

# SDAIII-CompleteLinQ

## Multi-Lane Serial Data, Noise and Crosstalk Analysis



# TOOLS TO MEET SERIAL DATA ANALYSIS CHALLENGES

## Key Features

- Most complete jitter decomposition, eye diagram and analysis tools
- Up to four simultaneous eye diagrams
- Fastest eye diagram creation
- Up to 4-lane measurement and analysis capability
- Unique Reference Lane and LaneScape Comparison Mode
- Vertical noise measurements
- Crosstalk analysis
- Single CompleteLinQ dialog

View our short introductory video:



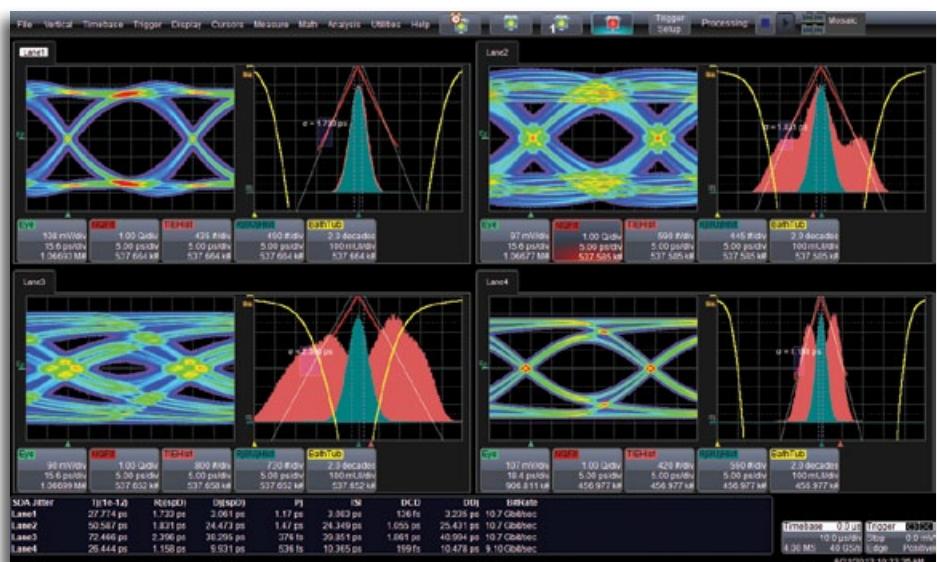
<http://lcrv.us/YB0qyY>

Mobile and cloud computing is driving demand for higher data throughput. Existing and emerging standards, such as PCIe Gen3, 40/100GBase-R, InfiniBand, are meeting these needs by utilizing multiple serial data lanes as well as increasing data rates on each lane — up to 28 Gb/s — to achieve very high data throughput. However, until now, serial data analysis toolsets have not adapted.

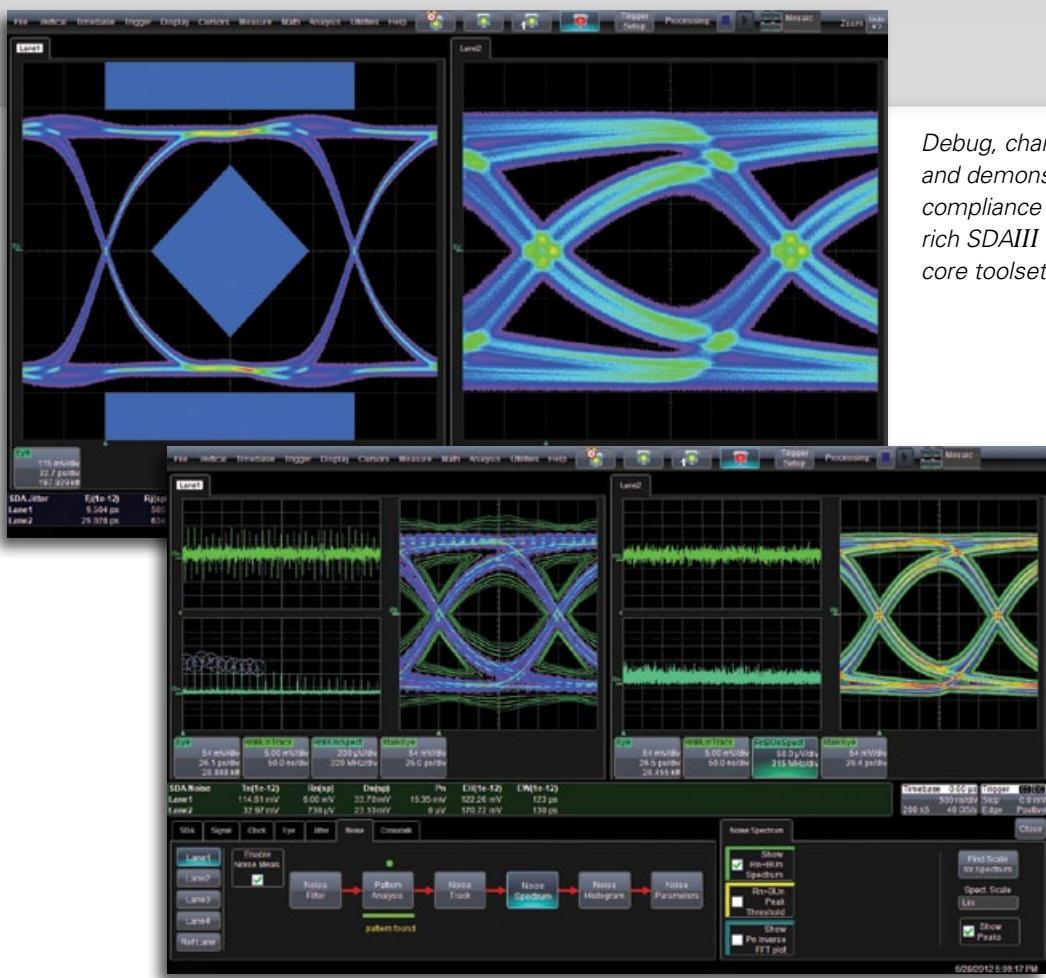
Higher-speed data rates increase the characterization, debug, and compliance test challenges on even a single lane of serial data. Determining the root cause of eye closure in the channel between the transmitter and receiver is the primary challenge. Simulating where you cannot place a probe or otherwise access the signal becomes critical.

The “parallelizing” of high speed serial data transmissions

results in additional challenges. Crosstalk between lanes, or coupled from other sources, and other signal integrity issues can be a source of significant problems. Quickly and simultaneously viewing performance of multiple lanes, measuring vertical noise, and determining pattern dependency of the jitter and the noise is the key to understanding root-cause of poor system performance.



Perform eye and jitter analysis on four lanes, simultaneously.



