TELEDYNE LECROY
Everywhereyoulook™

Eye Doctor™ II
Advanced Signal Integrity Tools

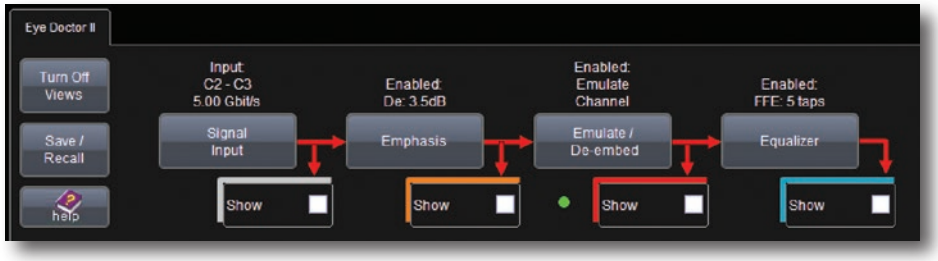
EYE DOCTOR II ADVANCED SIGNAL INTEGRITY TOOLS

Key Features

- **Eye Doctor™ II provides the channel emulation and de-embedding tools**
- **Adds precision to signal integrity measurements**
- **Vital for anyone using an 8 GHz or higher oscilloscope**
- **Seamlessly integrates into Teledyne LeCroy's SDA II and SDAIII-CompleteLinQ software for eye diagram and jitter analysis**
- **Creates eye diagrams 50x faster than existing solutions**
- **Uses industry standard Touchstone format S-parameter files for fixture and channel definition**
- **Ability to read single ended or mixed mode S-parameter files**
- **DFE, FFE and CTLE Receiver Equalization**
- **Fully integrated into the user interface which allows the engineer to use additional Teledyne LeCroy tools for post-processing**
- **Use Eye Doctor II's Advanced mode to:**
  - **Flexibly arrange components to allow any combination of de-embedding or emulation for Virtual Probing™ of any point in the test circuit not otherwise accessible**
  - **Increase measurement accuracy through the use of a more advanced transmitter and receiver termination model that incorporates customer-specific characteristics**

Tools for Next Generation Serial Data Standards

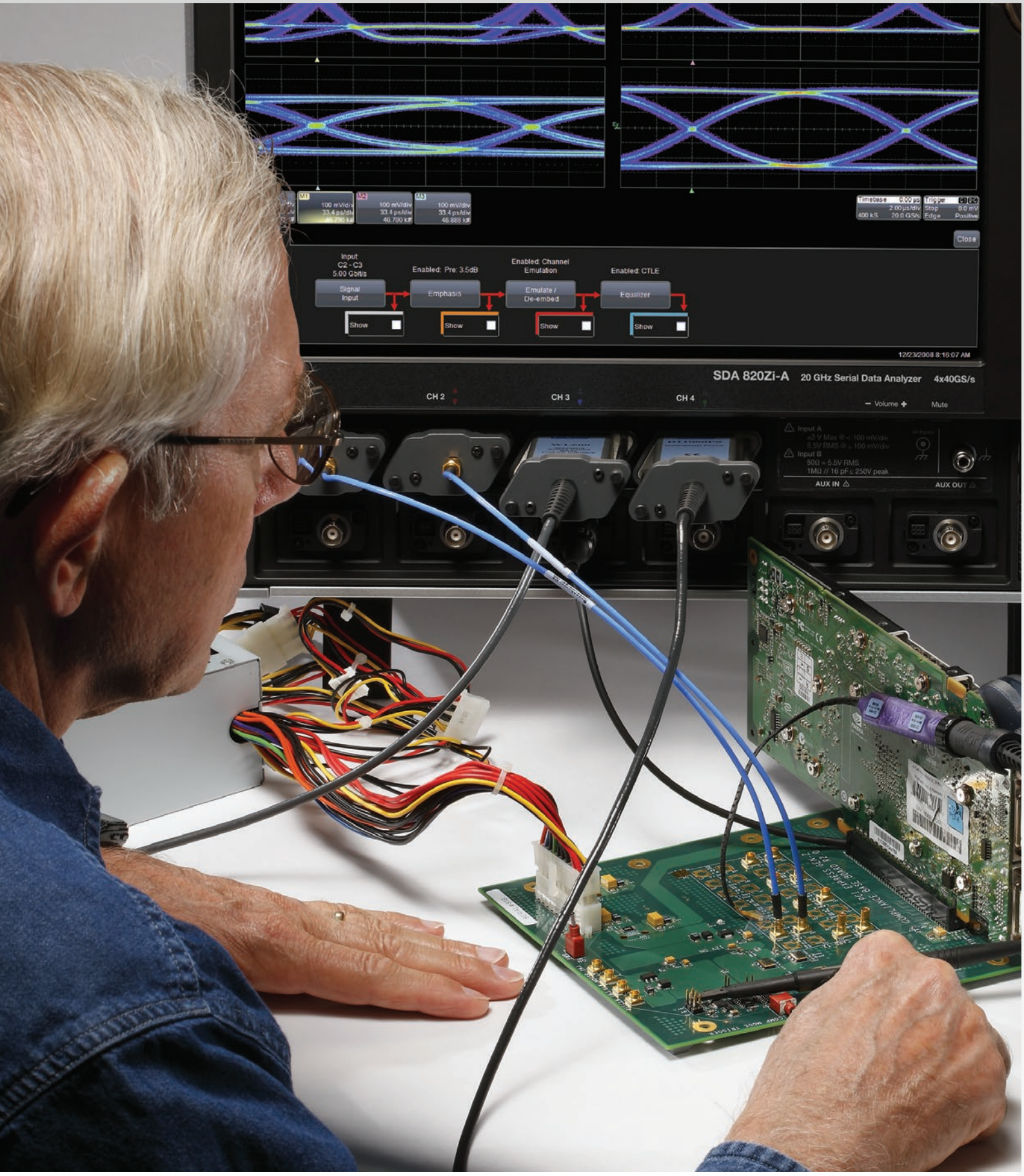
As signal speeds and data rates have increased to 5 Gb/s and greater while propagation mediums have remained unchanged, engineers have had to face new challenges with signal integrity. These faster signal speeds give rise to increased attenuation in the frequencies of interest. These effects were small enough to ignore at lower bit rates, but as rise times get faster and serial data rates increase, these effects must be accounted to avoid unacceptable intrusion into the design margin or completely unusable measurement results. As data rates increase, losses due to the serial data channels and fixtures increase at high frequency leading to eye closures. To truly understand jitter in the serial data signal, these effects must be removed. Clearly, design engineers need new tools to remove the impact of test fixtures and cables, model the impact of serial data channels and fixtures, and simulate the receiver equalization. These capabilities greatly enhance the ability to make useful measurements in high-speed circuits. Additionally, newer serial data standards are requiring such tools in order to make compliance measurements. For example, PCI Express 3.0 will require the use of fixture de-embedding to refer the compliance measurement back to the pins of the transmitter; SuperSpeed USB requires the use of continuous time linear equalization being applied in the oscilloscope software, SATA 6 Gb/s and 6 Gb/s SAS require the emulation of the Transmitter Compliance Transfer Function (TCTF) to simulate the worst allow case channel for debugging compliance failures.



