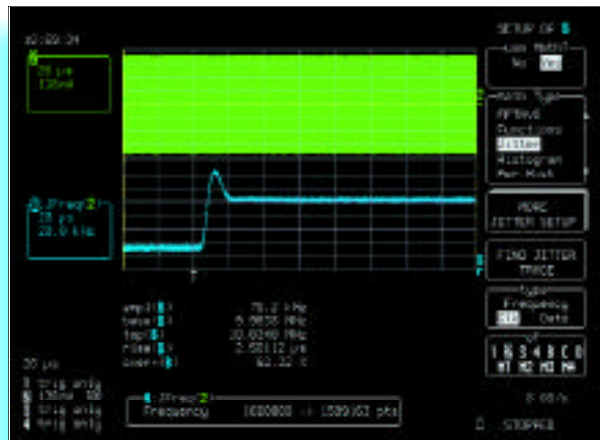
Power Spikes

Power quality problems are the most common source of excessive jitter, but how do you know if this is the case for your circuit? With JitterTrack! The upper trace is a clock signal. The middle trace is a time interval JitterTrack of the clock signal. The bottom trace shows the power signal to the clock chip. Notice that the JitterTrack signal shows spikes of jitter occurring simultaneously with the power spikes. A clear understanding of the impact of power spikes to jitter can be made here only because JitterTrack is synchronized in time with all other captured signals, and because of the long acquisition duration of LeCroy scopes.

JitterTrack for Characterization

PLL Step Response

The upper trace shows a PLL whose reference frequency is being stepped. The lower trace shows the JitterTrack of the PLL's output frequency. The PLL step-response is clearly seen in the JitterTrack, including frequency overshoot and settling time. In addition, a range of measurements are performed directly on the JitterTrack to numerically characterize the frequency step response. LeCroy's JitterTrack capability — combined with the flexibility of the LeCroy interface — allows this (and other critical timing analyses that simply cannot be accomplished with other scopes) to be easily performed.

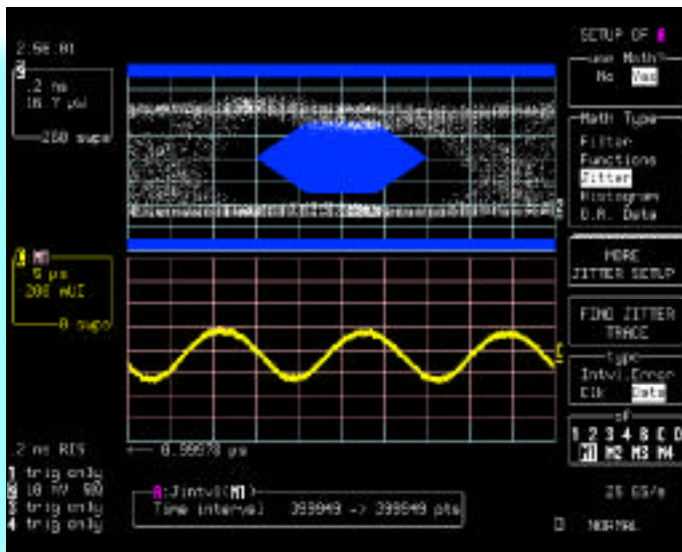


Applications of Timing and Jitter Measurements

Time Interval Error Measurements

LeCroy oscilloscopes and jitter/timing analysis packages can be used to test both optical and electrical communications signals. One type of analysis function which is common for both types of signals is Time Interval Error (TIE). TIE measures the position of each edge in a wave-

form and compares it to the position the edge would have if the waveform frequency was perfect. This analysis can reveal modulation effect, phase noise, and other sources of timing variations.