Debug, characterize and demonstrate compliance using the rich SDAIII core toolset.



## LabMaster 10 Zi Series Oscilloscope

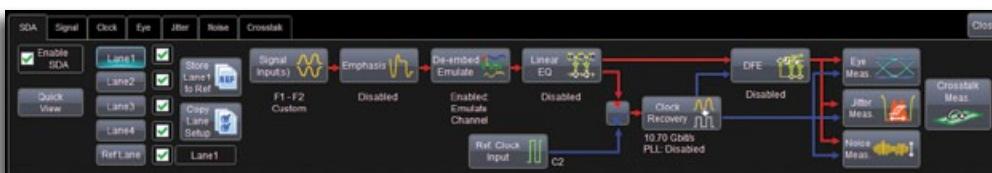
**Up to 65 GHz, 160 GS/s, 80 Channels**

With LabMaster 10 Zi-A series oscilloscopes, acquire 4 differential lanes with 8 input channels, and analyze all lanes simultaneously using SDAIII-CompleteLinQ.

Understand sources of crosstalk with new tools for decomposing vertical noise.

Only Teledyne LeCroy has the combination of real-time signal acquisition and serial data analysis capabilities that will allow you to quickly and successfully implement high-speed and/or multi-lane serial data systems:

- World's only multi-lane serial data and crosstalk analysis tools
- Most complete simulation and signal integrity toolsets for de-embedding, equalization and virtual probing
- Modular oscilloscopes that easily allow 4, 10, or more differential lanes to be acquired with cable inputs, and at bandwidths up to 65 GHz.
- Network analyzers to measure S-parameters on up to 12 ports, at a fraction of the price of a VNA.
- Single SDAIII-CompleteLinQ user interface to seamlessly integrate all of the toolsets.



The superior SDAIII-CompleteLinQ framework seamlessly integrates data acquisition, channel configuration and serial data analysis tools.



## SPARQ Signal Integrity Network Analyzers

**Up to 12-port, 40 GHz**

Use SPARQ to quickly measure S-parameters to use in SDAIII-CompleteLinQ's de-embedding and emulation capabilities.

# SUPERIOR SERIAL DATA ANALYSIS TOOLS

## 1. Eye Diagrams Analysis

Eye diagrams contain all acquired unit intervals, and are rendered 10-100x faster than competitive systems (1a). Use IsoBER to show expected eye infringement to a user-settable BER (1b).

## 2. Eye Mask Failures Analysis

Mask failures are highlighted showing the exact points where violations occur. Masks for many serial data standards are included.

## 3. Jitter Spectrum

Spectral analysis identifies the sources of Periodic Jitter ( $P_j$ ) (3a). The threshold separating the noise floor and  $P_j$  is shown (3b). The inverse FFT of the  $P_j$  contributors provides a time domain view (3c).

## 4. Data Dependent Jitter Analysis

Pattern analysis of repeating bit streams provides insight into data dependent jitter (DDj) sources. A plot showing the jitter for each bit is displayed in synch with the data pattern (4a). DDj Histograms may also be displayed (4b).

## 5. Jitter Track Analysis

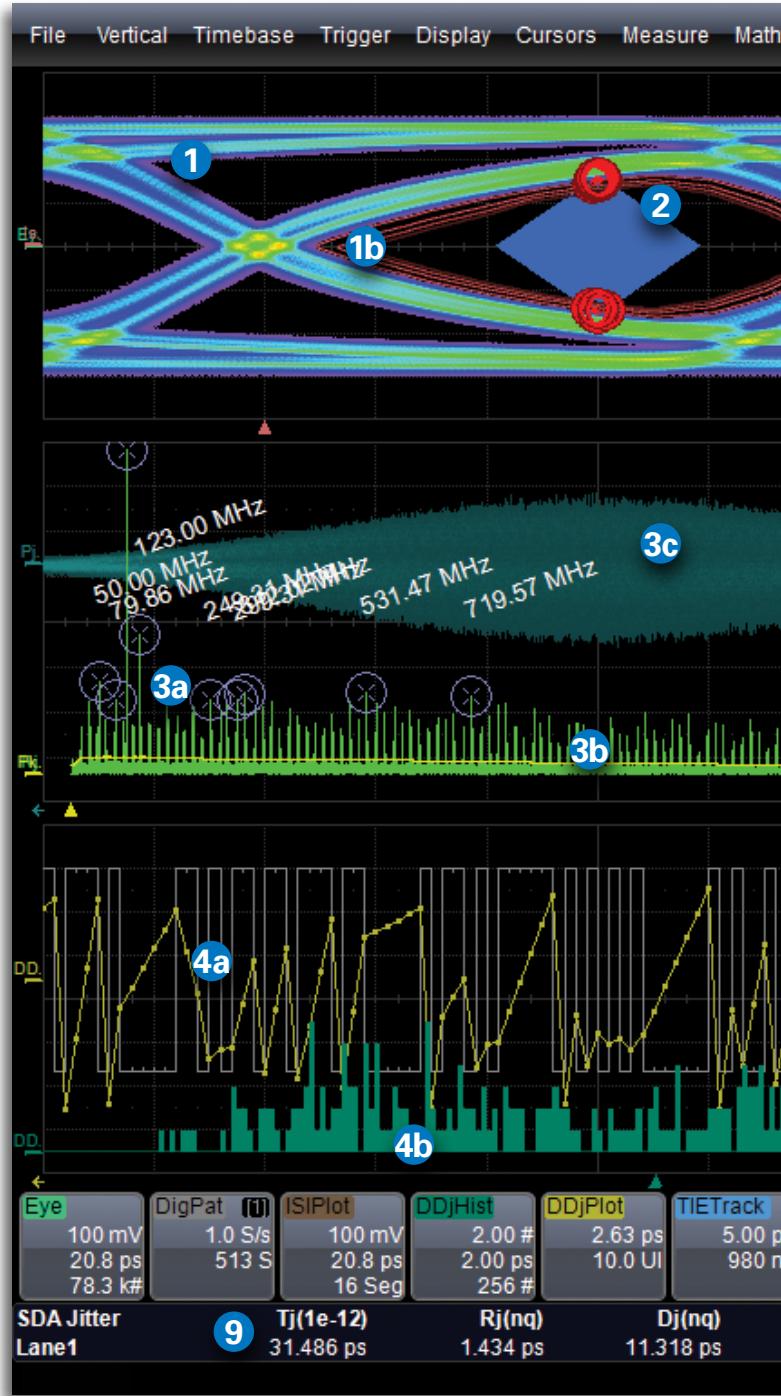
Display Time Interval Error (TIE) jitter with or without data dependent jitter effects in time with your source data. This view of jitter quickly detects bursted jitter and modulation.

