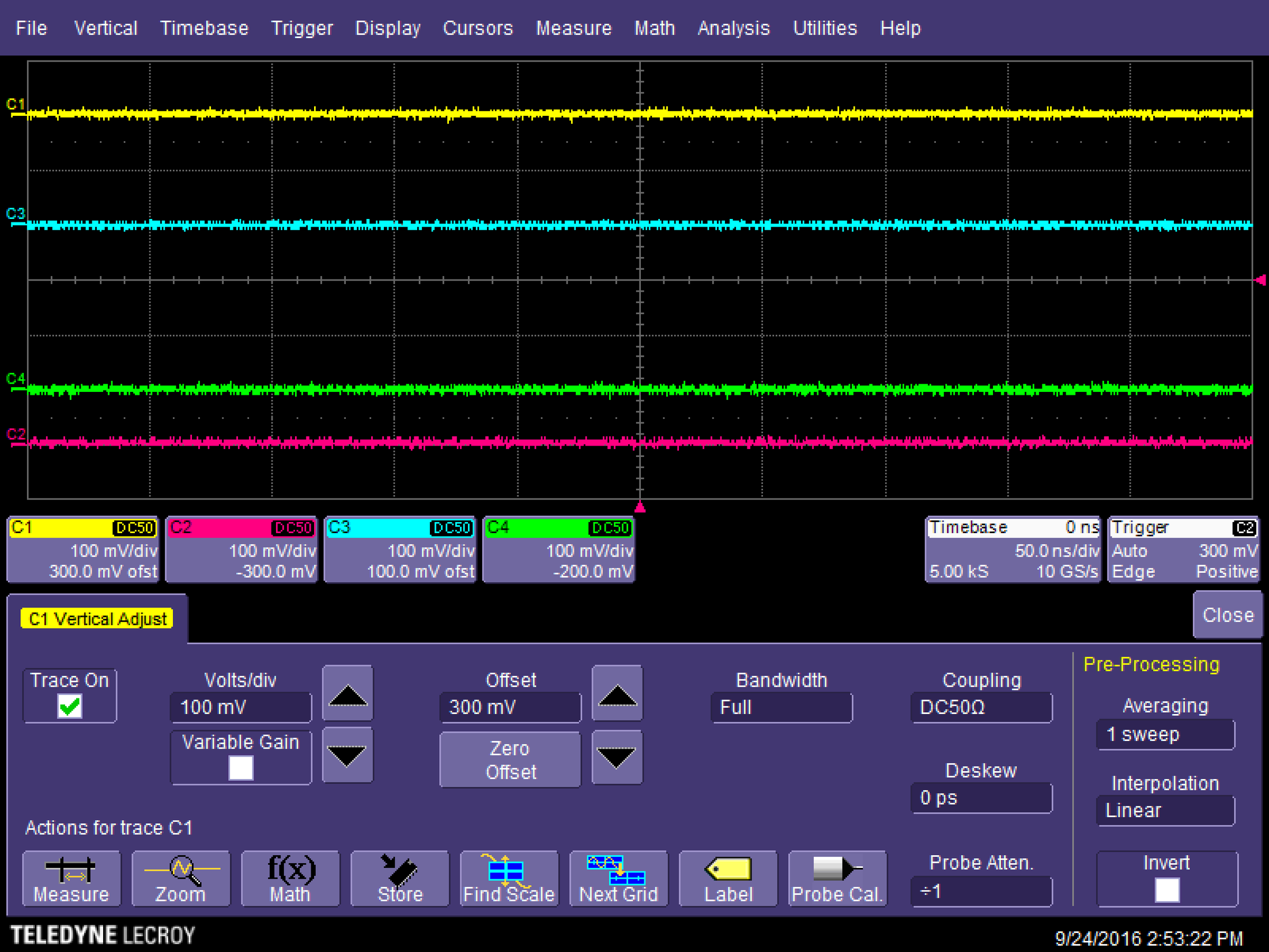

File Vertical Timebase Trigger Display Cursors Measure Math Analysis Utilities Help
C1
C3
C4
C2
C1 DC50
100 mV/div
300.0 mV ofst
500 µV
C2 DC50
100 mV/div
-300.0 mV
7.5 mV
C3 DC50
100 mV/div
100.0 mV ofst
-100 µV
C4 DC50
100 mV/div
-200.0 mV
4.7 mV
F1 zoom(C1)
100 mV/div
10.0 ns/div
500 µV
Timebase 0.0 ns
10.0 ns/div
1.00 kS 10 GS/s
X1= -50.0 ns
Trigger C2
Auto 187 mV
Edge Positive
Math F1 F2 F3 F4 F5 F6 F7 F8
Close
My Math Functions
Use either the button or the tab to change the definition of any of the processing functions.
Zoom Setup
F1 On zoom(C1)
F2 On zoom(C2)
F3 On zoom(C3)
F4 On zoom(C4)
F5 On zoom(C1)
F6 On zoom(C2)
F7 On zoom(C3)
F8 On zoom(C4)
Reset All
Clear Sweeps
TELEDYNE LECROY
9/24/2016 2:59:23 PM


File Vertical Timebase Trigger Display Cursors Measure Math Analysis Utilities Help
C1
C3
C4
C2
C1 DC50
100 mV/div
300.0 mV ofst
C2 DC50
100 mV/div
-300.0 mV
C3 DC50
100 mV/div
100.0 mV ofst
C4 DC50
100 mV/div
-200.0 mV
Timebase 0 ns
50.0 ns/div
5.00 kS 10 GS/s
Trigger C2
Auto 300 mV
Edge Positive
C1 Vertical Adjust
Close
Trace On
Volts/div
100 mV
Variable Gain
Offset
300 mV
Zero Offset
Bandwidth
Full
Coupling
DC50Ω
Deskew
0 ps
Pre-Processing
Averaging
1 sweep
Interpolation
Linear
Invert
Actions for trace C1
Measure
Zoom
f(x) Math
Store
Find Scale
Next Grid
Label
Probe Cal.
Probe Atten.
÷1
TELEDYNE LECROY
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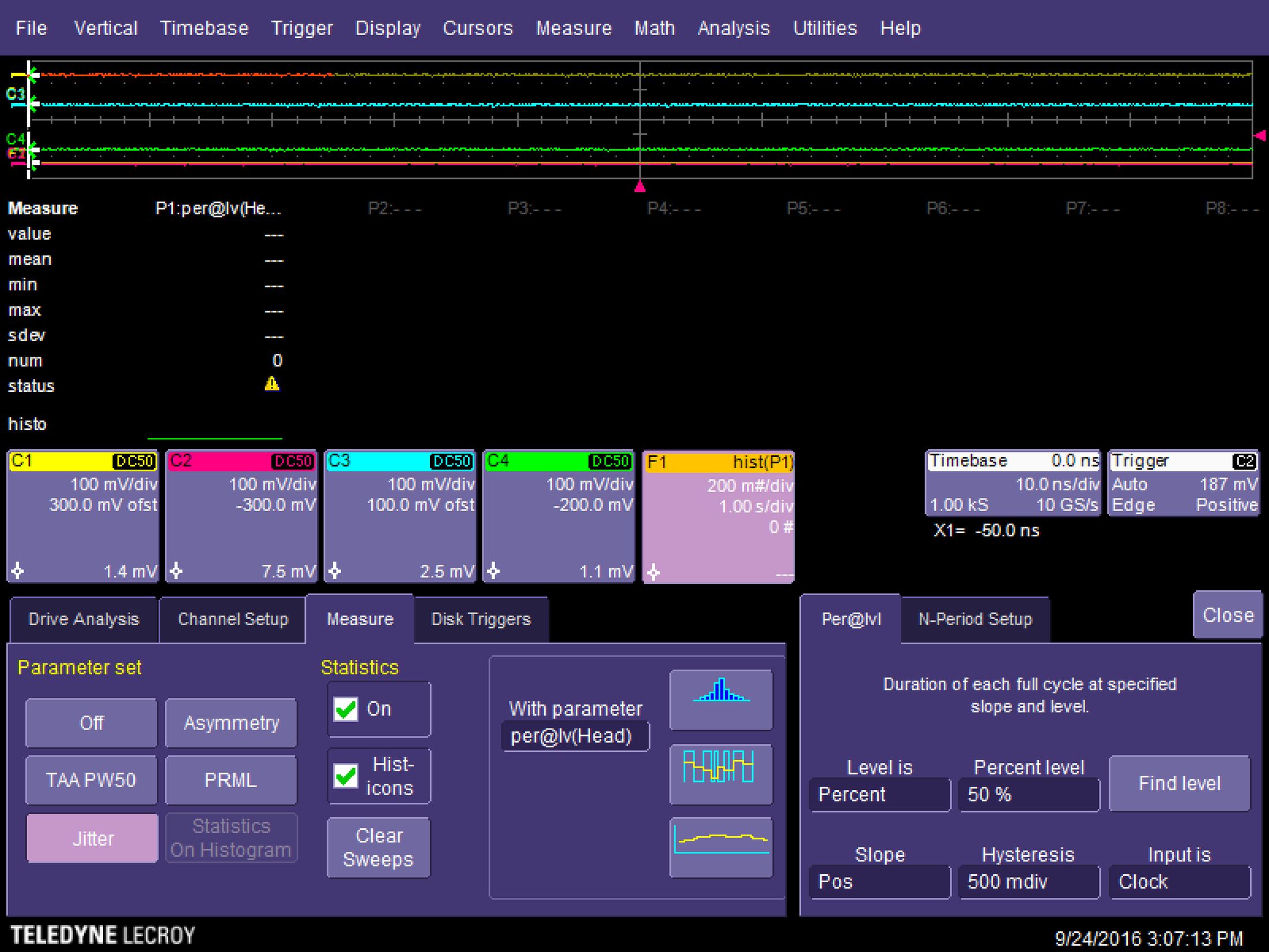
File Vertical Timebase Trigger Display Cursors Measure Math Analysis Utilities Help
C3
C4
Measure P1:per@lv(He... P2:- - - P3:- - - P4:- - - P5:- - - P6:- - - P7:- - - P8:- - -
value ---
mean ---
min ---
max ---
sdev ---
num 0
status
histo
C1 DC50 100 mV/div 300.0 mV ofst 1.4 mV
C2 DC50 100 mV/div -300.0 mV 7.5 mV
C3 DC50 100 mV/div 100.0 mV ofst 2.5 mV
C4 DC50 100 mV/div -200.0 mV 1.1 mV
F1 hist(P1) 200 m#/div 1.00 s/div 0 #
Timebase 0.0 ns 10.0 ns/div 1.00 kS 10 GS/s
X1= -50.0 ns
Trigger C2 Auto 187 mV Edge Positive
Drive Analysis
Channel Setup
Measure
Disk Triggers
Parameter set
Off
Asymmetry
TAA PW50
PRML
Jitter
Statistics On Histogram
Statistics
On
Hist-icons
Clear Sweeps
With parameter
per@lv(Head)
Per@lvl
N-Period Setup
Close
Duration of each full cycle at specified slope and level.
Level is
Percent
Percent level
50 %
Find level
Slope
Pos
Hysteresis
500 mdiv
Input is
Clock
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9/24/2016 3:07:13 PM