Eye Doctor II main user interface.

Integrates into SDAIII-CompleteLinQ

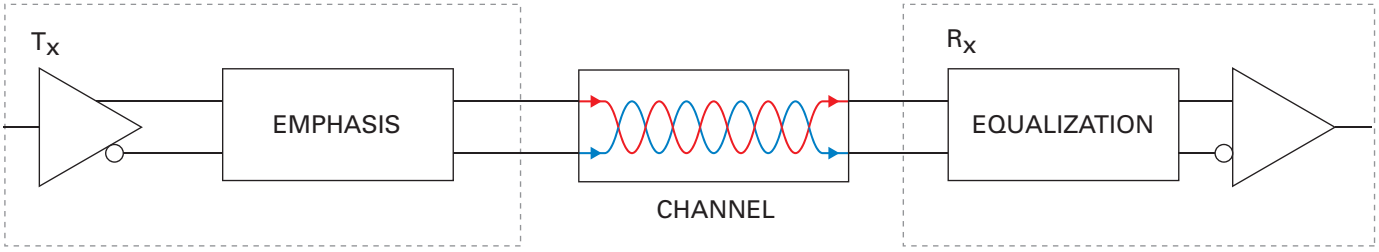
For more information: teledynelecroy.com/sdaiii


Input:
C2 - C3
5.00 GbW/s
Signal Input
Enabled: Pre: 3.5dB
Emphasis
Enabled: Channel Emulation
Emulate / De-embed
Enabled: CTLE
Equalizer
Show
Close
12/23/2008 8:16:07 AM
SDA 820Zi-A
20 GHz Serial Data Analyzer
4x40GS/s
CH 2
CH 3
CH 4
Volume
Mute
Input A
Input B
AUX IN
AUX OUT

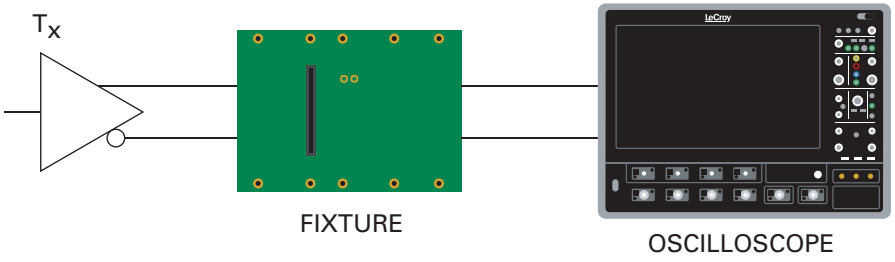
EYE DOCTOR II CAPABILITIES

Emulating Serial Data Link Components

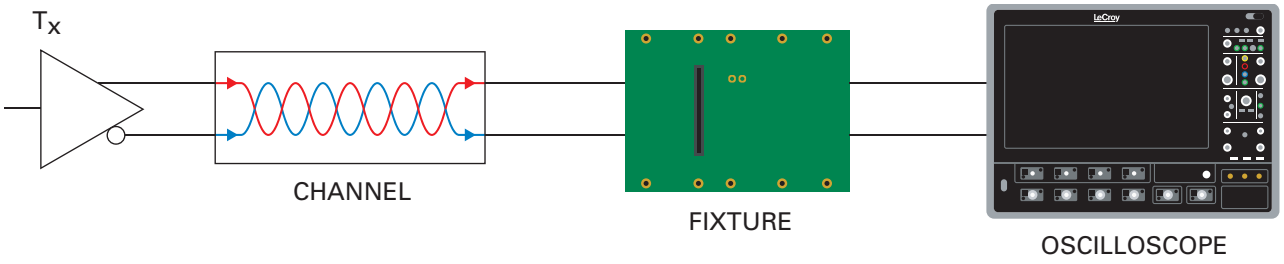
When performing serial data measurements on the physical layer, the main goal is to properly characterize the robustness of the serial data link. Measurements can either be made at the transmitter or the receiver as shown below.