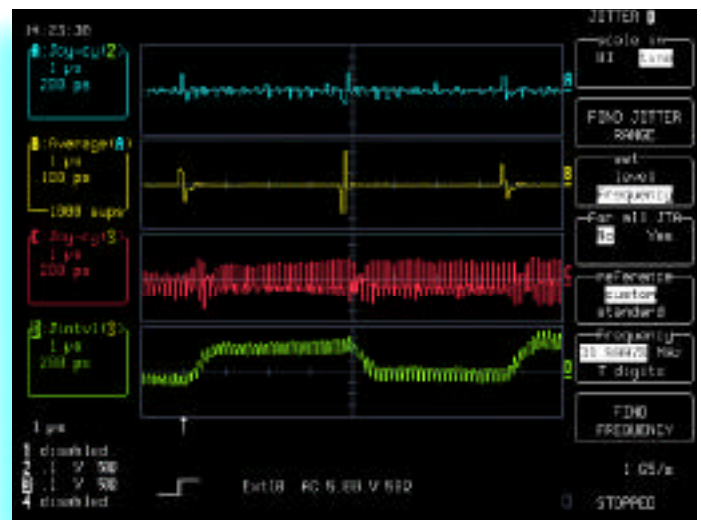
Jitter on Communications Signals

An example of testing an OC-12 optical signal. When mask-testing the signal on Channel 2, a high amount of jitter is noticeable, violating the mask boundaries. A waveform of 50 ms was captured (in memory M1) and the JitterTrack C reveals the jitter is due to modulation. In this case, the jitter is 0.2 UI in amplitude and is modulated by a 65 kHz sinusoid source.

Cycle-to-Cycle Jitter of CPU Clocks

Current microprocessor-based systems employ clock distribution technology that incorporates multiple Phase Locked Loop (PLL) frequency multipliers. This screen shot compares the oscillator and multiplier jitter.

Trace A is the cycle-to-cycle jitter of the PLL. Trace B is the average of Trace A for the 636 acquisitions, revealing noticeable jitter at certain times. Trace C shows the cycle-to-cycle jitter measured at an output of the frequency multiplier. This PLL-based device shows a higher level of cycle-to-cycle jitter. Trace D displays the time interval error of the frequency multiplier. This function plots the time difference between each edge and an ideal clock period as specified by the user. For a fixed frequency clock, this corresponds to instantaneous phase error. Note that the frequency multiplier phase error tracks the ripple waveform. As can be seen, it is possible to track timing effects through the entire clock system using tools found in LeCroy jitter options.



Applications

(continued)

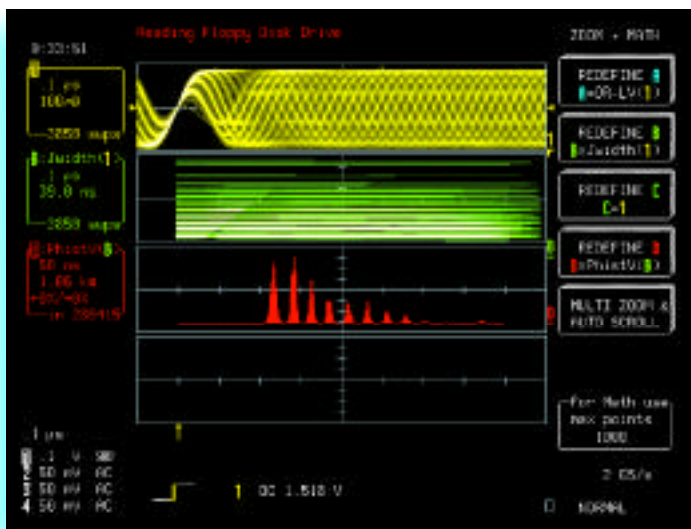
Characterizing the Encoding of Digital Signals

Many types of communications protocols use pulse width modulation or frequency shifting as methods of encoding data. In the examples below, a LeCroy oscilloscope with a jitter analysis package is used to verify proper encoding of the

pit widths in a DVD and correct frequency shifting of a wireless signal. No other instrument gives you this type of ability to capture, view and analyze signals.