File Vertical Timebase Trigger Display Cursors Measure Math Analysis Utilities Help
C1
C3
C4
C2
C1 DC50
100 mV/div
300.0 mV ofst
C2 DC50
100 mV/div
-300.0 mV
C3 DC50
100 mV/div
100.0 mV ofst
C4 DC50
100 mV/div
-200.0 mV
Z1 zoom(C1)
100 mV/div
1.00 ns/div
Timebase 0.0 ns
10.0 ns/div
1.00 kS 10 GS/s
Trigger C2
Auto 187 mV
Edge Positive
Zoom Z1 Z2 Z3 Z4 MultiZoom
Close
Trace On
Source
C1
Segments
First
1
Num
1
Horizontal
Scale / div
1.00 ns
Center
0.00 ns
x10.00
out
in
Var.
Vertical
Scale / div
100 mV
Center
-300.0 mV
x 1.00
out
in
Var.
Preview
Measure
Store
Next
Label
Reset Zoom
TELEDYNE LECROY
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File Vertical Timebase Trigger Display Cursors Measure Math Analysis Utilities Help
C1
C3
C4
C2
C1 DC50
100 mV/div
300.0 mV ofst
C2 DC50
100 mV/div
-300.0 mV
C3 DC50
100 mV/div
100.0 mV ofst
C4 DC50
100 mV/div
-200.0 mV
Timebase 0 ns
100 ns/div
10.0 kS 10 GS/s
Trigger C2
Auto 187 mV
Edge Positive
Utilities Status Remote Hardcopy Aux Output Date/Time Options
Close
Use Auxiliary Output For
Square
Trigger Enabled
Trigger Out
Pass/Fail
DC Level
Off
Amplitude into 1MOhm
1.000 V
Frequency
5.00 MHz
TTL Level
Set to 1KHz, 1V Square Wave
TELEDYNE LECROY
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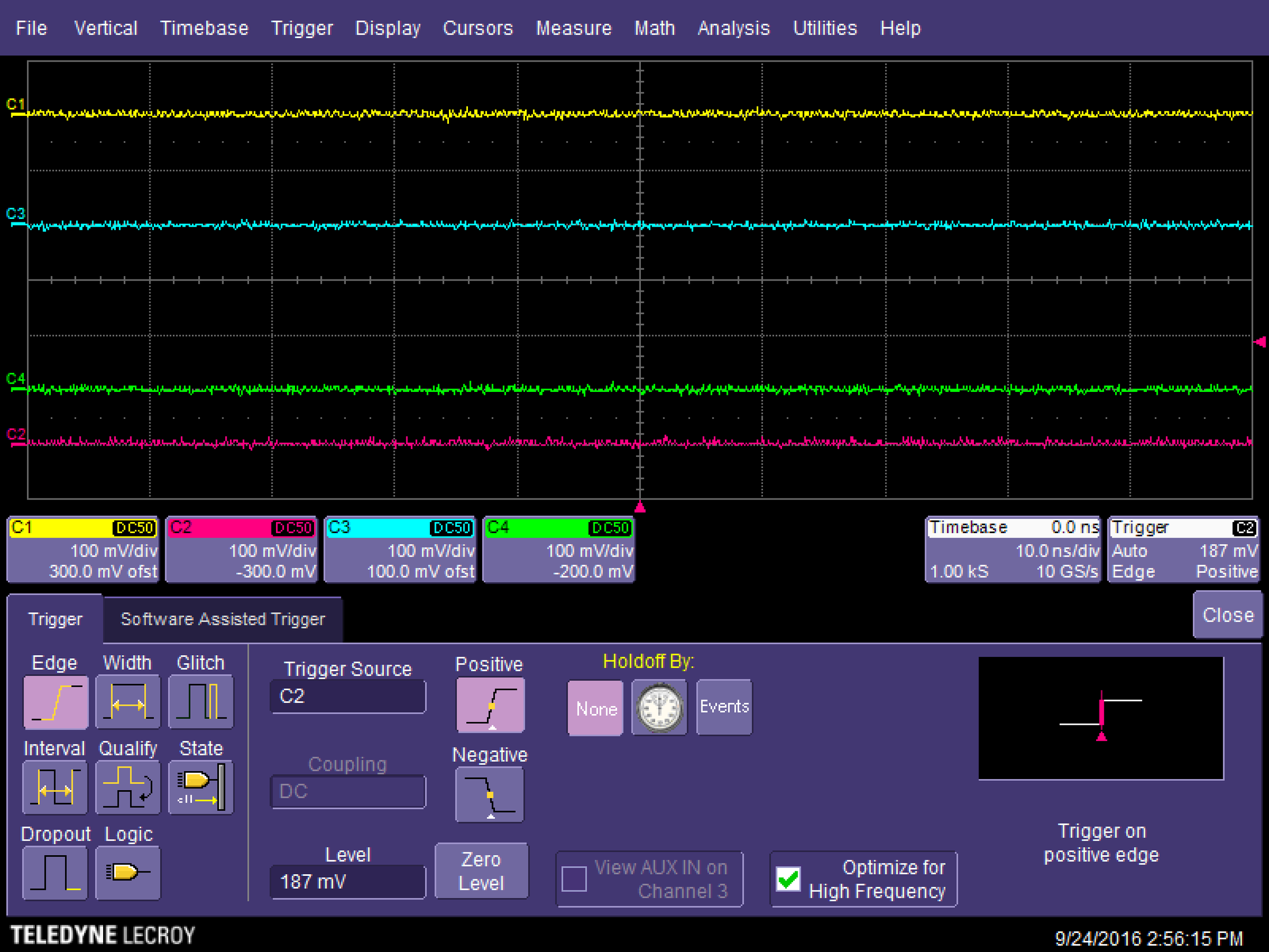
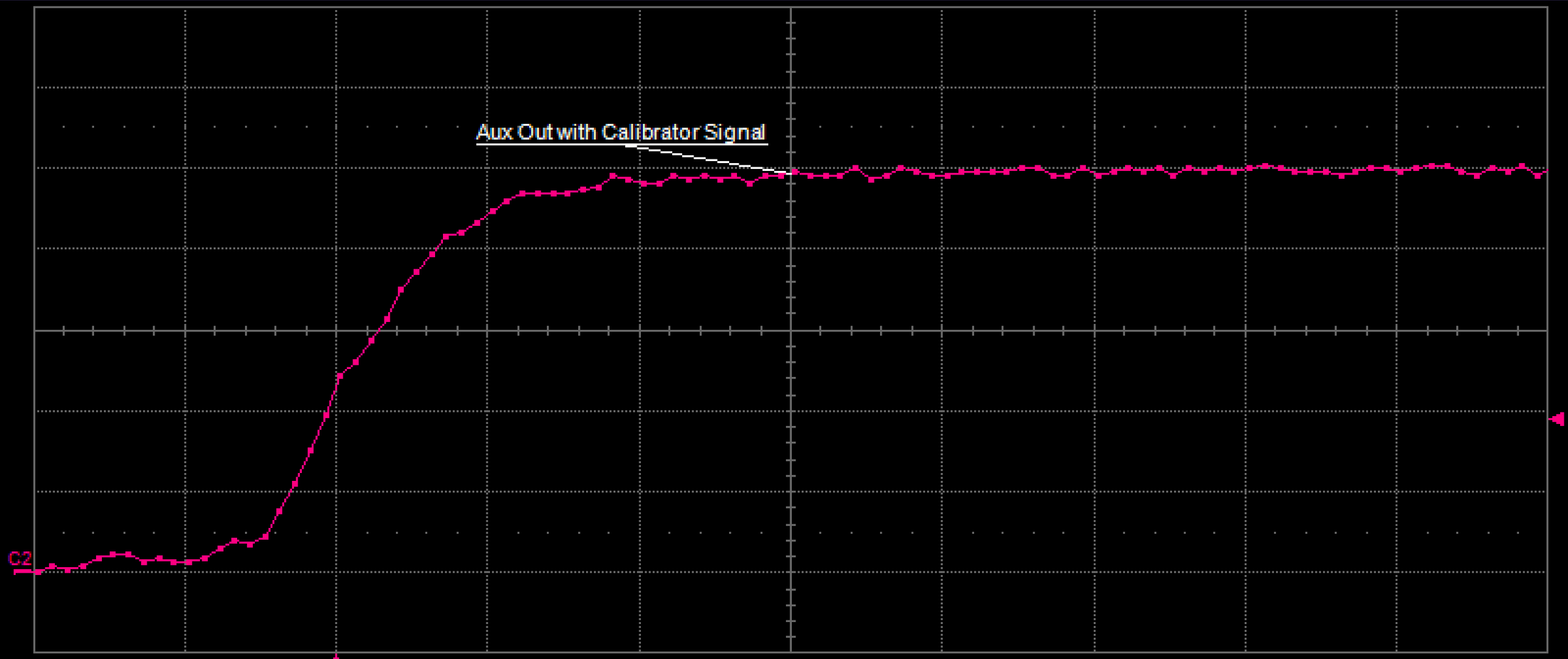
File Vertical Timebase Trigger Display Cursors Measure Math Analysis Utilities Help
C1
C3
C4
C2
C1 DC50
100 mV/div
300.0 mV ofst
C2 DC50
100 mV/div
-300.0 mV
C3 DC50
100 mV/div
100.0 mV ofst
C4 DC50
100 mV/div
-200.0 mV
Timebase 0 ns
100 ns/div
10.0 kS 10 GS/s
Trigger C2
Auto 187 mV
Edge Positive
Save/Recall
Save Waveform
Recall Waveform
Save Table
Save Setup
Recall Setup
Disk Utilities
Close
Delete
Delete
Create
Current Folder
D:\Waveforms\
Browse
Empty Folder
File To Be Deleted
Browse
Delete File
Disk Space
Size : 24.9 GB
Free : 24.4 GB
File(s) : 0
TELEDYNE LECROY
9/24/2016 3:12:12 PM