De-embedding Fixture from Tx Measurements

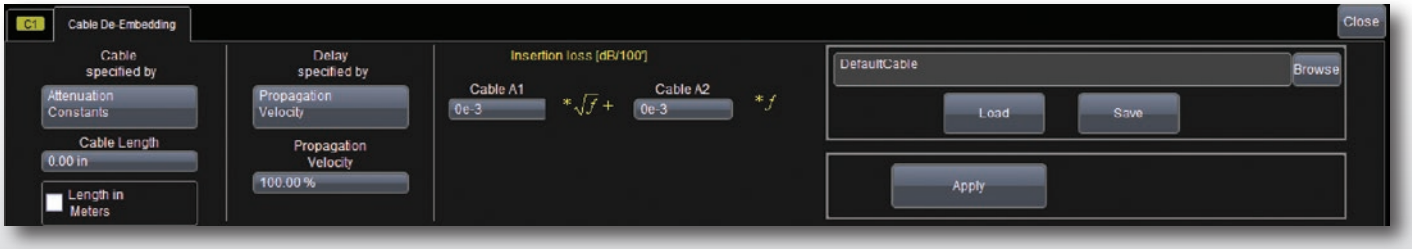


De-embedding Fixture from Rx Measurements



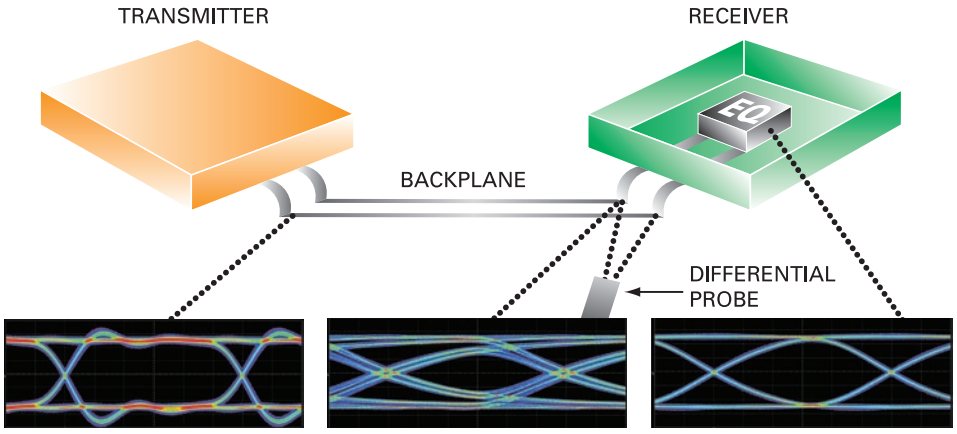
Cable De-embedding

Cable de-embedding is a standard feature on all SDA Zi/Zi-A oscilloscopes and is included with Eye Doctor II. Cable de-embedding gives the user the ability to quickly and easily remove the effect of cables by entering in an attenuation table or attenuation constants that are typically provided by the cable manufacturer.



EYE DOCTOR II ADVANCED SIGNAL INTEGRITY TOOLS

As signal speeds and data rates have increased to beyond 5 Gb/s while propagation mediums have remained unchanged, engineers have faced new signal integrity challenges, among these, increased attenuation in the frequencies of interest. These effects were small enough to ignore at lower bit rates, but now these effects must be accounted for to avoid unacceptable intrusion into the design margin or completely unusable measurement results.



Serial data signal probed at the transmitter output shows acceptable response

Losses in the serial data channel affect the signal integrity. This effect can be de-embedded or emulated

The receiver usually applies equalization to "open" the eye. This equalization can be modeled to show how the signal appears to the receiver after equalization is applied

Adding/Removing Pre- or De-emphasis

Transmitter designers sometimes employ the use of emphasis to pre-compensate for these effects. Eye Doctor II can remove de-emphasis or pre-emphasis from a signal measured at the transmitter output. This is useful when attempting to measure the jitter on such a signal in order to remove the DDj introduced by the de-emphasis. Eye Doctor II can also add de-emphasis or pre-emphasis to quantify the compensation necessary for specific serial data channels.

Cable/Fixture/Serial Data Channel De-embedding

In many typical high frequency measurement situations, engineers desire to connect as directly to their signal as possible and avoid the use of probes. However, even high quality test fixtures, channels, and cables have a negative impact on signal quality that increases with higher signal frequency. If the test fixture, channel, or cable can be electrically quantified in terms of S-parameters using Teledyne LeCroy's SPARQ or another type of network analyzer, then their electrical impact can be removed from the measurement result. The measurement result is then unaltered by the test setup, and the ability to further measure, apply math, or post-process this true measurement using additional tools, such as parameters, math functions, jitter tracks, histograms, eye diagrams, etc. is available.

Serial Data Channel Response Emulation

Most commonly, a design engineer will perform their serial data measurement at the output of the transmitter. However, the engineer may also be interested in referring their measurement to the far side of a particular serial data channel. To accomplish this they could either use a physical channel and make their measurement after the channel or they can use channel emulation to see what their serial data signal would look like if it had been transmitted through the channel. This is particularly useful for some compliance testing.

Receiver Equalization

Finally, the serial data receiver often incorporates equalization to compensate for losses associated with the serial data channel. Losses from the channel can cause the eye to be completely closed at the input of the receiver. Even though a receiver that utilizes equalization would be able to properly decode this signal, the oscilloscope jitter analysis software will not be able to recover a clock from the signal and will not be able to perform any jitter analysis. For this reason, the oscilloscope emulates the different equalizers the engineer's receiver could be using and thus provides the ability to view the eye diagram and jitter performance on the signal as it is actually seen by the specific receiver.