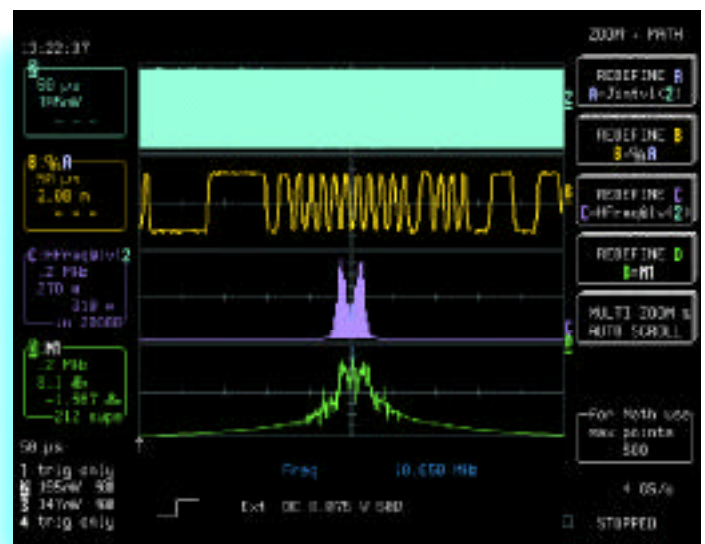
DVD Pulse Width Modulation

The signal from a PlayStation-2 DVD is displayed on Channel 1. The pulsewidth modulation of the signal is shown on Trace B. Trace D shows a histogram of B. It is clearly noticeable that the pulse widths are well defined within narrow bands with no interference between adjacent bands.



Frequency Hopping of a Bluetooth Wireless Signal

A 50 μ s long signal is acquired on Channel 2. Trace A (not shown) is the jitter interval of the input signal. Trace B represents a zoomed view of A, where the frequency hops are clearly noticeable. Trace C displays a frequency histogram of the input signal. And Trace D is the signal spectrum displayed in the frequency domain.

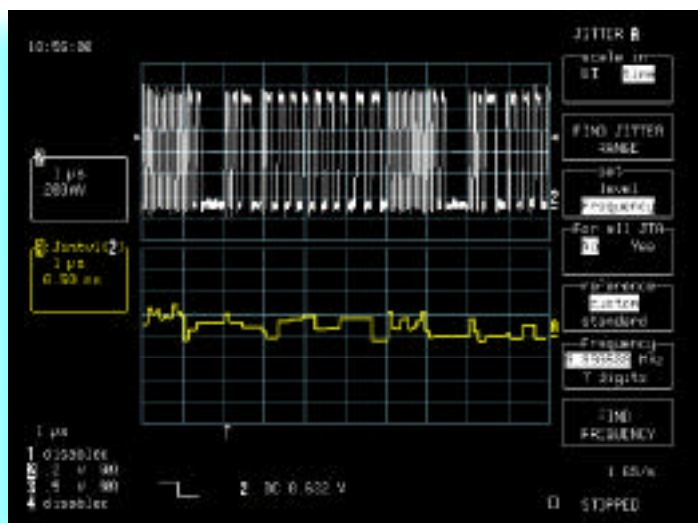


Datastream Time Interval Error (TIE) Measurements

For telecom, datacom, data storage, and other applications employing clock recovery circuitry, serial datastream jitter measurement is an absolute necessity. LeCroy's advanced jitter measurement algorithms provide this capability. Several datastream measurements — including the very important TIE — are