File Vertical Timebase Trigger Display Cursors Measure Math Analysis Utilities Help
C1
C3
C4
C2
C1 DC50
100 mV/div
300.0 mV ofst
C2 DC50
100 mV/div
-300.0 mV
C3 DC50
100 mV/div
100.0 mV ofst
C4 DC50
100 mV/div
-200.0 mV
Timebase 0.0 ps
20.0 ps/div
2.00 S 10 GS/s
Trigger C2
Auto 187 mV
Edge Positive
Horizontal
SMART Memory
Clock Source
Close
Timebase
Time/Division
20.0 ps
Max Sample Points
100 MS
2 S at 10 GS/s
100 ps/pt for 200 ps
SMART Memory
Delay
Delay
0.0 ps
Set To Zero
Active Channels
4 10GS/s
2 20GS/s
Auto Maximize
Sample Mode
RealTime
RIS
Sequence
Acquires a series of measured voltage values associated with a single trigger event
Num Segments
10
TELEDYNE LECROY
9/24/2016 2:55:36 PM


File Vertical Timebase Trigger Display Cursors Measure Math Analysis Utilities Help
C1
C3
C4
C2
C1 DC50
100 mV/div
300.0 mV ofst
C2 DC50
100 mV/div
-300.0 mV
C3 DC50
100 mV/div
100.0 mV ofst
C4 DC50
100 mV/div
-200.0 mV
Timebase 0.0 ns
10.0 ns/div
1.00 kS 10 GS/s
Trigger C2
Auto 187 mV
Edge Positive
Trigger
Software Assisted Trigger
Close
Edge
Width
Glitch
Interval
Qualify
State
Dropout
Logic
Trigger Source
C2
Coupling
DC
Level
187 mV
Zero Level
Positive
Negative
Holdoff By:
None
Events
View AUX IN on Channel 3
Optimize for High Frequency
Trigger on positive edge
TELEDYNE LECROY
9/24/2016 2:56:15 PM

File Vertical Timebase Trigger Display Cursors Measure Math Analysis Utilities Help



StdVer	P1:pkpk(C2)	P2:ampl(C2)	P3:max(C2)	P4:min(C2)	P5:sdev(C2)	P6:mean(C2)	P7:base(C2)	P8:top(C2)
value	504 mV	479.2 mV	503 mV	-1 mV	180.4 mV	386.4 mV	17.2 mV	496.3 mV
mean	505.698 mV	480.285 mV	508.182 mV	2.484 mV	179.783 mV	388.336 mV	17.686 mV	497.971 mV
min	495 mV	470.0 mV	503 mV	-5 mV	177.0 mV	384.7 mV	-523 µV	493.5 mV
max	513 mV	512.7 mV	517 mV	8 mV	182.6 mV	391.5 mV	25.6 mV	512.1 mV
sdev	3.792 mV	3.306 mV	2.499 mV	3.147 mV	1.299 mV	1.578 mV	2.623 mV	1.733 mV
num	435	435	435	435	435	435	435	435
status	✔	✔	✔	✔	✔	✔	✔	✔
histo								

