Using LeCroy's EyeDoctor™II

APPLICATION BRIEF
LAB-WM778

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Summary

As signal speeds and data rates have increased to 5 Gb/s and greater while progation mediums have remained unchanged, engineers have had to face new challenges with signal integrity measurements. Eye Doctor™ II is a complete set of tools that adds precision to signal integrity measurements by permitting de-embedding and emulation (emphasis, serial data channel, or receiver equalization).

Figure 1 shows a summary view of Eye Doctor II's capabilities. The eye diagram of the input signal in the upper left quadrant shows the effects of transmitter de-emphasis plus channel and fixture losses. In the upper right eye 3.5 dB of de-emphasis has been removed. The eye diagram with the fixture effects removed and a serial data channel emulation, as described by their respective S-parameter files, is shown in the lower left hand quadrant. The eye in the lower right emulates Feed Forward Equalization (FFE) that could be applied by the receiver. By using Eye Doctor II to apply serial data channel emulation to simulate backplane losses, then using Eye Doctor to apply receiver equalization to mimic functionality of the hardware receiver, we can understand whether the signal as received by the receiver has acceptable jitter performance or not.

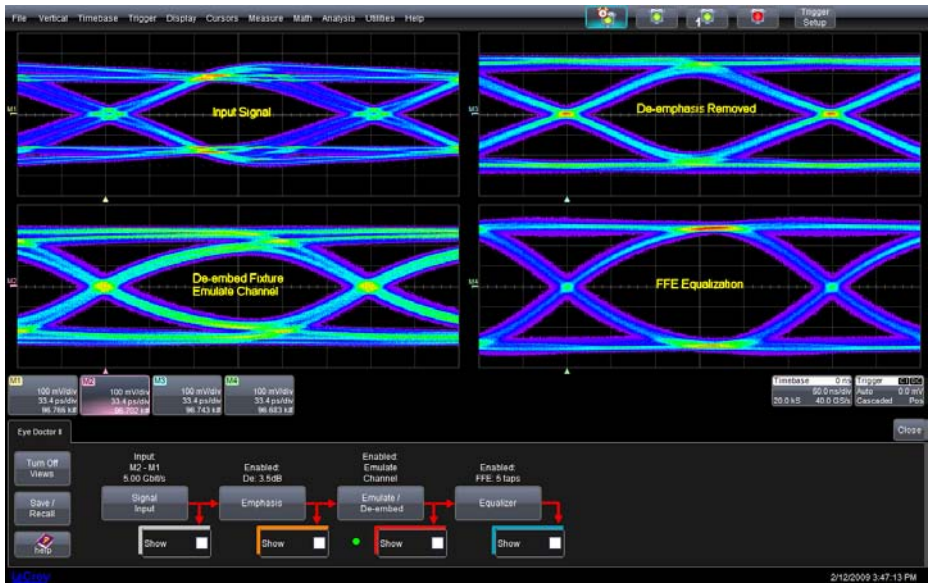

***Figure 1**: Eye Doctor™ II operates on the serial data signal input shown in the upper left quadrant, removes de-emphasis(upper right), De-embeds the fixture and emulates the channel(lower left), and applies equalization (lower right) providing an accurate view of the serial data signal as it is inside the receiver immediately after the equalizer.*

All basic capabilities of Eye Doctor II are easily accessible in a streamlined, simple user interface shown below the eye diagrams. This simple flow diagram documents each step in the process and allows highly interactive operation of the process.