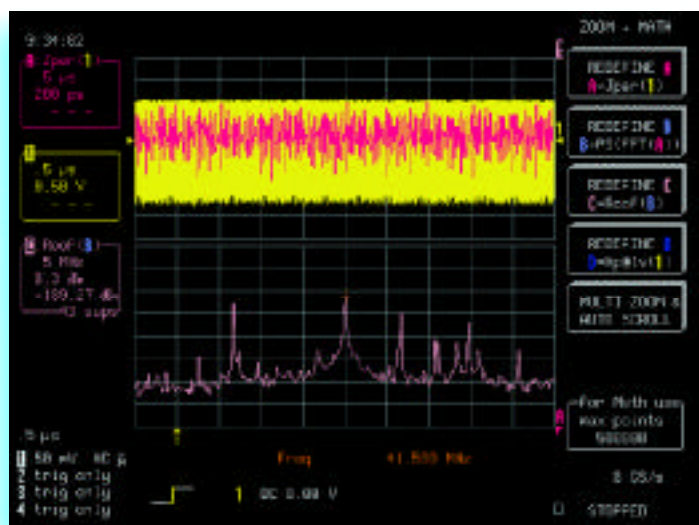
provided. For TIE measurements, high clock stability and long acquisition duration are essential. LeCroy's industry-leading acquisition duration and high-stability sampling clock make them the only scopes to use for TIE measurements.

Shown is a non-standard datastream signal (upper trace) and the corresponding Time Interval Error JitterTrack (lower trace). The variations of datastream jitter in time are easily seen. As with clock signals, all three views of jitter can be selected for datastream signals. In addition, datastream signals based on telecom standards can be easily configured using the "standard" menu selection.



Power Supply Effects on Digital Signals

The upper traces are a high-speed clock (yellow) and JitterTrack of the signal period (red). The lower trace is a spectral view of the jitter. The central frequency is at 41.5 MHz. The locations of peaks in the jitter spectrum are the electronic "fingerprints" of circuit problems. You can use the spectral fingerprint to identify jitter sources. In this example, inadequate decoupling of the 41.5 MHz clock caused power surges each time the clock transitioned. This caused jitter (with a spectral component at 41.5 MHz) of other signals.