C2 DC50
100 mV/div
-300.0 mV

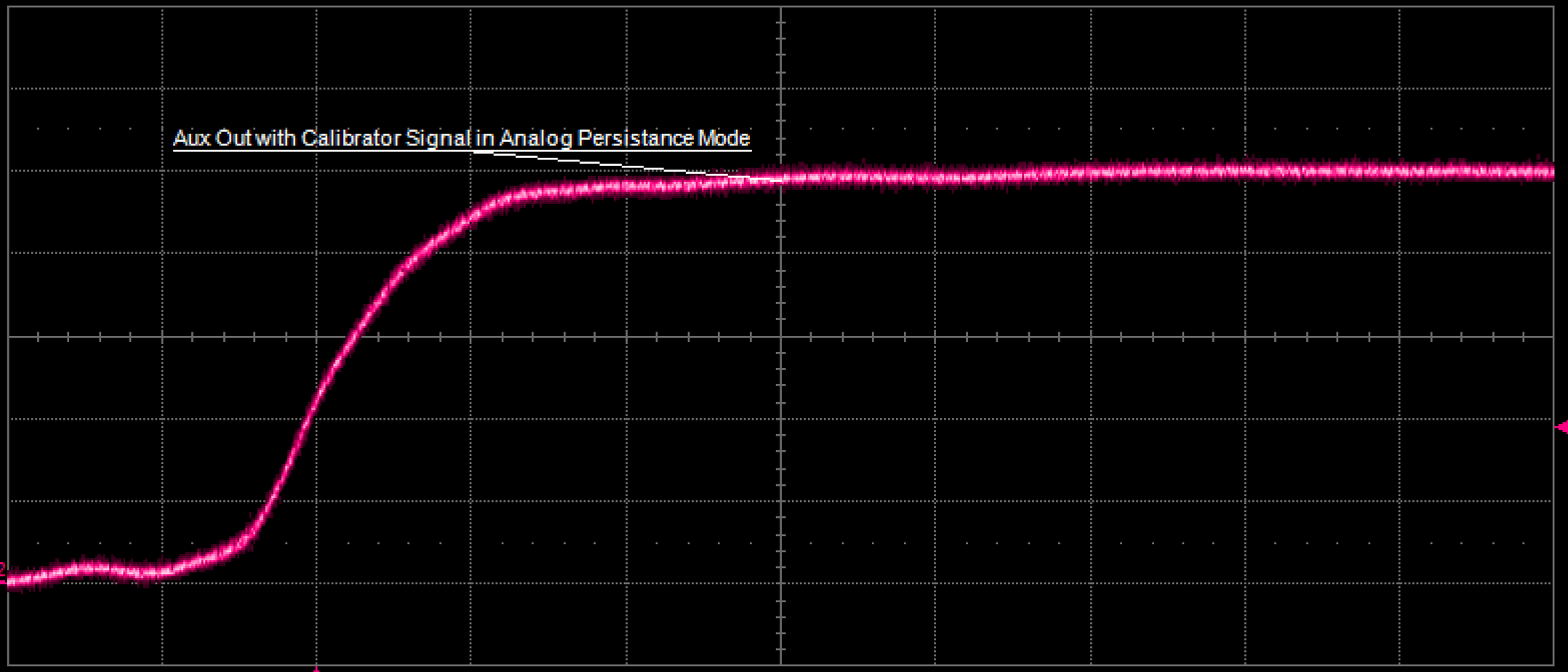
Timebase -1.50 ns
500 ps/div
100 S 20 GS/s

Trigger C2
Stop 187 mV
Edge Positive

TELEDYNE LECROY

9/24/2016 3:45:52 PM

File Vertical Timebase Trigger Display Cursors Measure Math Analysis Utilities Help



StdVer	P1:pkpk(C2)	P2:ampl(C2)	P3:max(C2)	P4:min(C2)	P5:sdev(C2)	P6:mean(C2)	P7:base(C2)	P8:top(C2)
value	504 mV	480.2 mV	508 mV	4 mV	180.1 mV	387.1 mV	16.9 mV	497.1 mV
mean	505.729 mV	480.317 mV	508.219 mV	2.490 mV	179.810 mV	388.222 mV	17.641 mV	497.957 mV
min	495 mV	470.0 mV	503 mV	-9 mV	176.8 mV	384.7 mV	-4.9 mV	493.1 mV
max	517 mV	512.7 mV	517 mV	8 mV	183.1 mV	391.5 mV	25.6 mV	512.1 mV
sdev	3.936 mV	3.400 mV	2.526 mV	3.253 mV	1.269 mV	1.563 mV	2.713 mV	1.711 mV
num	745	745	745	745	745	745	745	745
status	✔	✔	✔	✔	✔	✔	✔	✔
histo								

C2 DC50
100 mV/div
-300.0 mV

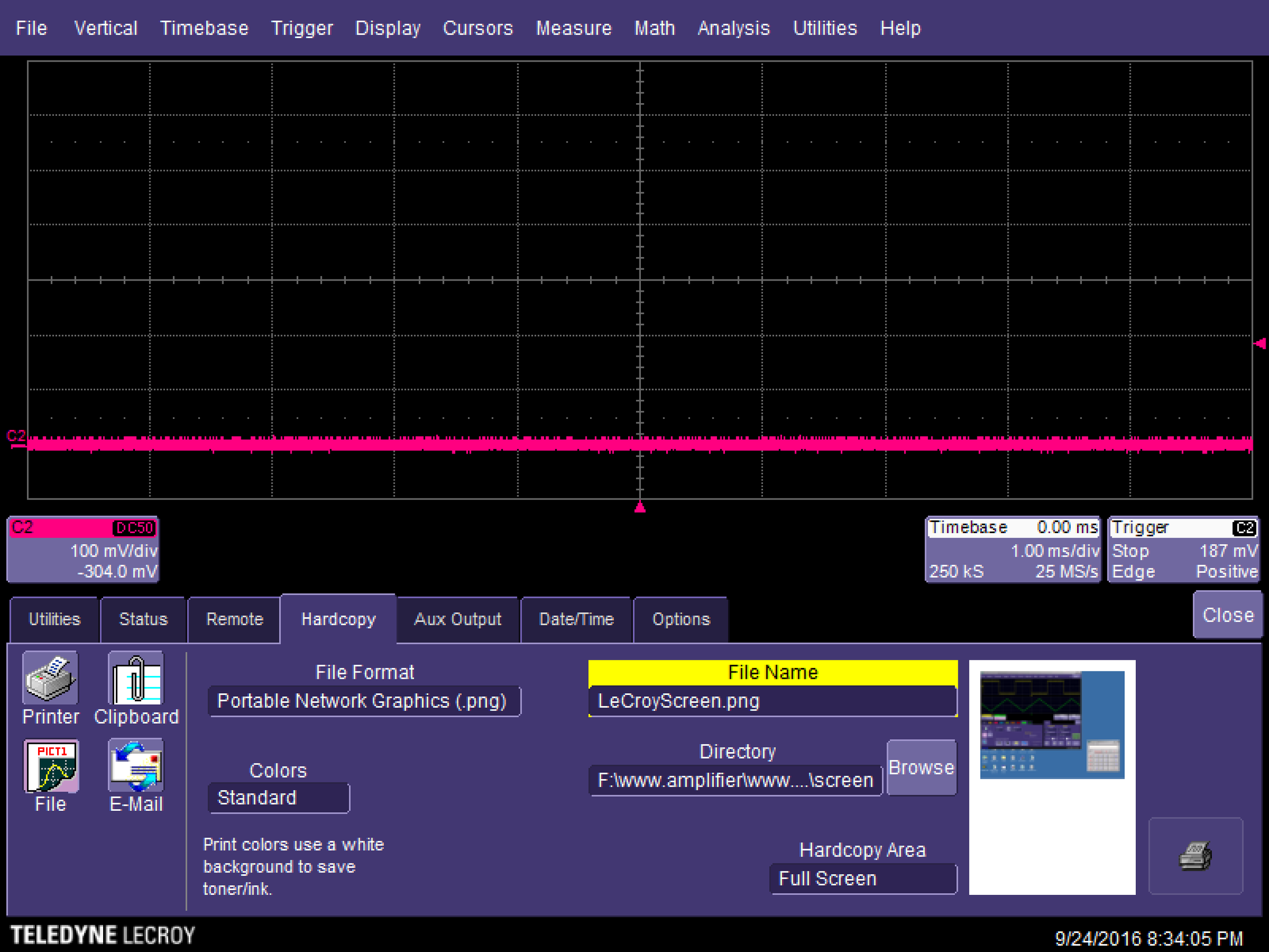
Timebase -1.50 ns
500 ps/div
100 S 20 GS/s