Learn More

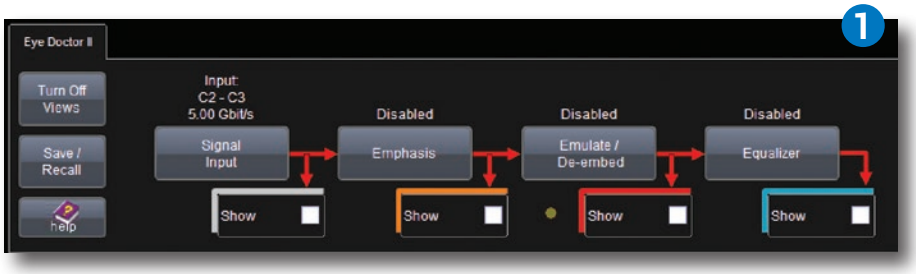
teledynelecroy.com/dl/1023

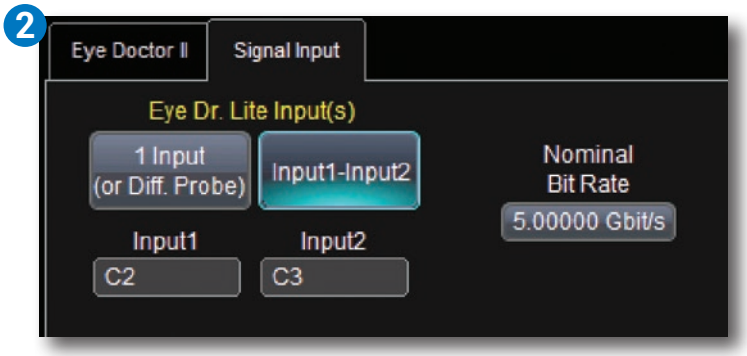
teledynelecroy.com/vid/M0T6WEC0JYQ

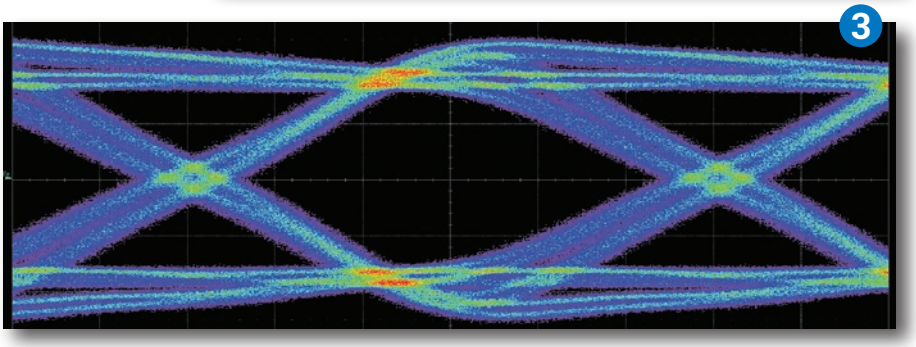
teledynelecroy.com/dl/1216

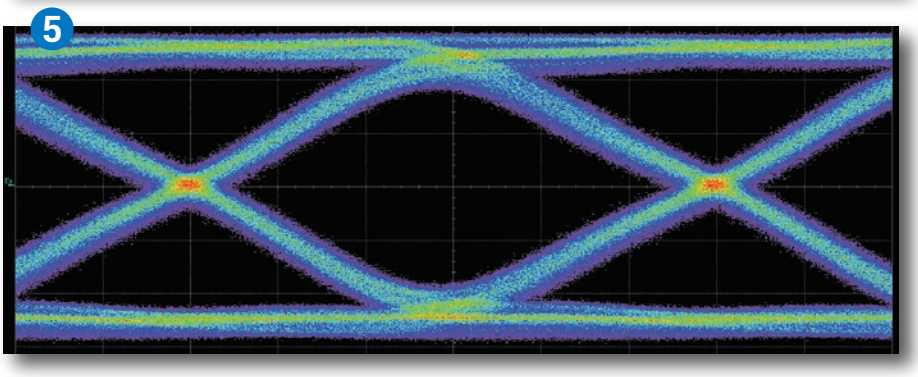
teledynelecroy.com/dl/1136

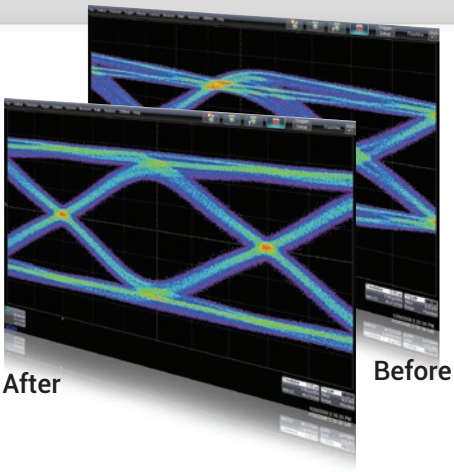
TRANSMITTER EMPHASIS EMULATION





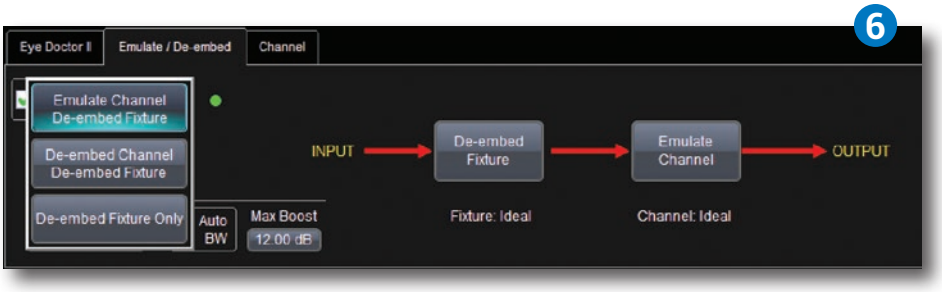


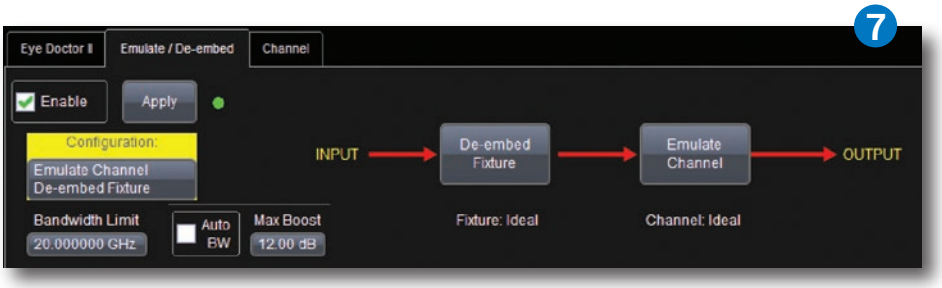


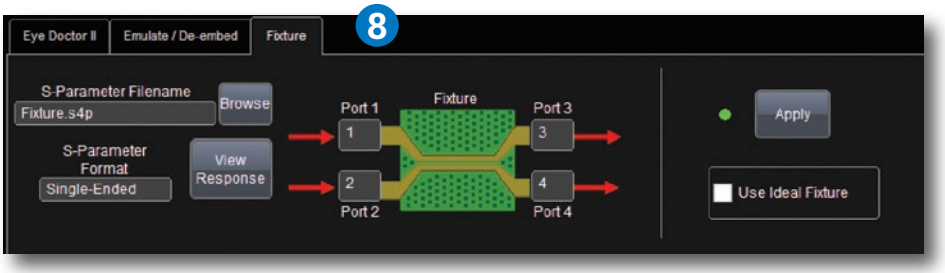


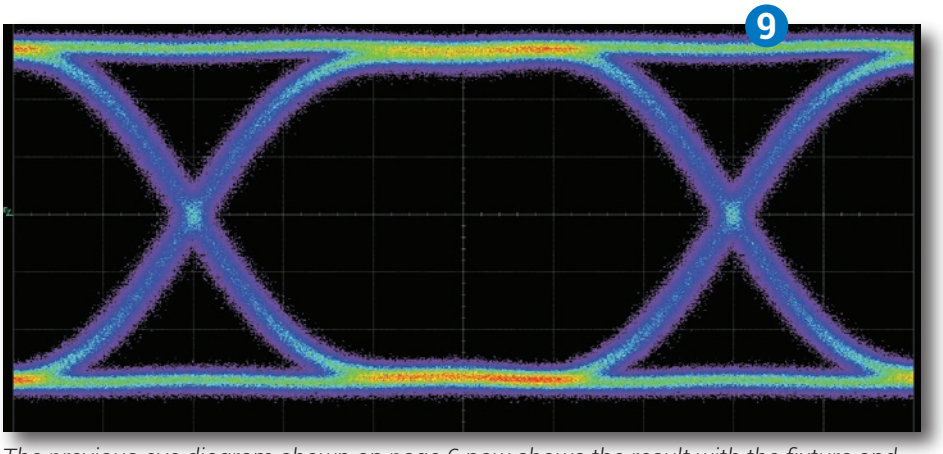
1. Teledyne LeCroy's Eye Doctor II Advanced Signal Integrity Tools provide the ability to impose the effects of a channel or an equalizer on a measured signal. Eye Doctor II allows the subtraction of fixture effects, and the emulation of emphasis, serial data