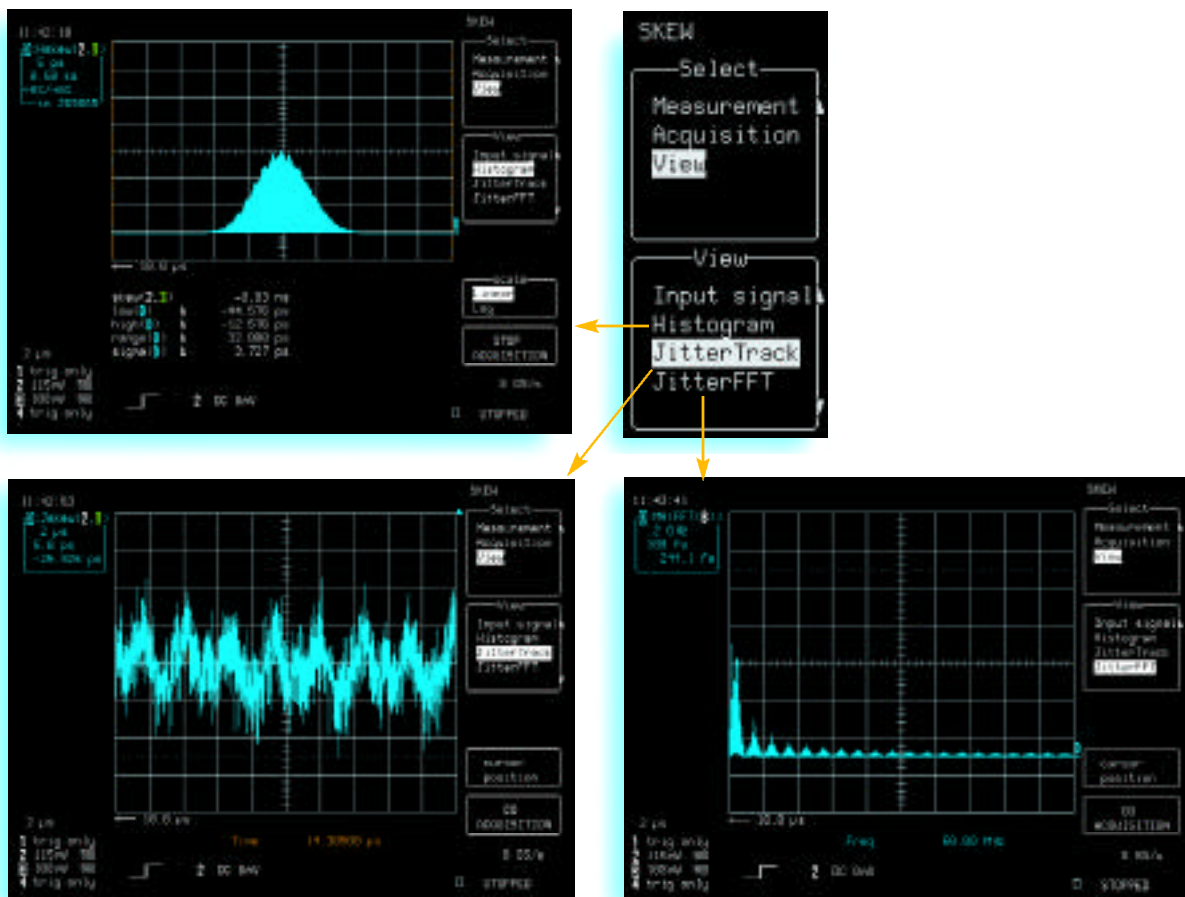
LeCroy Jitter and Timing Products

JitterPro is LeCroy's newest, most powerful and complete jitter measurement and analysis package. It is available for the LC684, LC584 and WavePro™ series of high-end oscilloscopes.

FEATURES

- JitterTrack and a full set of jitter measurements including skew, setup, hold, and n-cycle analysis
- JitterWizard turns your LeCroy DSO into a dedicated jitter analyzer for incredible ease of operation, combined with unparalleled jitter analysis capabilities. All three views of jitter are automatically set up and displayed through a simple menu selection.

Histograms characterize the range and distribution of jitter.



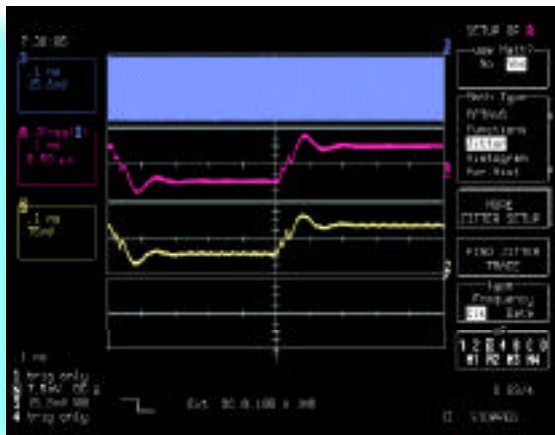
JitterTrack reveals modulation effects and allows intermittent jitter events to be correlated with the signal.

Jitter FFT gives insight to jitter sources using the frequency domain view.

Jitter and Timing Analysis (JTA) Package

JTA is a moderately priced jitter and timing analysis solution for design and test engineers who work with lower performance signals or who only occasionally need to perform jitter and timing measurements. It has broad application from high-speed clock measurements

to lower-speed digital electronics or mechanically related measurements. You can measure a wide variety of timing parameters including cycle-to-cycle, period, frequency, time interval, and width.

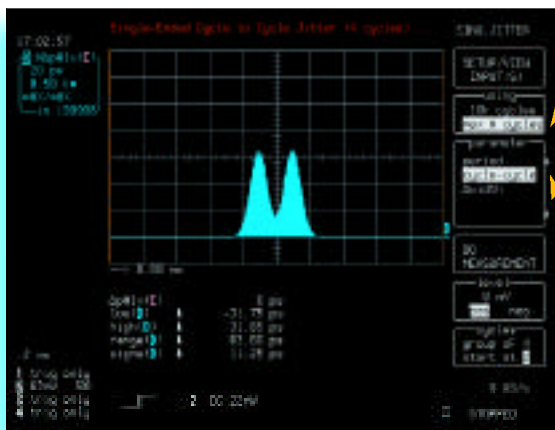


For Voltage Controlled Oscillators (VCOs), linearity of response of output frequency to input voltage is a key characteristic. JTA's JitterTrack feature, combined with the flexibility of LeCroy's user interface, makes VCO linearity easy to determine. The top trace is the output of the VCO. The center trace is a JitterTrack of the VCO output frequency. The bottom trace is the input voltage for the VCO. The linearity of response of the VCO is clearly evident, thanks to the JitterTrack time synchronization to other scope signals.