Trigger C2
Stop 187 mV
Edge Positive

TELEDYNE LECROY

9/24/2016 3:47:33 PM


File Vertical Timebase Trigger Display Cursors Measure Math Analysis Utilities Help
C1
C3
C4
C2
C1 DC50
100 mV/div
300.0 mV ofst
C2 DC50
100 mV/div
-300.0 mV
C3 DC50
100 mV/div
100.0 mV ofst
C4 DC50
100 mV/div
-200.0 mV
Timebase 0.0 ns
10.0 ns/div
1.00 kS 10 GS/s
Trigger C2
Auto 187 mV
Edge Positive
Display
Persistence
Monitor
Close
Auto
Single
Dual
Quad
Octal
XY
XYSingle
XYDual
Tandem
Quattro
Grid
Grid Intensity
40 %
Grid on Top
Axis Labels
Trace
Line
Points
XY
Input X
C2
Input Y
C3
Sequence
Display Mode
Adjacent
Use Zoom traces to select segments viewed and processed.
TELEDYNE LECROY
9/24/2016 2:56:50 PM


File Vertical Timebase Trigger Display Cursors Measure Math Analysis Utilities Help
C2
C2 DC50
100 mV/div
-304.0 mV
Timebase 0.00 ms
1.00 ms/div
250 kS 25 MS/s
Trigger C2
Stop 187 mV
Edge Positive
Utilities Status Remote Hardcopy Aux Output Date/Time Options
Close
Printer
Clipboard
File
E-Mail
File Format
Portable Network Graphics (.png)
Colors
Standard
Print colors use a white background to save toner/ink.
File Name
LeCroyScreen.png
Directory
F:\www.amplifier\www....\screen
Browse
Hardcopy Area
Full Screen
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DRIVE ANALYSIS OVERVIEW

Channel Emulation
With or Without Reference
Stop on SAM
Analog Compare
Measure's Drive Parameters

Obstacles that Can be Overcome using the DDA's Channel Analysis

Disk Drive engineers who are analyzing channels to determine where and why data errors occur face important obstacles. But the DDA's Channel Analysis feature can be used to overcome these obstacles.

Lack of Synchronization

The first obstacle is the lack of integration or synchronization between the computers used to identify and locate data errors, and the instruments that analyze the channel signals. It is, therefore, difficult to capture the signal that may be responsible for an error at the same point in time at which the error occurs. If an error is repetitive, its signal can be captured and viewed. But if the error is intermittent, capturing it at the correct time may be impossible.

Unknown Sectors

Another obstacle is that the data written to a particular sector may not be known. And because no reference is available, the exact location of an error in a particular sector cannot be determined. In order to have a known data set, data may subsequently be written to the sector concerned. Nevertheless, there is no guarantee that this will recreate the error. For many, writing to a sector with errors is the last resort.

Problematic PRML

Another problem is the difficulty of analyzing partial response maximum likelihood (PRML) head signal quality and identifying both the problem locations and the margin available before errors occur. Head signals for PRML channels have complex waveshapes, which are very difficult or even impossible to analyze by visual inspection. Analysis of these signals with an oscilloscope is often limited to looking for gross abnormalities such as significant thermal asperities or dropouts of sufficient duration. Furthermore, because of the sophistication of PRML signal processing, even some visible anomalies may not necessarily cause an error.

Time and Effort

VL Memory Option	32M
XL Memory Option	50M

WaveMaster 8400A XXL and 8600A XXL: 50 Mpts/Ch; 100 Mpts when using 4 or 2 Ch, respectively

WavePro 7100A, 7200A, 7300A:

	Maximum Acquisition Points/Ch 4 Ch/2 Ch
Standard	10M/20M
VL Memory Option	16M/32M
XL Memory Option	24M/50M

WavePro 7100A, 7200A, 7300A XXL models: 50 Mpts/Ch; 100 Mpts when using 4 or 2 Ch, respectively

Disk Drive Analyzers:

	Maximum Acquisition Points/Ch 4 Ch/2 Ch
DDA 3000	50M/100M
DDA 5005A	24M/50M
DDA 5005A XXL	50M/100M

Acquisition Modes

Single-shot: For transient and repetitive signals: 20 ps/div to 10 s/div

Sequence: 2 to 20,000 segments (number of segments depends upon memory option)

Acquisition Modes

Single-shot: For transient and repetitive signals: 20 ps/div to 10 s/div

Sequence: 2 to 20,000 segments (number of segments depends upon memory option)

	Number of Segments
Standard	500
VL Memory Option	10,000
XL Memory Option	20,000
XXL Memory Option	25,000

Intersegment Time: typically 5 µs (WavePro 7000A Series, DDA-3000A: </= 6 µs)

Acquisition Processing

Averaging: Summed averaging to 1 million sweeps; Continuous averaging to 1 million sweeps

Enhanced Resolution (ERES): from 8.5 to 11 bits vertical resolution

Envelope (Extrema): Envelope, floor, roof for up to 1 million sweeps

Triggering System

Modes: Normal, Auto, Single, and Stop

Sources: Any input channel, External, ExtX10, Ext/10 or line; slope and level are unique to each source (except line)

Coupling Mode: DC; WavePro 7000A Series: GND, DC 50 ohms, DC 1 Mohms, AC 1 Mohms

Pre-trigger Delay: 0 to 100% of horizontal time scale

Post-trigger Delay: 0 to 10,000 divisions

Holdoff by Time or Events: Up to 20 s or from 1 to 99,999,999 events

Internal Trigger Range: +/-5 div from center

Maximum Trigger Frequency:

WM 8600A	5 GHz with Edge Trigger, 750 MHz with SMART Trigger
WM 8500/8500A DDA-5005/DDA-5005A	5 GHz with Edge Trigger, 750 MHz with SMART Trigger
WM 8400A/8420	4 GHz with Edge Trigger, 750 MHz with SMART Trigger
DDA-3000A	3 GHz with Edge Trigger, 750 MHz with SMART Trigger
WP 7300A	3 GHz w/Edge Trigger, 750 MHz with SMART Trigger
WP 7200A	2 GHz w/Edge Trigger, 750 MHz with SMART Trigger
WP 7100A	1 GHz w/Edge Trigger, 750 MHz with SMART Trigger

Trigger Jitter: 2.5 ps rms (typical)

Basic Triggers

Edge/Slope/Line: Triggers when the signal meets the slope and level condition.

SMART Triggers

State or Edge qualified: Triggers on any input source only if a defined state or edge occurred on another input source. Delay between sources is selectable by time or events.

Dropout: Triggers if the input signal drops out for longer than a selectable time-out between 2 ns and 20 s.

Pattern: Logic combination (AND, NAND, OR, NOR) of 5 inputs (4 channels and external trigger input). Each source can be high, low, or don't care. The High and Low level can be selected independently. Triggers at start or end of pattern.

SMART Triggers with Exclusion Technology

source can be high, low, or don't care. The High and Low level can be selected independently. Triggers at start of end of pattern.

SMART Triggers with Exclusion Technology

Glitch: Triggers on positive or negative glitches with widths selectable from 600 ps to 20 s or on intermittent faults.

Signal or Pattern Width: Triggers on positive or negative pulse widths selectable from 600 ps to 20 s or on intermittent faults.

Signal or Pattern Interval: Triggers on intervals selectable from 2 ns to 20 s.

Automatic Setup

Autosetup: Automatically sets timebase, trigger, and sensitivity to display a wide range of repetitive signals.

Vertical Find Scale: Automatically sets the vertical sensitivity and offset for the selected channels to display a waveform with maximum dynamic range.

Probes

Probes: A variety of optional passive and active probes is available.