channels, and receiver DFE, FFE, and CTLE equalization effects and integrates seamlessly into Teledyne LeCroy's SDA II software for eye diagram and jitter analysis.
2. Notice that the Signal Input is set to Channel 2 minus Channel 3 and the Nominal Bit Rate is set to 5 Gb/s.
3. As you can see this eye diagram contains de-emphasis. This de-emphasis can be removed from the signal so that the eye diagram can be observed without the de-emphasis.
4. The pre- or de-emphasis can either be added or removed. In this case, it is set to remove 3.5 dB of de-emphasis.
5. The eye diagram is calculated and displayed with the de-emphasis removed.

FIXTURE DE-EMBEDDING

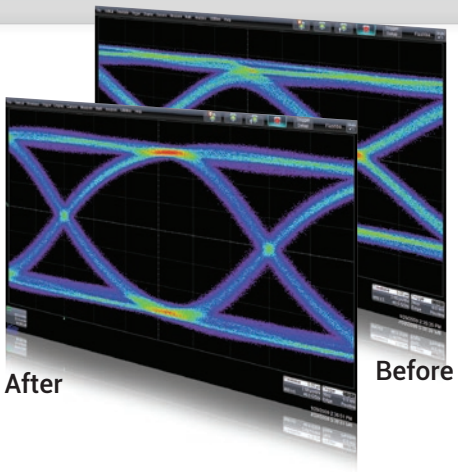








The previous eye diagram shown on page 6 now shows the result with the fixture and cables de-embedded.