## 6. Jitter Histogram Analysis

Histogram the Time Interval Error (TIE) data with or without data dependent jitter removed. This view of jitter provides a quick way to clearly determine if jitter aggressors are causing non-Gaussian distributions or long tails.

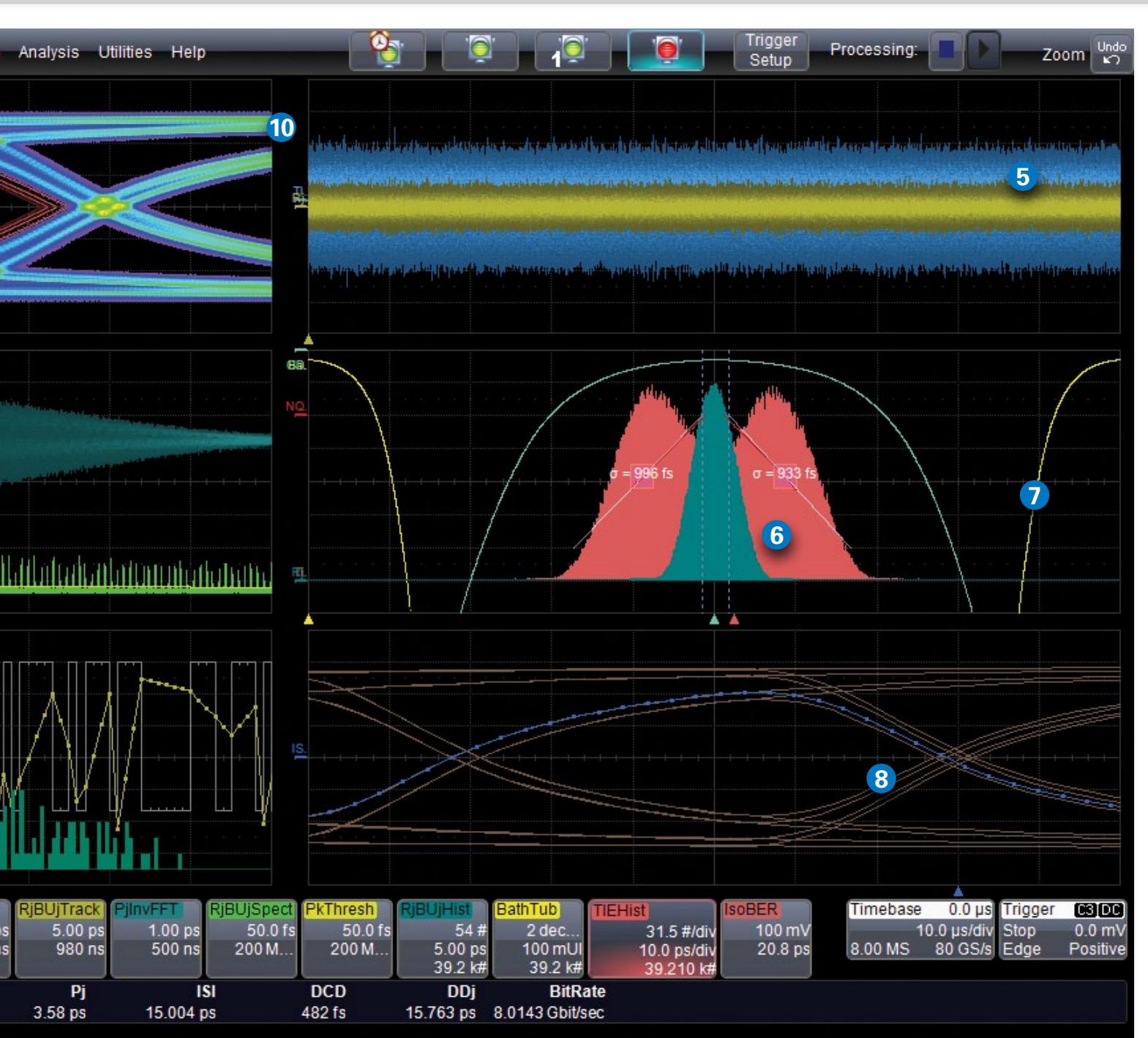
## 7. Bathtub Curve

The bathtub curve, which represents the total jitter at a particular bit error ratio, is a standard plot used to understand the degree to which an eye is closed due to noise and intersymbol interference (ISI).



## 8. Intersymbol Interference (ISI) Analysis

The ISI Plot pinpoints bit sequences that have high ISI and are sources of bit errors. The plot shows the nominal signal trajectory for all bit sequences "N" bits long and highlights a specific trajectory of interest to the user.



## 9. Jitter Measurements Table

Total jitter ( $T_j$ ) can be separated into deterministic jitter ( $D_j$ ) and random jitter ( $R_j$ ).  $D_j$  is further decomposed into Periodic and data dependent components ( $P_j$ ,  $DD_j$ ,  $ISI$ ,  $DCD$ ). Results are tabulated for all enabled lanes. Three jitter decomposition methodologies are provided.

## 10. Completely Integrated Toolset

SDAIII waveform displays and calculations are a completely integrated part of the oscilloscope analysis tool set. Any SDAIII function can be displayed with any other channel acquisition, math function, or measurement parameter on the oscilloscope grid.

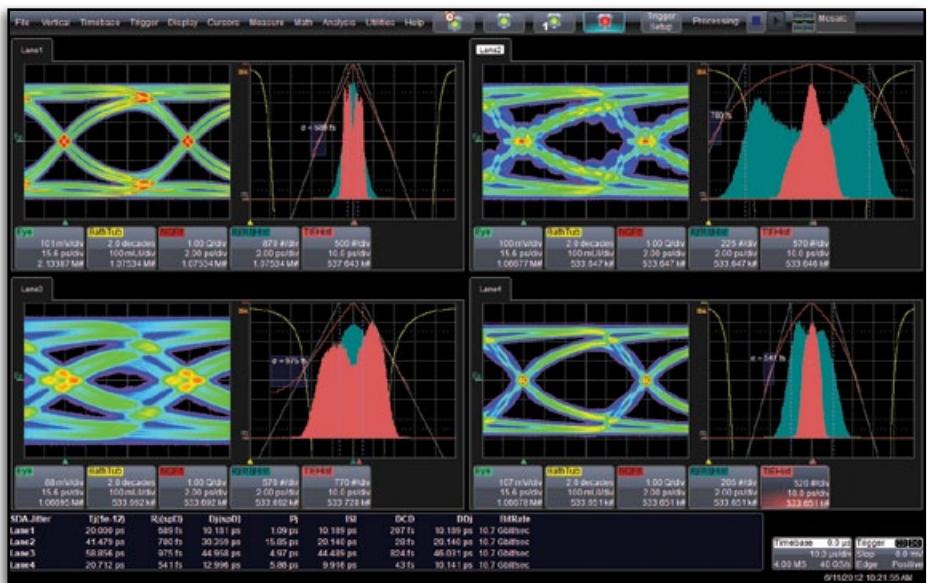
# SEE THE COMPLETE 4-LANE PICTURE

## See Four Eye Diagrams at One Time

Your oscilloscope can acquire multiple lanes, and now it can also analyze and display them, giving you the complete picture of your circuit behavior. The SDAIII-LinQ, SDAIII-CrossLinQ and SDAIII-CompleteLinQ products all enable four lanes of analysis, plus a Reference Lane. View four eyes at once, and enable additional views of jitter.