Probe System – ProLink with ProBus: Automatically detects and supports a wide variety of compatible probes; supports ProLink-SMA and ProLink-BNC adapters (ProLink is not available for WavePro 7000A series)

Scale Factors: Automatically or manually selected depending on probe used

AP-1M Hi-Z Adapter: (not available for WavePro 7000A series) Bandwidth: 500 MHz; full-scale range: +/-8 V; input protection: +/-150 V

Color Waveform Display

Type: Color 10.4-inch flat panel TFT LCD with high resolution touch screen

Resolution: SVGA; 800 x 600 pixels

Real Time Clock: Date, hours, minutes, and seconds displayed with waveform; SNTP support to synchronize to precision internet clocks

Number of Traces: Maximum of eight traces; simultaneously displays channel, zoom, memory, and math traces

Analog Persistence Display

Analog and Color-graded Persistence: Variable saturation levels; stores each trace's persistence data in memory

Persistence Selections: Select analog, color, or 3-D

Trace Selection: Activate Analog Persistence on all or any combination of traces

Persistence Aging Time: From 500 ms to infinity

Sweeps Displayed: All accumulated or all accumulated with last trace highlighted

Zoom Expansion Traces

Display up to 4 Zoom and 4 Math/Zoom traces; 8 Math/Zoom traces available with XMAP (Master Analysis Package) and XMATH (Advanced Math Package) options.

Rapid Signal Processing

Processor: Intel *Pentium®* 4 @ 2.53 GHz (or better) with MS *Windows®* XP Platform

Processor Memory: Up to 1 Gbyte (WaveMaster: up to 2 Gbytes with XXL memory option)

Internal Waveform Memory

Waveform: M1, M2, M3, M4 (Store full-length waveforms with 16 bits/data point.) Or save to any number of files (limited only by data storage media).

Setup Storage

Front Panel and Instrument Status: Save to the internal hard drive, floppy drive, or to a USB connected peripheral device.

Interface

Remote Control: Through Windows Automation or LeCroy Remote Command set, supports front panel controls and internal functions via GPIB or Ethernet.

Interface

Remote Control: Through Windows Automation or LeCroy Remote Command set, supports front panel controls and internal functions via GPIB or Ethernet.

GPIB Port (optional): Supports IEEE-488.2

Ethernet Port: 10/100Base-T Ethernet interface

USB Ports: 4 USB ports support Windows compatible devices.

External Monitor Port (standard): 15-pin D-Type SVGA compatible

Parallel Port: 1 standard

Auxiliary Output

Signal Types: Select from calibrator or control signals output on front panel.

Calibrator Signal: 5 Hz to 5 MHz (1 MHz for WavePro 7000A Series, DDA-3000A) square wave or DC level; 0.0 to 5.0 V (selectable) into 50 ohms (0 to 1 V into 1 Mohms), or TTL Volts

Control Signals: trigger enabled, trigger out, pass/fail status, square, DC level

Auxiliary Input

Signal Types: Select External Trigger input on front panel. 1X: 100 mV/div; 10X: 1 V/div; /10: 10 mV/div

Math Tools (standard)

Display up to four math function traces (F1 to F4). The easy-to-use graphical interface simplifies setup of up to two operations on each function trace. Function traces can be chained together to perform math-on-math.

absolute value	invert (negate)
average (summed)	ln (log base e)
average (continuous)	log (base 10)
derivative	product (X)
	ratio (/)

Math Tools (standard)

Display up to four math function traces (F1 to F4). The easy-to-use graphical interface simplifies setup of up to two operations on each function trace. Function traces can be chained together to perform math-on-math.

absolute value	invert (negate)
average (summed)	ln (log base e)
average (continuous)	log (base 10)
derivative	product (X)
deskew (resample)	ratio (/)
difference (–)	reciprocal
enhanced resolution (to 11 bits vertical)	rescale (with units)
envelope	roof
exp (base e)	segment
exp (base 10)	(sinX)/X
fft (basic)	square
floor	square root
histogram of 1,000 events	sum (+)
integral	trend (datalog) of 1,000 events
	zoom (identity)

Measure Tools (standard)

Display any 8 parameters together with statistics, including their average, high, low, and standard deviations. Histicons provide a fast, dynamic view of parameters and wave shape characteristics.

Amplitude	Number of points
Area	Overshoot+

Measure Tools (standard)

Display any 8 parameters together with statistics, including their average, high, low, and standard deviations. Histicons provide a fast, dynamic view of parameters and wave shape characteristics.

Amplitude	Number of points
Area	Overshoot+
Base	Overshoot-
Cycles	Peak-to-peak
Delay	Period
Delta delay	Phase
Delta time @ level	Rise time (10-90%, 20-80%, @ level)
Duration	RMS
Duty cycle	Std. Deviation
Fall time (90-10%, 80-20%, @ level)	Time @ level
First	Top
Frequency	Width
Last	X @ minimum (min.)
Level @ x	X @ maximum (max.)
Maximum	X at max
Mean	X at min
Minimum	

Standard Jitter and Timing Measurements

Period @ level
Width @ level
Duty Cycle @ level

Minimum	

Standard Jitter and Timing Measurements

Period @ level
Width @ level
Duty Cycle @ level
Frequency @ level
TIE @ level
Edge @ level
Jitter Track
Jitter Trend (up to 1000 points)
Histograms (up to 1000 points)

Pass/Fail Testing

Test multiple parameters against selectable parameter limits at the same time. Pass or fail conditions can initiate actions including: document to local or networked files, email the image of the failure, save waveforms, send a pulse out at the front panel auxiliary BNC output, or (with GPIB option) send a GPIB SRQ.

Master Analysis Package (XMAP)

This package provides a comprehensive set of signal WaveShape Analysis tools that provide insight into the wave shape of complex signals. Additional analysis capability provided by XMAP includes:

- Jitter and Timing Analysis package (JTA2)
- 8 math traces total (4 additional)
- Parameter Math — add, subtract, multiply, or divide two different parameter measurements
- User-definable parameter measurements and math functions, using VBScripting with MS Excel and MATLAB

Master Analysis Package (XMAP)

This package provides a comprehensive set of signal WaveShape Analysis tools that provide insight into the wave shape of complex signals. Additional analysis capability provided by XMAP includes:

- Jitter and Timing Analysis package (JTA2)
- 8 math traces total (4 additional)
- Parameter Math — add, subtract, multiply, or divide two different parameter measurements
- User-definable parameter measurements and math functions, using VBScripting with MS Excel and MATLAB
- Histograms expanded with 19 histogram parameters and up to 2 billion events
- Trend (datalog) of up to one million events
- Track graphs of any measurement parameter
- FFT capability expands the basic FFT to include; power averaging, power density, real and imaginary components, frequency domain parameters and FFT on up to 25 Mpts.
- Narrow Band power measurements
- Correlation function
- Interpolation
- Sparse

Web Editor (XWEB)

The Processing Web provides a graphical way to quickly and easily set up math functions and parameter measurements. Practically unlimited math-on-math functions can be chained together, and parameter measurements for any math output waveform anywhere on the web can be inserted.

Jitter and Timing Analysis Package (JTA2)

HISTOGRAM THEORY OF OPERATION

An understanding of statistical variations in parameter values is needed for many waveform parameter measurements. Knowledge of the average, minimum, maximum, and standard deviation of the parameter may often be enough, but in many cases you may need a more detailed understanding of the distribution of a parameter's values.

Histograms allow you to see how a parameter's values are distributed over many measurements. They do this by dividing a range of parameter values into sub-ranges called bins. A count of the number of parameter values (events) that fall within ranges of the bin itself is maintained for each bin.

While such a value range can be infinite, for practical purposes it need only be defined as large enough to include any realistically possible parameter value. For example, in measuring TTL high-voltage values a range of ±50 V is unnecessarily large, whereas one of 4 V ±2.5 V is more reasonable. It is the 5 V range that is then subdivided into bins. And if the number of bins used were 50, each would have a range of 5 V/50 bins or 0.1 V/bin. Events falling into the first bin would then be between 1.5 V and 1.6 V. While the next bin would capture all events between 1.6 V and 1.7 V, and so on.

After a process of several thousand events, the bar graph of the count for each bin (its histogram) provides a good understanding of the distribution of values. Histograms generally use the 'x' axis to show a bin's sub-range value, and the 'Y' axis for the count of parameter values within each bin. The leftmost bin with a non-zero count shows the lowest parameter value measurements. The vertically highest bin shows the greatest number of events falling within its sub-range.