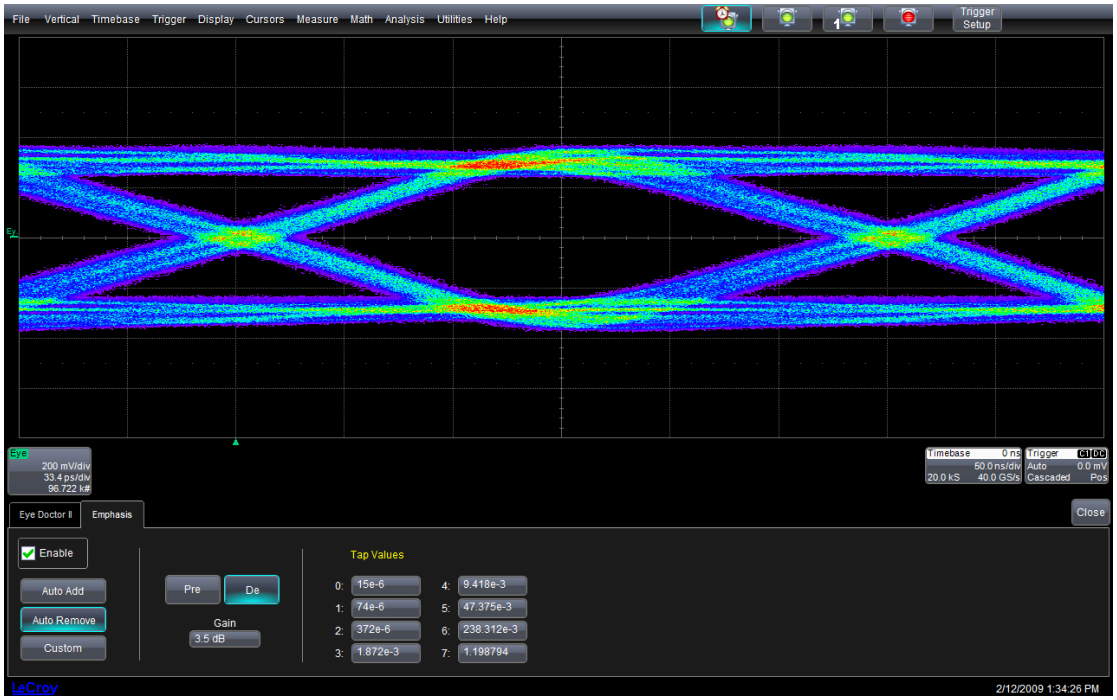

Figure 2: *The Emphasis tab in the Eye Doctor II dialog box is used to add or remove pre or de-emphasis.*

More advanced capability is accessible through the Processing Web Editor. The complete LeCroy analysis toolbox, such as S-parameters, math functions, jitter tracks, histograms, eye diagrams, etc., may be further applied to any Eye Doctor II processed signal.

This allows the engineer to re-capture design margin, better understand actual circuit performance, and perform compliance testing on emerging high-speed standards, such as PCIe Gen3, USB 3.0, and SAS/SATA 6 Gb/s that require these tools to ensure high field reliability and interoperability.

Let's look at the setup of Eye Doctor II in detail: Serial data channels have a significant impact on the high frequency content of the serial data signal. Therefore, transmitter designers sometime employ the use of emphasis to pre-compensate for these effects.

Figure 2 shows the Emphasis tab of the Eye Doctor II dialog box. This allows users to add or remove pre- or de-emphasis from the serial data signal.

Pre- and de-emphasis are used to correct for the loss in the transmission medium. In some applications, users may want to add emphasis in order to compensate for the effects of the transmission path. In other situations, such as in making jitter measurements on a transmitter, they may want to remove emphasis.

In the example shown in Figure 2, 3.5 dB of de-emphasis is being removed. Emphasis is implemented using digital filters which require the entry of tap weights or values. The Auto Add and Auto Remove buttons in the dialog box will automatically compute and enter the tap values for the entered Gain value. Pressing the Custom button allows the user to enter the tap values manually. A detailed description of the emphasis filters can be found in a technical brief titled:

"Dealing with De-emphasis in Jitter Testing".

This technical brief can be found on LeCroy's website at: http://www.lecroy.com/tm/library/AppNotes/SerialData/De-emphasis_Technical_Brief.pdf

When measuring serial datastreams, there are additional considerations. Most commonly, but not always, a design engineer will measure the serial data signal at the output of the transmitter. Therefore, it is commonly desired to emulate the serial data channel after the transmitter output.