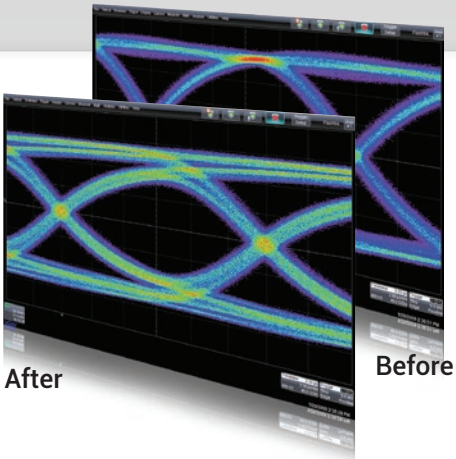
6. Fixtures and the attached cables can be de-embedded to see what the eye would actually look like directly at the transmitter output. The Emulate/De-embed menu has three choices.

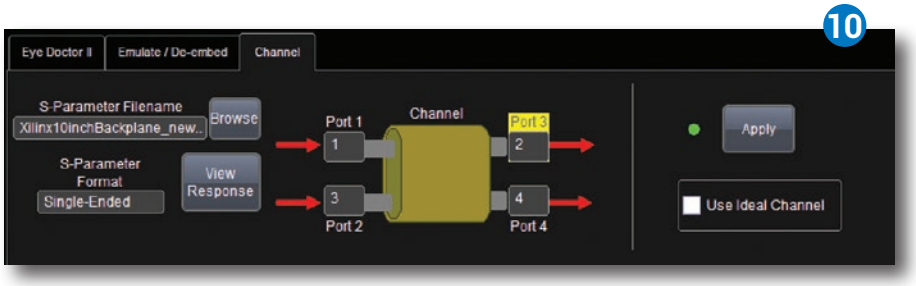
7. Here "Emulate Channel/de-embed Fixture" has been chosen.

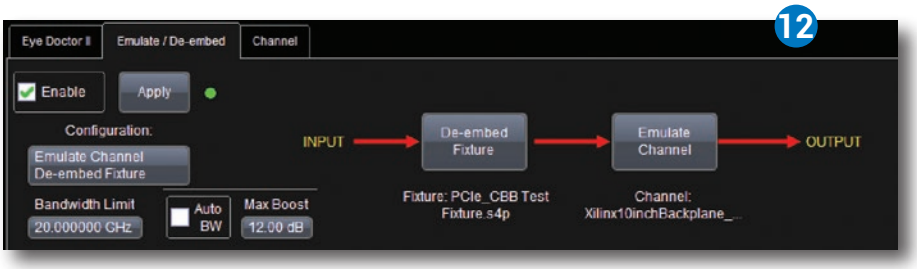
8. The S-parameter file that contains the fixture response information is an industry-standard Touchstone file format. Simply browse for the file and select the appropriate file for the fixture you are using. The user must first measure or simulate the lossy fixture and then copy it to the oscilloscope.

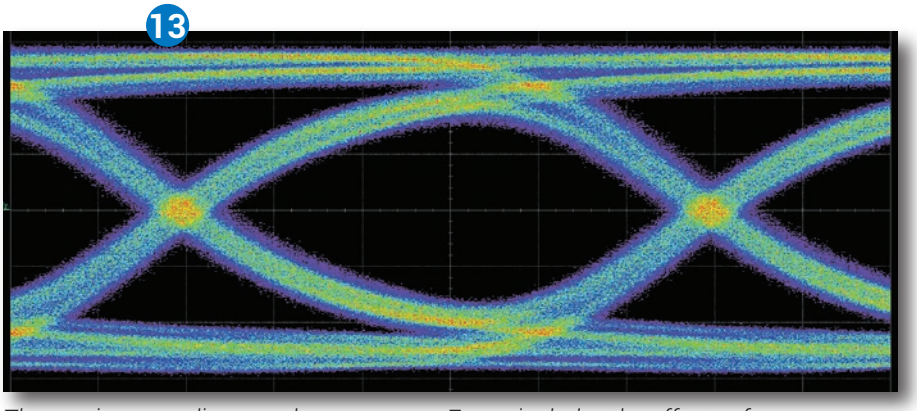
9. Clicking "Apply" will now de-embed the fixture.

CHANNEL RESPONSE EMULATION









The previous eye diagram shown on page 7 now includes the effects of an emulated serial data channel.

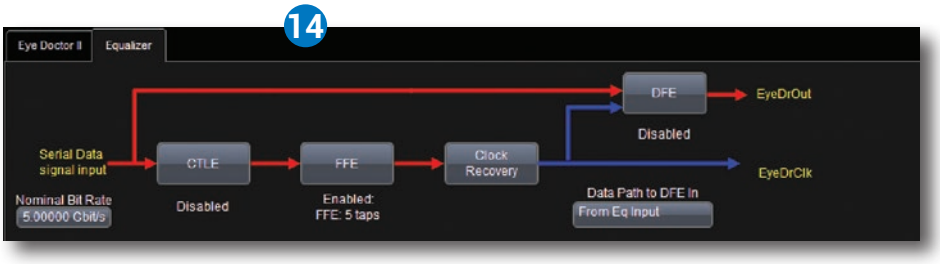
10. In addition to cable and fixture de-embedding, serial data channels may also be emulated. Again, the S-parameter file defining the channel is selected and applied. If the ports in the S-parameter file are different from those shown, the ports used can be reassigned via the dialog. The user must first measure or simulate the lossy channel and then copy it to the oscilloscope.