Note: The range of the histogram is limited to the portion of the trace that is visible on screen. That is, if you zoom in on a trace, the histogram will not contain data for that part of the original trace no longer visible.

The number of events in a bin, peak or a histogram is referred to as its population. The following figure shows a histogram's highest population bin as the one with a sub-range of 4.3 to 4.4 V (which is to be expected of a TTL signal).

Web Editor (XWEB)

The Processing Web provides a graphical way to quickly and easily set up math functions and parameter measurements. Practically unlimited math-on-math functions can be chained together, and parameter measurements for any math output waveform anywhere on the web can be inserted.

Jitter and Timing Analysis Package (JTA2)

This package provides jitter timing and analysis using JitterTrack (time), Histogram (statistical) and JitterFFT (frequency) views for common timing parameters, and other useful tools.

- Jitter and Timing parameters with JitterTrack graphs of:

Cycle-to-Cycle	Half Period	Skew
N-Cycle	Width	Duty Cycle
N-Cycle with Start selection	Time Interval Error	Duty Cycle Error (Delta Width)
Frequency	Setup	
Period	Hold	

- edge@lv parameter (counts edges)
- Histograms expanded with 19 histogram parameters and up to 2 billion events
- Trend (datalog) of up to one million events
- Persistence Histogram; Persistence Trace

Disk Drive Measurement Package (DDM2)

This package provides disk drive parameter measurements and related mathematical functions for performing disk drive WaveShape Analysis.

- Disk Drive Parameters:

amplitude symmetry	local time over threshold

RESCALING AND ASSIGNING UNITS

To Set Up Rescaling

This feature allows you to apply a multiplication factor (*a*) and additive constant (*b*) to your waveform: *a*X + *b*. You can do it in the unit of your choice, depending on the type of application.`

Allowable unit abbreviations are as follows:

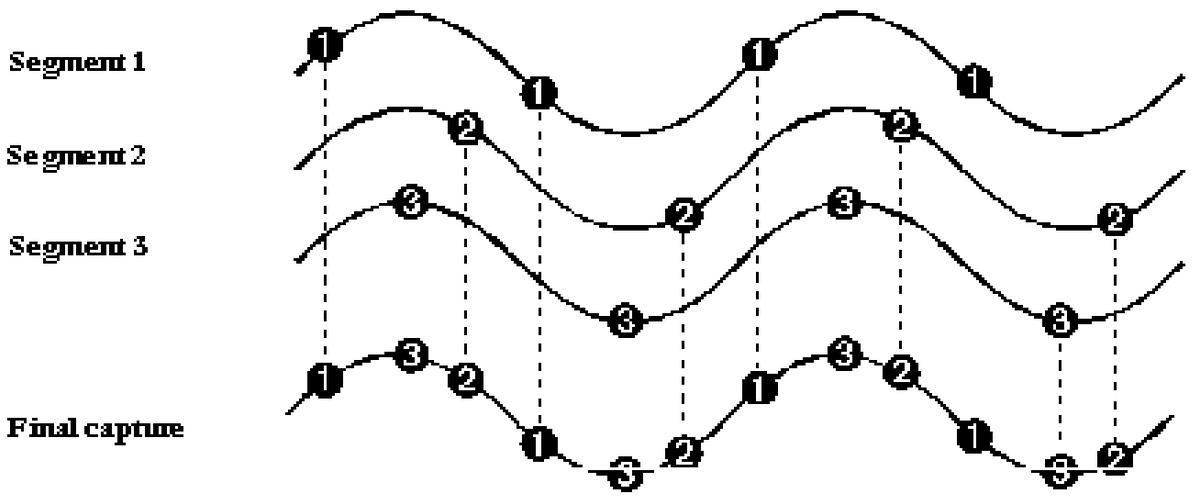
(blank)	no units
A	Ampere
C	Coulomb
CYCLE	cycles
DB	Decibel
DBC	Decibel referred to carrier
DBM	Decibel Milliwatt
DBV	Decibel Volts
DBUZ	Decibel Microamp
DEC	Decade
DIV	Divisions
Event	Events
F	Farad
G	Gram
H	Henry

RIS SAMPLING MODE -- FOR HIGHER SAMPLING RATES

To Select a Sampling Mode

RIS (Random Interleaved Sampling) is an acquisition technique that allows effective sampling rates higher than the maximum single-shot sampling rate. It is used on repetitive waveforms with a stable trigger. The maximum effective sampling rate of 50 GS/s can be achieved with RIS by making 100 single-shot acquisitions at 500 MS/s. The bins thus acquired are positioned approximately 20 ps apart. The process of acquiring these bins and satisfying the time constraint is a random one. The relative time between ADC sampling instants and the event trigger provides the necessary variation, measured by the timebase to 5 ps resolution.

The instrument requires multiple triggers to complete an acquisition. The number depends on the sample rate: the higher the sample rate, the more triggers are required. It then interleaves these segments (see figure) to provide a waveform covering a time interval that is a multiple of the maximum single-shot sampling rate. However, the real-time interval over which the instrument collects the waveform data is much longer, and depends on the trigger rate and the amount of interleaving required. The oscilloscope is capable of acquiring approximately 40,000 RIS segments per second.



Note: RIS mode is not available when the scope is operating in Fixed Sample Rate mode.

When the SDA 11000 is operating in 11 GHz mode, RIS mode sampling is not available.

AP-1M HI-Z ADAPTER

For some instruments, the AP-1M adapter provides a means to connect a high-impedance input to your instrument. In order to achieve high bandwidth with excellent signal integrity, these instruments have a ±4 V dynamic range and 50 Ω termination to ground. However, for applications that combine one or more high-speed signals with slower, higher-voltage signals, the AP-1M provides a 1 MΩ input impedance path and a full-scale range of ±8 V. It is also suitable as an interface for current probes that require a 1 MΩ input path.

In addition to acting as a ProLink-to-ProBus adapter, the AP-1M also enables a much larger offset voltage range (up to ±50 V).

The AP-1M is supplied with a PP005A passive probe.

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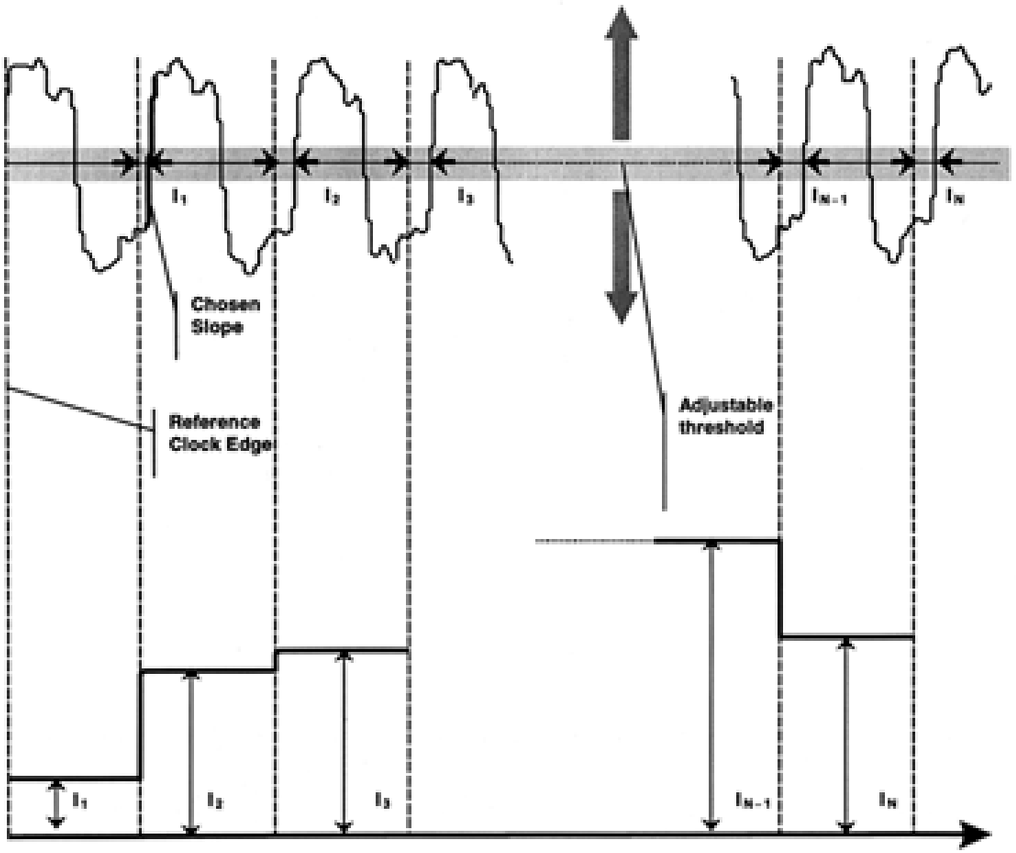
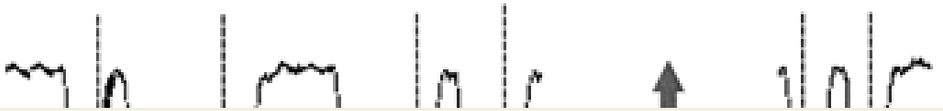
HOW JITTERTRACK WORKS

Using "Clock" or "Data"

Use this function to plot as a bar chart the evolution over time of this and five other waveform attributes in simple steps.