## Measure Multiple Lanes Simultaneously

With multi-lane analysis, quickly understand differences in the performance of lanes in your systems and devices. Multi-lane analysis gives you the ability to measure jitter on all lanes simultaneously, simplifying the measurement process and eliminating concerns that arise when making measurements that are not synchronized. Teledyne LeCroy provides the only serial data toolkits capable of analyzing multiple lanes simultaneously. With SDAIII-CompleteLinQ on your oscilloscope, the limitations of single-lane analysis have finally been eliminated.

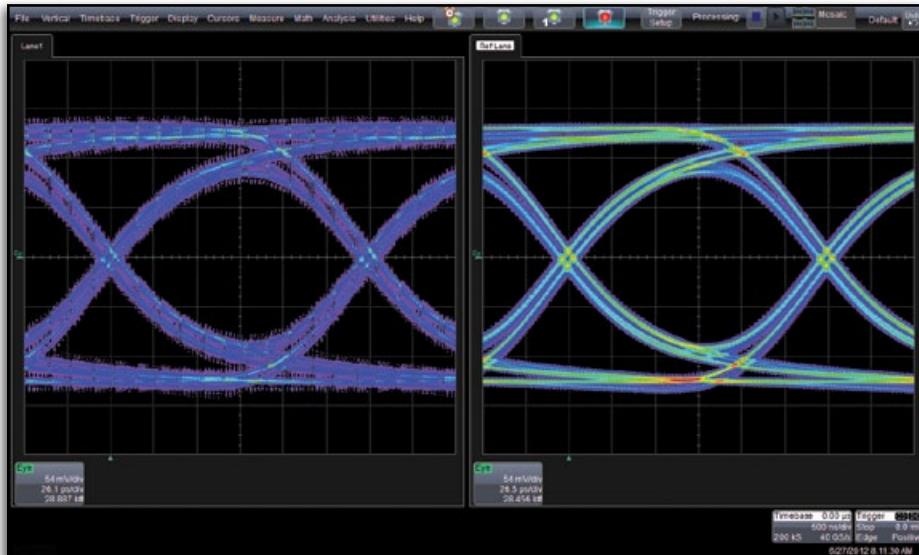


SDAIII-Complete shows a complete analysis of four single-ended or differential lanes.

## Use the Reference Lane for Multi-Scenario Testing

The Reference Lane allows engineers to easily perform multi-scenario testing. One common test performed is aggressor on/off analysis: users can measure eye and jitter characteristics with a neighboring aggressor lane turned on, and store this analysis to the Reference Lane. Then perform the analysis with the aggressor turned off. The Reference Lane can then be compared to other lanes using the LaneScape display mode.

*All products in the SDAIII-CompleteLinQ family include the Reference lane for comparisons.*



The Reference Lane lets you easily see the results of aggressor on/off testing or comparisons to a golden lane.

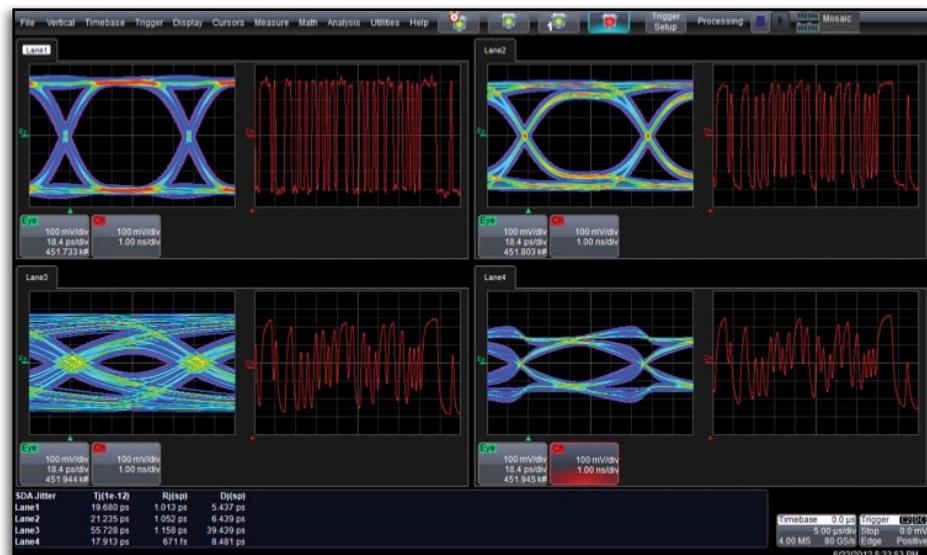
# EASILY COMPARE RESULTS ACROSS LANES

## Single-Lane, Multi-Point Analysis

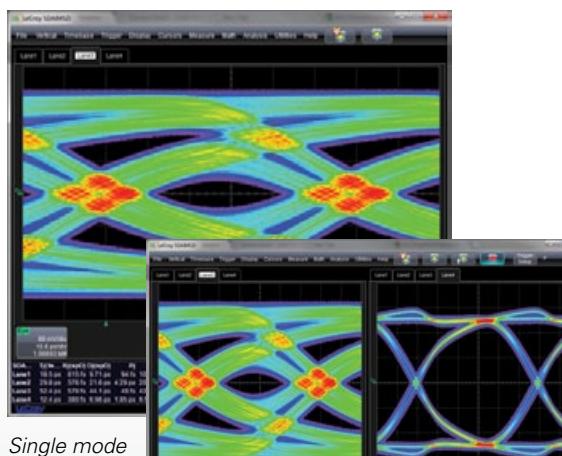
The data under analysis can be from the same lane, but probed at different points with multiple probes, or can be virtually probed using the VirtualProbe software option, which shows you the signal where the probe can't reach. (See page 9).

## Single-Lane, Multi- Configuration Analysis

Users can also configure each lane to show a different analysis of the same source data. This is ideal for comparing the effects of different analysis schemes, such as different equalization or de-embedding models. With SDAIII-CompleteLinQ, you can configure one lane to analyze the raw input, de-embed a fixture on a second lane, add transmitter emphasis on a third lane, and add transmitter emphasis and receiver equalization on a fourth lane. Or use all four lanes to compare the benefits of different DFE and FFE training schemes.