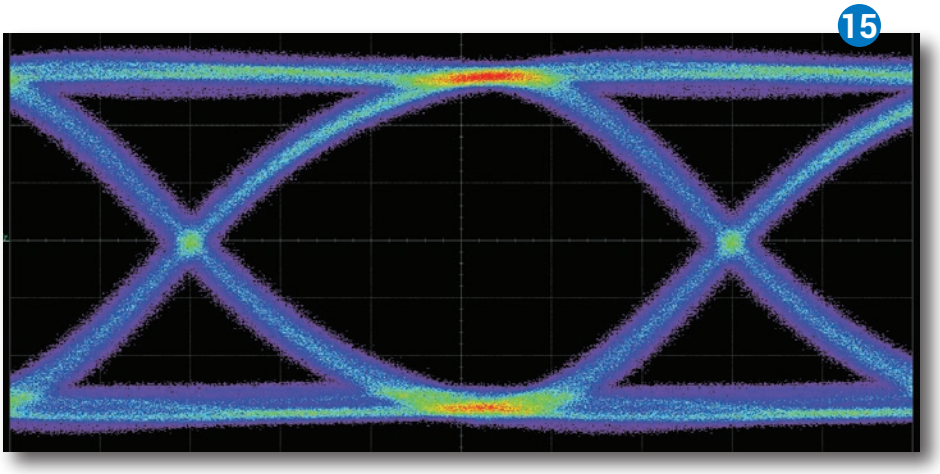
11. The "View Response" feature allows the user to view a plot of any of the s-parameters in the Touchstone file being used, and allows verification of correct setup. In this case, "S21" and "Magnitude" are selected to show the insertion loss.

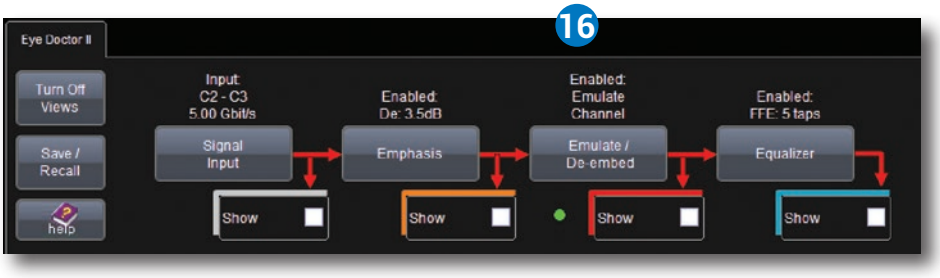
12. The Emulate/De-embed menu shows the setup as defined, with the S-parameter file names used conveniently displayed in the user interface, at the bottom.

13. Notice how the Eye diagram begins to close and the ISI increases when the channel is emulated. This provides insight into how a serial data channel that is not present in the test circuit will affect the serial data signal. Additional Teledyne LeCroy tools, such as masks or IsoBER, can be applied on this eye diagram.

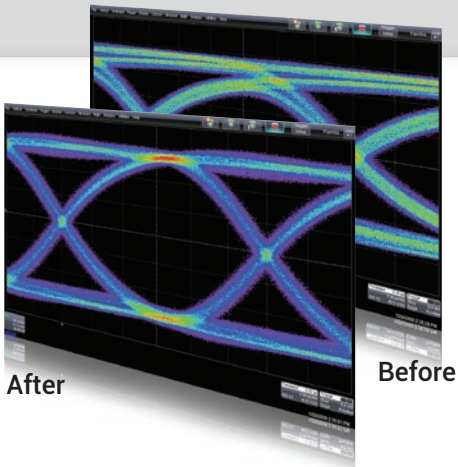
RECEIVER EQUALIZATION







The Teledyne LeCroy Eye Doctor II Advanced Signal Integrity Tools add precision to your signal integrity measurements, re-capture design margin lost to test fixtures and cables, allow you to support PCI Express 3.0, SATA 6 Gb/s, SuperSpeed USB and 6 Gb/s SAS. When used with Teledyne LeCroy's SDA II software, Eye Doctor II provides fast eye diagram and jitter measurement analysis results using the de-embedded and emulated data on full record lengths.

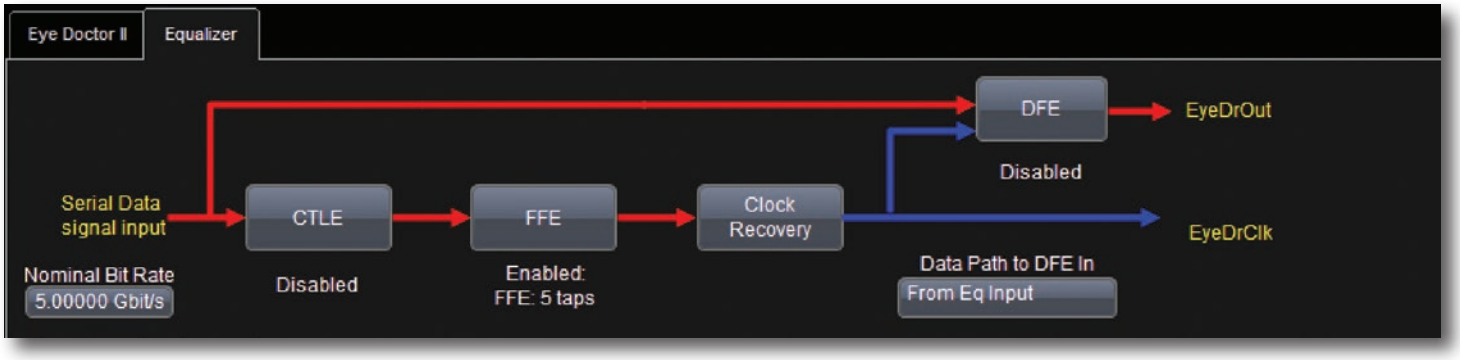


14. Receiver Equalization can allow insight into how the receiver will correct for a "closed eye" situation. In this example, a receiver that employs FFE equalization is simulated. The number of taps is set to five and the number of precursor taps is set to three. Levels are automatically found by the software.