How JitterTrack's Interval Error works when "Clock" Mode is selected



WHY USE FFT?

For a large class of signals, you can gain greater insight by looking at spectral representation rather than time description. Signals encountered in the frequency response of amplifiers, oscillator phase noise and those in mechanical vibration analysis, for example, are easier to observe in the frequency domain.

If sampling is done at a rate fast enough to faithfully approximate the original waveform (usually five times the highest frequency component in the signal), the resulting discrete data series will uniquely describe the analog signal. This is of particular value when dealing with transient signals because, unlike FFT, conventional swept spectrum analyzers cannot handle them.

Spectral analysis theory assumes that the signal for transformation is of infinite duration. Since no physical signal can meet this condition, a useful assumption for reconciling theory and practice is to view the signal as consisting of an infinite series of replicas of itself. These replicas are multiplied by a rectangular window (the display grid) that is zero outside of the observation grid.

An FFT operation on an N-point time domain signal can be compared to passing the signal through a comb filter consisting of a bank of N/2 filters. All the filters have the same shape and width and are centered at N/2 discrete frequencies. Each filter collects the signal energy that falls into the immediate neighborhood of its center frequency. Thus it can be said that there are N/2 frequency bins. The distance in Hz between the center frequencies of two neighboring bins is always the same: Delta f.

Power (Density) Spectrum

Because of the linear scale used to show magnitudes, lower amplitude components are often hidden by larger components. In addition to the functions offering magnitude and phase representations, the FFT option offers power density and power spectrum density functions. These latter functions are even better suited for characterizing spectra. The power spectrum (V^2) is the square of the magnitude spectrum (0 dBm corresponds to voltage equivalent to 1 mW into 50 ohms.) This is the representation of choice for signals containing isolated peaks — periodic signals, for instance.

The power density spectrum (V^2/Hz) is the power spectrum divided by the equivalent noise bandwidth of the filter associated with the FFT calculation. This is best employed for characterizing broadband signals such as noise.

Memory for FFT

WAVEMASTER & WAVEPRO SPECIFICATIONS

Note: Specifications are subject to change without notice.

Vertical System

Bandwidth (-3 dB @ 50 ohms):[a]

WaveMaster 8600A & 8620A[b]	6 GHz @ 50 ohms (at sample speed ≥ 20 GS/s)	
WaveMaster 8500A[c] DDA-5005A	5 GHz	
WaveMaster 8400A, 8420	4 GHz	
DDA-3000A	3 GHz	
WavePro 7100A	5 mV/div to 1 V/div	1 GHz
	2 mV/div to 4.99 mV/div	500 MHz
WavePro 7200A	10 mV/div to 1 V/div	2 GHz
	5 mV/div to 9.95 mV/div	1 GHz
	2 mV/div to 4.99 mV/div	500 MHz
WavePro 7300A	10 mV/div to 1 V/div	3 GHz
	5 mV to 9.95 V/div	1 GHz

	2 mV/div to 4.99 mV/div	500 MHz

[a] At max. channel sampling rate

[b] Derates 50 MHz/°C @ T>30 °C

[c] Derates 20 MHz/°C @ T>30 °C

Input Channels: 4

Rise Time (typical):

WaveMaster 8600A & 8620A	75 ps (at sample speed >/= 20 GS/s)
WaveMaster 8500A DDA-5005A	90 ps
WaveMaster 8400A, 8420	105 ps
DDA-3000A	150 ps
WavePro 7100A	400 ps
WavePro 7200A	225 ps
WavePro 7300A	150 ps

Bandwidth Limiters:

- Full
- 4 GHz (WaveMaster 8600A, 8500A, DDA-5005A)
- 3 GHz (WaveMaster 8600A, 8500A, 8400A, 8420, DDA-5005A)
- 1 GHz (WaveMaster scopes, DDA-5005A, DDA-3000A)
- 200 MHz

Bandwidth Limiters:

- Full
- 4 GHz (WaveMaster 8600A, 8500A, DDA-5005A)
- 3 GHz (WaveMaster 8600A, 8500A, 8400A, 8420, DDA-5005A)
- 1 GHz (WaveMaster scopes, DDA-5005A, DDA-3000A)
- 200 MHz
- 20 MHz

Input Impedance: 50 ohms +/-2%; WavePro 7000A Series: 50 ohms +/-1.5%, 1 Mohms

Input Coupling: DC, GND; AC (WavePro 7000A Series)

Max Input Voltage: WaveMaster, DDA-5005A: +/-4 V peak; WavePro 7000A Series, DDA-3000A: 50 ohms: 5 Vrms, 1 Mohms: 100 Vmax (peak AC: </= 5 kHz + DC)

Installation (Overvoltage) Category: CAT I

Vertical Resolution: 8 bits; up to 11 bits with enhanced resolution (ERES)

Sensitivity: 2 mV to 1 V/div fully variable (WavePro 7000A Series: 1 Mohms: 2 mV to 2 V/div fully variable)

DC Gain Accuracy: +/-1.5% of full scale

Offset Range: 2 mV to 194 mV/div: +/-750 mV; 195 mV to 1 V/div: +/-4 V (WaveMaster, DDA-5005A)

DDA-3000A, WavePro 7000A Series:

50 ohms	+/-700 mV @ 2.0 to 4.99 mV/div +/-1.5 V @ 5 to 100 mV/div +/-10 V @ 0.102 to 1 V/div
1 Mohms	+/-700 mV @ 2.0 to 4.99 mV/div +/-1.5 V @ 5 to 100 mV/div +/-20 V @ 0.102 to 2 V/div

Offset Accuracy: +/-(1.5% of full scale value + 1.5% of offset value + 2 mV); WavePro 7000A Series, DDA-3000A: +/-(1.5% of full scale value + 0.5% of offset value + 2 mV)

Horizontal System

Timebases: Internal timebase common to 4 input channels; an external clock can be applied at the auxiliary input

Time/div Range: 20 ps/div to 1000 s/div (10 s/div in Auto trigger mode)

Math & Zoom Traces: 4 independent zoom and 4 math/zoom traces standard; 8 math/zoom traces available with XMAP (Master Analysis Package) option

Clock Accuracy: </= 1 ppm at 0 to 50 °C (WavePro 7000A Series, DDA-3000A: </= 10 ppm at 0 to 40 °C)

Interpolator Resolution: 1.2 ps

External Timebase Reference: 100 MHz, 50 ohms impedance, applied at the rear input (10 MHz, 50 ohms for WavePro 7000A Series)

External Sample Clock: 30 MHz to 2 GHz max., 50 ohms impedance, applied at the Auxiliary input (WavePro 7100A, DDA-3000A: 30 MHz to 1 GHz)

Acquisition System

Single-shot Sample Rate/Ch: 10 GS/s (WaveMaster 8620A: 20 GS/s)

Memory:

WaveMaster 8420A and 8620A:

	Maximum Acquisition Points/Ch 2 Ch/4 Ch
Standard	10M
VL Memory Option	32M
XL Memory Option	50M

WaveMaster 8400A XXL and 8600A XXL: 50 Mpts/Ch; 100 Mpts when using 4 or 2 Ch, respectively