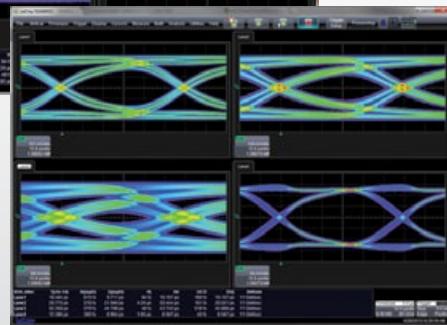


Configure the lanes to analyze multiple points on a trace, or to compare different equalization schemes for a single lane.



Single mode

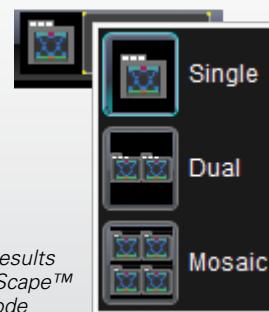
Dual mode



Mosaic mode

## Compare Lane Results with LaneScape™ Mode

With LaneScape™ Comparison Mode, the SDAIII-CompleteLinQ product family builds on Teledyne LeCroy's serial data analysis toolset to solve the problem of lane-to-lane-comparisons. CompleteLinQ is the only toolset with this capability. Included in this mode is the new Reference Lane, which saves and displays the complete analysis of a lane, and LaneScape display, which shows the analysis of one, two or all lanes simultaneously for easy comparisons. Choose between Mosaic, Dual or Single LaneScape mode as needed and at any time to meet your specific analysis needs.

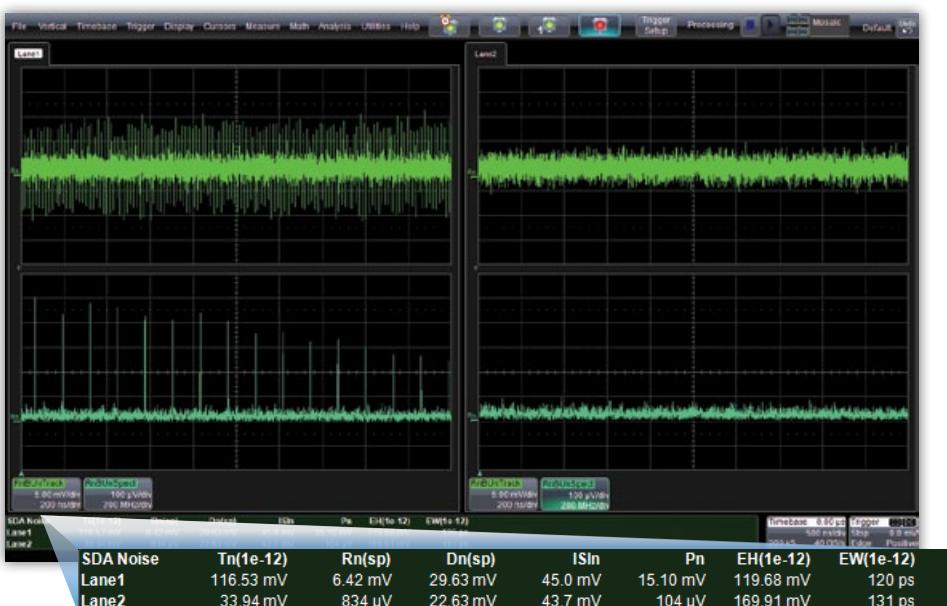


Compare lane results using the LaneScape™ Comparison mode

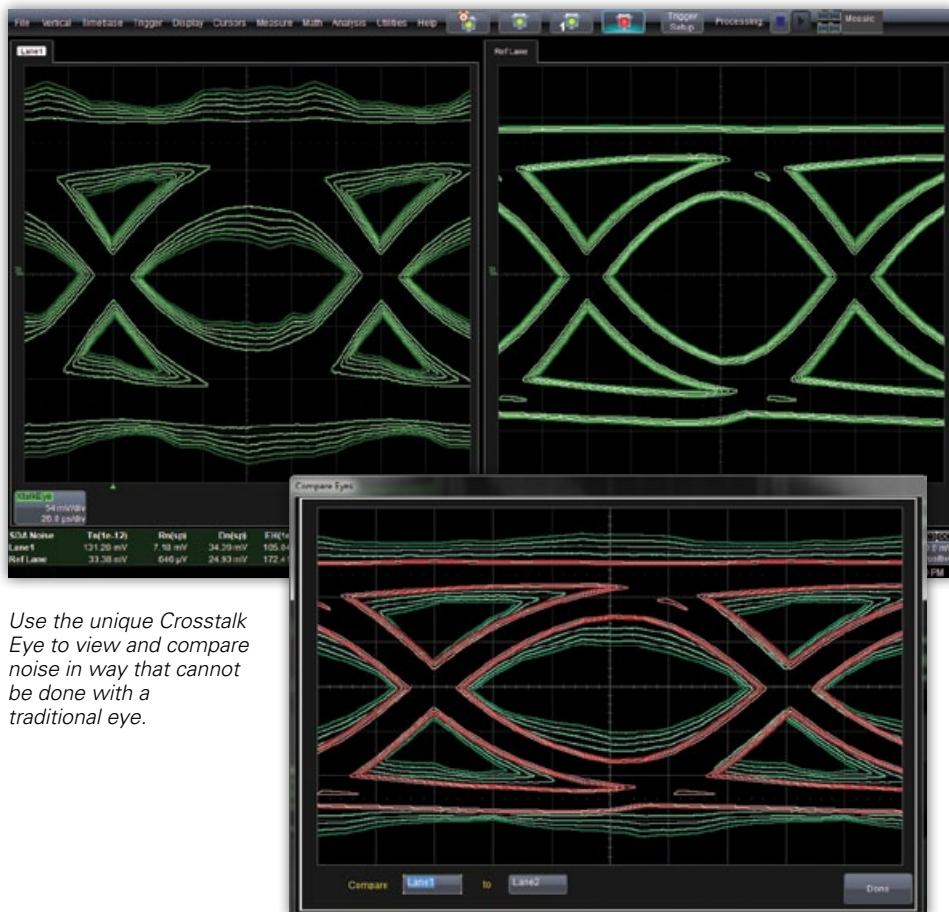
# CHARACTERIZE CROSSTALK AGGRESSORS

## Vertical Noise Measurements

The Crosstalk and CrossLinQ packages provide vertical noise measurements and crosstalk analysis tools for complete aggressor/victim analysis. Use one of three dual-Dirac models to measure and separate noise into total ( $T_n$ ), random ( $R_n$ ) and deterministic ( $D_n$ ) components, and further decompose  $D_n$  into Intersymbol Interference Noise ( $I_{SIn}$ ) and Periodic Noise ( $P_n$ ). *Only Teledyne LeCroy performs this analysis on real-time oscilloscopes.* Similar to the jitter analysis included in all SDAIII-CompleteLinQ products, noise can be viewed as a noise track, histogram and spectrum, providing insight into the vertical noise resulting from coupling to other active serial data lanes or other interference sources.