15. With equalization applied, the eye opening widens from that shown on page 8.

16. The main Eye Doctor II user interface displays all of the processing steps that are currently being performed directly under each processing block.

MOST ADVANCED EQUALIZATION



Eye Doctor II has advanced equalization capability that allows the user to perform Continuous Time Linear Equalization (CTLE), Feed Forward Equalization (FFE) and/or Decision Feedback Equalization (DFE) on their data signal. Additionally, the data signal after the CTLE or FFE blocks can be used for clock recovery.

As seen in the image above, a simple user interface gives the user access to all three of these equalization methodologies. Each equalization type (CTLE, FFE and DFE) can be separately enabled or disabled, and each has a caption showing its current state. Clicking on the **CTLE, FFE, DFE** or **Clock** Recovery boxes brings the user to the configuration page for that selection. The **Data Path to DFE In** selection can be set to **From Eq Input, From CTLE or From FFE.** Making one of these selections updates the user interface showing the correct connection between the data signal and the DFE input. These different configurations make it possible to have the independent equalization of the data signal and the signal that is used for clock recovery. This ability is very important for serial data standards such as 6 Gb/s SAS. These signals could have closed eye diagrams in which some form of equalization must be performed on the data prior to recovering the clock signal. However, the standard also requires that Decision Feedback Equalization be the only form of equalization used on the data signal. Eye Doctor II makes this possible.

Additionally the Feed Forward Equalizer and the Decision Feedback Equalizer have the ability to automatically train to find the optimal tap values. User defined tap values can also be entered.

Eye Doctor II contains two separate waveform outputs: **EyeDrOut** and **EyeDrClk.** These signals can be used as inputs to SDA II for Eye Diagram and Jitter analysis on the equalized data and clock signals.

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

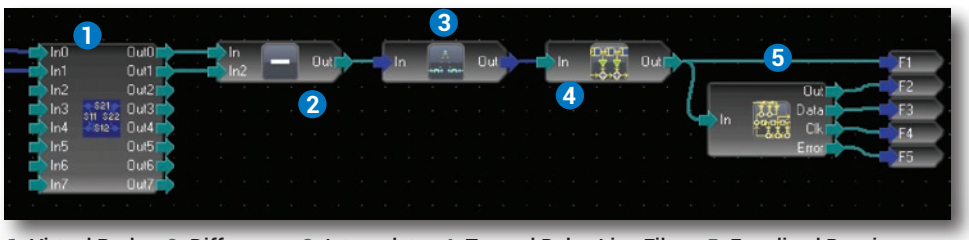
VNA measurements begin with the unpleasant and complex task of calibration. This involves multiple connections that can produce misleading results due to operator error. The SPARQ provides calibrated measurements with a single connection to the DUT and offers simple setup choices. Start and complete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

Eye Doctor II's Advanced Capabilities

Through the use of Eye Doctor II's advanced capabilities the user can flexibly arrange components to allow any combination of de-embedding or emulation for Virtual Probing™ of any point in the test circuit not otherwise accessible; increase measurement accuracy through the use of a more advanced transmitter and receiver termination model that incorporates customer-specific characteristics; simulate cross-talk with more than one channel; specify multiple outputs and much more.



1. Virtual Probe 2. Difference 3. Interpolate 4. Tapped Delay Line Filter 5. Equalized Receiver

SPECIFICATIONS AND ORDERING INFORMATION

Specifications

Feature or Capability	Eye Doctor II
Cable De-embedding	Yes
Fixture De-embedding	Yes
Channel De-embedding	Yes
Emphasis Emulation	Yes
Channel Emulation	Yes
Receiver Equalizer Emulation	DFE, FFE, CTLE
Record Length	Up to 512 Mpts
Single-ended S-parameters	Yes
Mixed mode S-parameters	Yes
Non-ideal Termination Models*	Yes

* Advanced Mode capability.

Ordering Information

Product Description	Product Code
Eye Doctor II Advanced Signal Integrity Tools for LabMaster 10 Zi Oscilloscopes	LM10Zi-EYEDRII*
Eye Doctor II Advanced Signal Integrity Tools for LabMaster 9 Zi-A Oscilloscopes	LM9Zi-EYEDRII*
Eye Doctor II Advanced Signal Integrity Tools for WaveMaster 8 Zi/Zi-A Oscilloscopes, SDA 8 Zi/Zi-A Serial Data Analyzers, and DDA 8 Zi/Zi-A Disk Drive Analyzers	WM8Zi-EYEDRII*
Eye Doctor II Advanced Signal Integrity Tools for WavePro 7 Zi Oscilloscopes, SDA 7 Zi Serial Data Analyzers, and DDA 7 Zi Disk Drive Analyzers	WPZi-EYEDRII*
Eye Doctor II Advanced Signal Integrity Tools for WaveRunner 6 Zi Oscilloscopes	WR6Zi-EYEDRII**

*SDAIII software is required for eye diagram and jitter analysis.
**SDA II software is required for eye diagram and jitter analysis.

Customer Service

Teledyne LeCroy oscilloscopes and probes are designed, built, and tested to ensure high reliability. In the unlikely event you experience difficulties, our digital oscilloscopes are fully warranted for three years and our probes are warranted for one year. This warranty includes:

- No charge for return shipping
- Long-term 7-year support
- Upgrade to latest software at no charge

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1-800-5-LeCroy
teledynelecroy.com

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