Clock Certification & Test Module (CCTM) for Rambus®-Specified Jitter Performance

LeCroy's CCTM package is specified by Rambus Inc. as the first approved tool for compliance testing of DRCG (Direct Rambus Clock Generator) jitter. All jitter measurements as

required by Rambus are automatically configured and easily performed through the CCTM wizard.



Rambus specifies that measurements be performed over the same acquisition. Select "10 k" clock cycles for a very rapid snapshot of jitter. Or choose "maximum number" of cycles to apply the power of LeCroy's unparalleled capture length and analysis window to achieve maximum peak-to-peak jitter measurement accuracy. Selection between different measurement choices results in display of jitter measurement distributions and peak-to-peak values using data from the same acquisition.

N-Cycle jitter measurement results are often dependent on the specific clock cycle on which the measurement is initiated. To account for this dependency, CCTM provides the ability to select each possible start cycle (i.e., 0-3 for a 4-cycle measurement) to see how the jitter measurements vary for each of these — all on the same acquisition. Shown (left) is a four-cycle measurement with a start cycle of two.

Jitter Measurement Specifications

Single-Shot Measurements	JitterPro	JTA	CCTM
Clock			
Cycle-to-Cycle	•	•	•
N-Cycle	•	•	•
N-Cycle w/Start Selection	•		•
Frequency	•	•	
Period	•	•	
Width	•	•	
Duty-Cycle Error			•
Time Interval Error	•	•	
Datastream			
Cycle-to-Cycle	•	•	
Frequency	•	•	
Period	•	•	
TIE	•	•	
Two-Signal Measurements			
Skew	•	•	
Setup	•		
Hold	•		
Troubleshooting Tools			
JitterTrack	•	•	•
Jitter FFT	•	•	•
Histogram	•	•	•
JitterWizard	•		•

Jitter Noise Floor

The jitter noise floor specification represents the lowest value of timing jitter which can be observed. The noise floor is determined using an extremely stable pulse generator such as an HP8133 operating at 50 MHz. The signal must be measured in a low-noise environment with high quality cables. The jitter noise floor of JTA and JitterPro when used with a WavePro or LC series oscilloscope is 2 ps rms.

Maximum Clock Stability

1-2 ppm typical, 10 ppm max. Better than 1 ppm with external reference clock option

Capture Duration

Up to 4 ms at 16 GS/s for WavePro 960

Processing Performance

Capture, measure, and view histogram of a 400 MHz clock

Number of Jitter Measurements that can be Displayed

Four traces of JitterTrack, FFT, or histogram can be displayed simultaneously with a choice of any five parameter measurements. Parameter measurements include average, max, min, and standard deviation of parameter values.

JitterTrack and Jitter FFT

Available with JitterPro, JTA, and CCTM

JitterWizards

Available with JitterPro and CCTM

Ordering Information

Ordering Information	Product Code
JitterPro	JPRO
JitterPro Retrofit into a previously delivered scope	RK-JPRO
JitterPro Upgrade for JTA Owners	RK-UPG-JPRO
Jitter and Timing Analysis Package	JTA
JTA Retrofit into a previously delivered scope	RK-JTA
JTA Upgrade for oscilloscopes already containing the Parameter Analysis Package	RK-UPG-JTA
Clock Certification & Test Module (requires JitterPro)	CCTM
Clock Certification & Test Module Field Retrofit	RK-CCTM

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