View noise measurements in both time and frequency domains for insight into sources of crosstalk leading to bit errors.

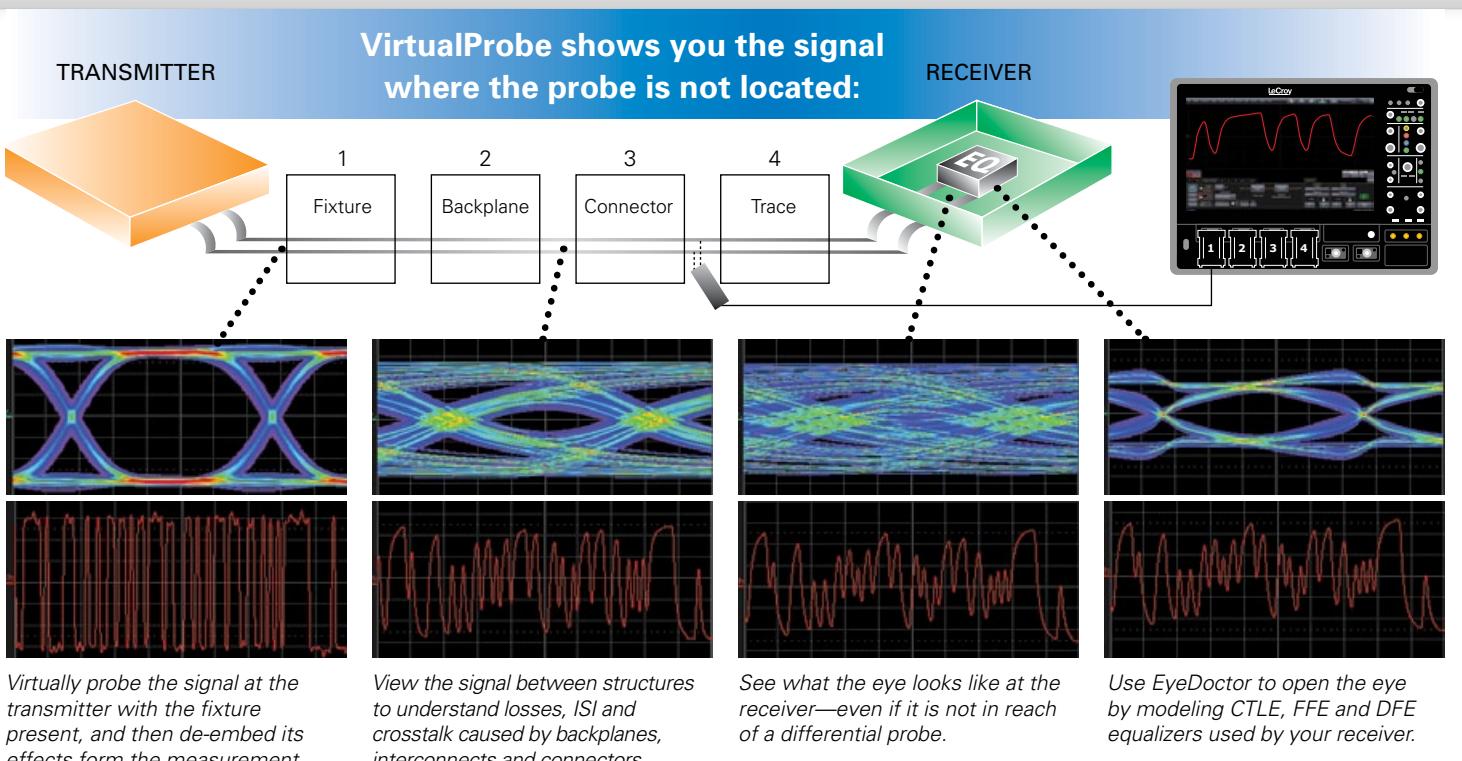


Use the unique Crosstalk Eye to view and compare noise in way that cannot be done with a traditional eye.

## Crosstalk Eye Analysis

The new Crosstalk Eye contour plot is an innovative view that quickly displays the impact of excessive noise that is not possible to see in a traditional eye diagram. The Crosstalk Eye shows the probabilistic extent of noise, both inside and outside the eye. Use LaneScape Comparison mode to generate crosstalk eyes on multiple lanes, and use the Reference Lane when performing multi-scenario testing, such as aggressor on/off analysis. Two crosstalk eyes from different signals can be compared to easily see the result of the analysis.

# EYEDOCTOR™II AND VIRTUALPROBE SIGNAL INTEGRITY TOOLS



Virtually probe the signal at the transmitter with the fixture present, and then de-embed its effects from the measurement.

View the signal between structures to understand losses, ISI and crosstalk caused by backplanes, interconnects and connectors.

See what the eye looks like at the receiver—even if it is not in reach of a differential probe.

Use EyeDoctor to open the eye by modeling CTLE, FFE and DFE equalizers used by your receiver.

As signal speeds and data rates continue to rise, signal integrity effects such intersymbol interference (ISI) and crosstalk become more prevalent and challenging. Use Teledyne LeCroy's Advanced Signal Integrity tools to transform your measured signal to include the effects of de-embedding, emulation and equalization algorithms.

## De-embed, Equalize and Emulate with EyeDoctorII

Curious to know what your signal would look like without fixture effects? Do you need to understand how ISI and crosstalk of a modeled channel will affect your jitter margin? Or are you seeking to determine which equalization schemes will do the best job of opening a closed eye? The EyeDoctorII package includes easy configuration of basic de-embed/ emulation scenarios, CTLE, DFE and FFE equalizers, and transmitter emphasis/de-emphasis.

## Advanced De-embedding, Emulation and Virtual Probing

The VirtualProbe package expands the de-embedding and emulation capabilities of EyeDoctorII. Configure a multi-block circuit using modeled S-parameters or measured with a Teledyne LeCroy SPARQ (or other VNA), and VirtualProbe will build the transfer function that returns the signal as it would appear before or after any block in the circuit. The electrical behavior of a block to reflect and transmit signals can be included, added or removed in order to de-embed or emulate fixtures or channels. Probe loading effects can also be removed. When used in conjunction with the Crosstalk, CrossLinQ or CompleteLinQ SDAIII options, cross-talk between lanes can be modeled using 8 and 12-port S-parameters. Use the Teledyne LeCroy SPARQ to measure these S-parameters at a fraction of the price of a VNA.

## Use EyeDoctorII and VirtualProbe with SDAIII CompleteLinQ products

When using EyeDoctorII and VirtualProbe on oscilloscopes enabled within the SDAIII-CompleteLinQ products, configure de-embedding, emulation and equalization from the same simple flow-chart dialog as all other serial data analysis features. When enabled with the "LinQ" option to enable four lanes, users can configure EyeDoctorII and VirtualProbe configurations on each lane, facilitating rapid comparisons of different de-embedding and equalization setups.

### Learn More

[teledynelecroy.com/dl/1023](http://teledynelecroy.com/dl/1023)

[teledynelecroy.com/vid/M0T6WEC0JYQ](http://teledynelecroy.com/vid/M0T6WEC0JYQ)

[teledynelecroy.com/dl/1216](http://teledynelecroy.com/dl/1216)

[teledynelecroy.com/dl/1136](http://teledynelecroy.com/dl/1136)

# SPARQ SIGNAL INTEGRITY NETWORK ANALYZER



**The SPARQ signal integrity network analyzers connect directly to the device under test (DUT) and to PC-based software through a single USB connection for quick, multi-port S-parameter measurements.**

**SPARQ is the ideal instrument for characterizing multi-port devices common in signal integrity applications at a fraction of the cost of traditional methods. It is ideal for:**

- **Development of measurement-based simulation models**
- **Design validation**
- **Compliance testing**
- **High-performance TDR**
- **PCB testing**
- **Portable measurement requirements**

## High-bandwidth, Multi-port S-parameters for the Masses

S-parameter measurements are most often produced by the vector network analyzer (VNA), a difficult instrument that is beyond many budgets. SPARQ is very affordable and simplifies measurements, making S-parameters accessible to all.

## PC-based, Small and Portable

Traditional instruments that produce S-parameters are large and fundamentally stationary. The SPARQ, in contrast, is small and weighs less than 20 lbs. It connects to any standard PC through a USB 2.0 interface, allowing SPARQ to run where computing power is easily upgraded.

## S-parameters, Quick

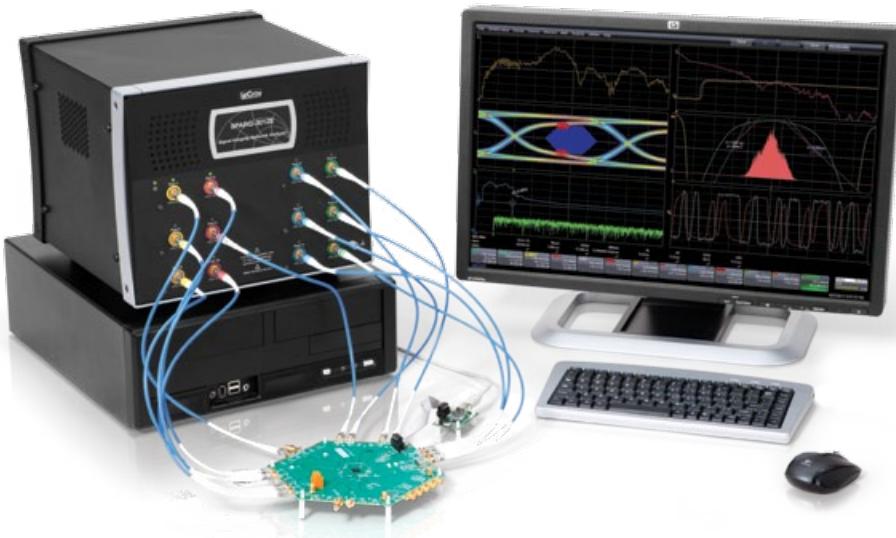
VNA measurements begin with the unpleasant and complex task of calibration. This involves multiple connections that can produce misleading results due to operator error. The SPARQ provides calibrated measurements with a single connection to the DUT and offers simple setup choices. Start and complete the entire measurement with a single button press.

## Internal Calibration

SPARQ takes a revolutionary approach to calibration by building in calibration standards. This enables measurements to be made without multiple connection steps and removes the need for additional electronic calibration (ECAL) modules. Calibration proceeds quickly without user intervention, so one can calibrate often without resorting to the use of out-of-date saved calibrations.

## Characterize Crosstalk with 8 and 12-port SPARQs

Don't just model crosstalk - measure it. With the 8 and 12 port SPARQs, characterize interconnects with two and three differential lanes in order to obtain S-parameters needed for simulations of aggressor/victim/aggressor topologies.



# SPECIFICATIONS

## Specifications

### SDAIII Serial Data Analysis Software (Included in all options)

#### Total Jitter

A complete jitter measurement and analysis toolset with the SDAIII-CompleteLinQ user interface framework. The CompleteLinQ framework provides a single user interface for "LinQ", "Crosstalk", "EyeDrill" and "Virtual Probe" capabilities (purchased separately).

SDAIII provides complete serial data and clock jitter and eye diagram measurement and analysis capabilities. Eye Diagrams with millions of UI are quickly calculated from up to 512 Mpt records, and advanced tools may be used on the Eye Diagram to aid analysis. Complete TIE and Total Jitter ( $T_j$ ) parameters and analysis functions are provided. Comparison of eye diagrams and jitter analysis between captured lanes and one "reference" location is provided.

Includes:

- Time Interval Error (TIE) Measurement Parameter, Histogram, Spectrum and Jitter Track
- Total Jitter ( $T_j$ ) Measurement Parameter, Histogram
- Spectrum
- Eye Diagram Display (sliced)
- Eye Diagram IsoBER (lines of constant Bit Error Rate)
- Eye Diagram Mask Violation Locator
- Eye Diagram Measurement Parameters
  - Eye Height
  - One Level
  - Zero Level
  - Eye Amplitude
  - Eye Width
  - Eye Crossing
  - Avg. Power
  - Extinction Ratio
  - Mask hits
  - Mask out
  - Bit Error Rate
  - Slice Width (setting)
- Q-Fit Tail Representation
- Bathtub Curve
- Cumulative Distribution Function (CDF)
- PLL Track

#### Jitter Decomposition Models

Three dual-dirac jitter decomposition methods are provided for maximum measurement flexibility. Q-Scale, CDF, Bathtub Curve, and all jitter decomposition measurement parameters can be displayed using any of the three methods.

- Spectral,  $R_j$  Direct
- Spectral,  $R_j+D_j$  CDF Fit
- NQ-Scale

#### Random Jitter ( $R_j$ ) and Non-Data Dependent Jitter ( $R_j+BU_j$ ) Analysis

- Random Jitter ( $R_j$ ) Meas Param
- Periodic Jitter ( $P_j$ ) Meas Param
- $R_j+BU_j$  Histogram
  - $R_j+BU_j$  Spectrum
  - $R_j+BU_j$  Track
  - $P_j$  Inverse FFT

#### Deterministic Jitter ( $D_j$ ) Analysis

- Deterministic Jitter ( $D_j$ ) Measurement Parameter

#### Data Dependent Jitter ( $DD_j$ ) Analysis

- Data Dependent Jitter ( $DD_j$ ) Param
- Duty Cycle Distortion (DCD) Param
- InterSymbol Interference (ISI) Param
- Digital Pattern display
  - $DD_j$  Plot (by Pattern or N-bit Sequence)
  - $DD_j$  Histogram
  - ISI Plot (by Pattern)

#### Reference Lane

- Compare current acquisition to Reference with a side-by-side or single (tabbed) display mode

#### SDAIII "LinQ" Capability

(Included in SDAIII-LinQ, SDAIII-CrossLinQ, and SDAIII-CompleteLinQ Options)

In addition to all SDAIII capabilities, "LinQ" options includes 4 lanes of simultaneous serial data analysis plus the reference lane. If EyeDrill or VirtualProbe are purchased with SDAIII "LinQ" capability, then those capabilities are provided for all four lanes.

#### Landscape Comparison Mode

When multiple lanes are enabled for display, Landscape Comparison Modes is used. Selections for this mode are as follows:

- Single: One lane is displayed at a time.
- Dual: Two lanes are selected for display.
- Mosaic: All enabled lanes are displayed.

#### SDAIII "Crosstalk" Capability

(Included in SDAIII-Crosstalk, SDAIII-CrossLinQ, and SDAIII-CompleteLinQ Options)

In addition to all SDAIII capabilities, "Crosstalk" options add the following noise and crosstalk measurements and analysis tools:

- Total, Random and Deterministic noise ( $T_n$ ,  $R_n$ ,  $D_n$ ) measurements
- Breakdown of  $D_n$  into InterSymbol Interference noise (ISIn) and Periodic noise ( $P_n$ )
- Noise-based eye height and width: EH(BER) and EW(BER)
- Random noise ( $R_n$ ) + Bounded Uncorrelated noise (BUn) Noise Histogram
- Q-fit for Noise Histogram
- $R_n+Bun$  Noise Spectrum and Peak threshold
- $P_n$  Inverse FFT Plot
- $R_n+Bun$  Noise Track
- Crosstalk Eye Contour Plot

#### SDAIII-CompleteLinQ

The ultimate in serial data single or multi-lane link analysis. Provides all the capabilities mentioned above in SDAIII, "LinQ", and "Crosstalk", and also includes EyeDrill and Virtual Probe capabilities.

#### Eye Doctor II Advanced Signal Integrity Tools (EYEDRII) (SDAIII-CompleteLinQ Compatible Options)

Complete set of channel emulation, de-embedding and receiver equalization simulation tools. Provides capability to emulate a serial data link, de-embed or embed a fixture, cable or serial data channel, add or remove emphasis, and perform CTLE, FFE, or DFE equalization. If purchased with SDAIII, then capabilities are accessed from within the SDAIII-CompleteLinQ user interface framework.

#### Virtual Probe Signal Integrity Tools (VIRTUALPROBE) (SDAIII-CompleteLinQ Compatible Options)

Provides ability to define a complex serial data channel or topology with up to six circuit elements that may be embedded or de-embedded, allowing "probing" at a location different than the measured position. If purchased with SDAIII and EyeDrill (or with the EYEDRII-VP or CompleteLinQ options), then capabilities are accessed from within the single SDAIII-CompleteLinQ user interface framework.

#### EyeDoctorII and Virtual Probe Bundle EYEDRII-VP (SDAIII-CompleteLinQ Compatible Options)

Provides all capabilities of Eye Doctor II and Virtual Probe Signal Integrity Tools.

# ORDERING INFORMATION

## Options

SDAIII-CompleteLinQ	Bundle - Multi-Lane SDA LinQ Framework, incl. Eye, Jitter, Noise, Crosstalk Meas, w/EyeDrill & VirtualProbe
SDAIII-CrossLinQ	Multi-Lane Serial Data Analysis LinQ Framework, Eye, Jitter, Noise and Crosstalk Measurements
SDAIII-LinQ	Multi-Lane Serial Data Analysis LinQ Framework, Eye and Jitter Measurements
SDAIII-Crosstalk	Single-Lane Serial Data Analysis Framework, Eye, Jitter, Noise and Crosstalk Measurements
SDAIII	Single-Lane Serial Data Analysis Framework, Eye and Jitter Measurements

## Related Products

EyeDrill	Advanced Signal Integrity Toolkit
VirtualProbe	Multi-block De-embedding, Emulation and Probe Relocation Toolkit
EyeDrill-VP	Bundle Including EyeDrill and VirtualProbe

\*EyeDrill and VirtualProbe are included standard when ordering the SDAIII-CompleteLinQ option.

	SDAIII	SDAIII-LinQ	SDAIII-Crosstalk	SDAIII-CrossLinQ	SDAIII-CompleteLinQ
Single lane Analysis	✓	✓	✓	✓	✓
Reference Lane	✓	✓	✓	✓	✓
Eye	✓	✓	✓	✓	✓
Jitter	✓	✓	✓	✓	✓
Multi-lane Analysis		✓		✓	✓
LaneScape Comparisons		✓		✓	✓
Noise				✓	✓
Crosstalk				✓	✓
Equalization	(1)	(1)	(1)	(1)	✓
De-embedding & Emulation	(1,2)	(1,2)	(1,2)	(1,2)	✓
VirtualProbe	(2)	(2)	(2)	(2)	✓

(1): Available with EyeDoctorII

(2): Available with VirtualProbe

- Single-Lane (+Ref):
- SDAIII
  - SDAIII-Crosstalk

- Emphasis, De-embed/Emulate, Equalization:
- EyeDoctorII
  - EyeDoctorII-VP
  - SDAIII-CompleteLinQ

- Multi-lane (+Ref): All "LinQ" products:
- SDAIII-LinQ
  - SDAIII-CrossLinQ
  - SDAIII-CompleteLinQ

Note: All buttons not in boxes, including Ref Lane are included as part of SDAIII core functionality.

- Noise and Crosstalk:
- SDAIII-Crosstalk
  - SDAIII-CrossLinQ
  - SDAIII-CompleteLinQ



1-800-5-LeCroy  
teledynelecroy.com

Local sales offices are located throughout the world.  
Visit our website to find the most convenient location.