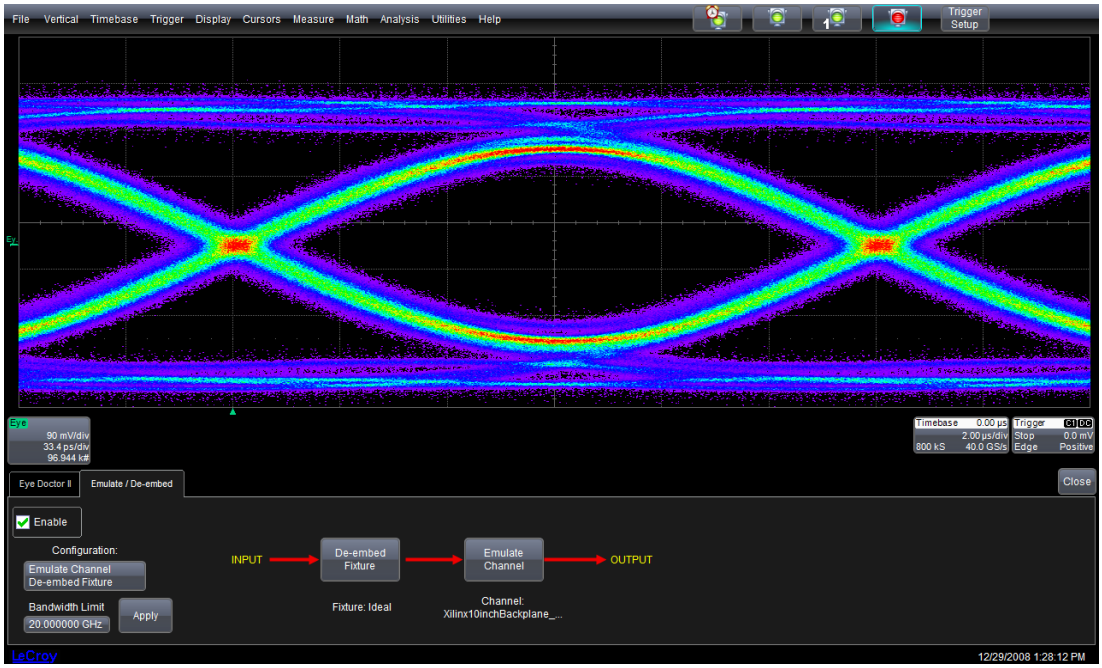

Figure 3: *The Emulate/De-embed tab is used to remove the effects of test fixtures and to emulate of the data path.*

Figures 3, 4, and 5 show the dialog boxes associated with test fixture de-embedding and channel emulation.

Some emerging high-speed standards, such as SuperSpeed USB or PCIe Gen3, require various test conditions to emulate a variety of serial data channels to ensure reliable communications under all circumstances.

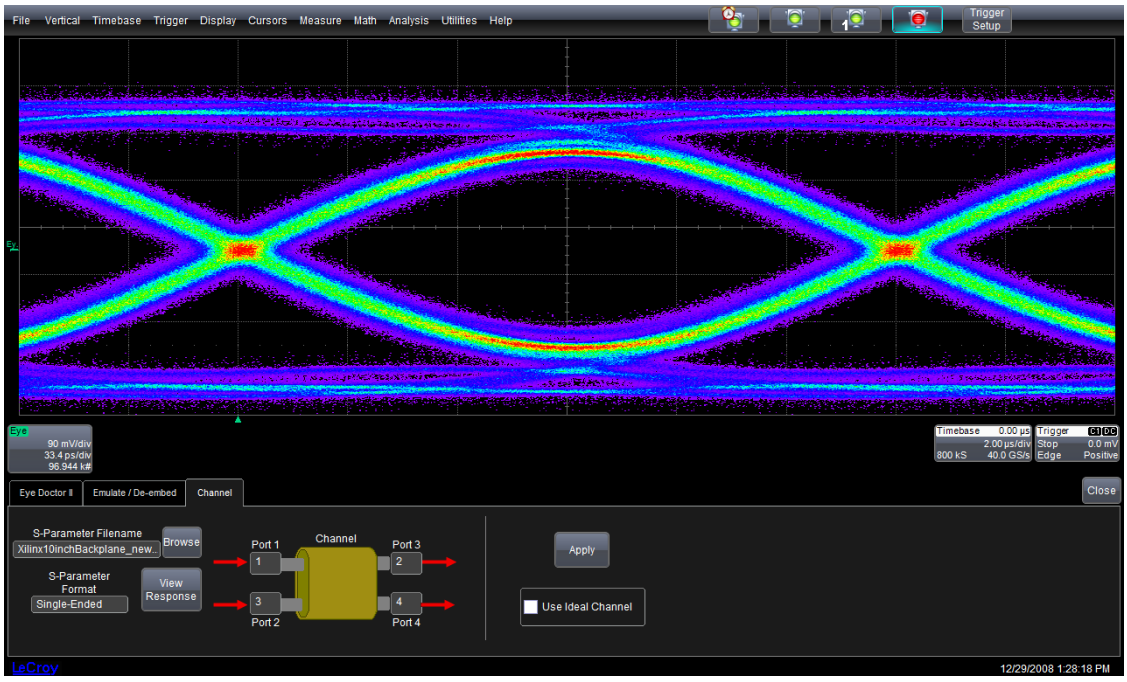

Figure 4: *The Channel emulation tab showing the port configuration and the entries for the S-parameter files.*

It may also be desired to "virtually probe" the serial data signal in your circuit using a combination of de-embedding and emulation to allow a view of the signal anywhere in your circuit, regardless of whether you can actually probe there or not. Eye Doctor II makes this possible.

These dialog boxes use industry standard.

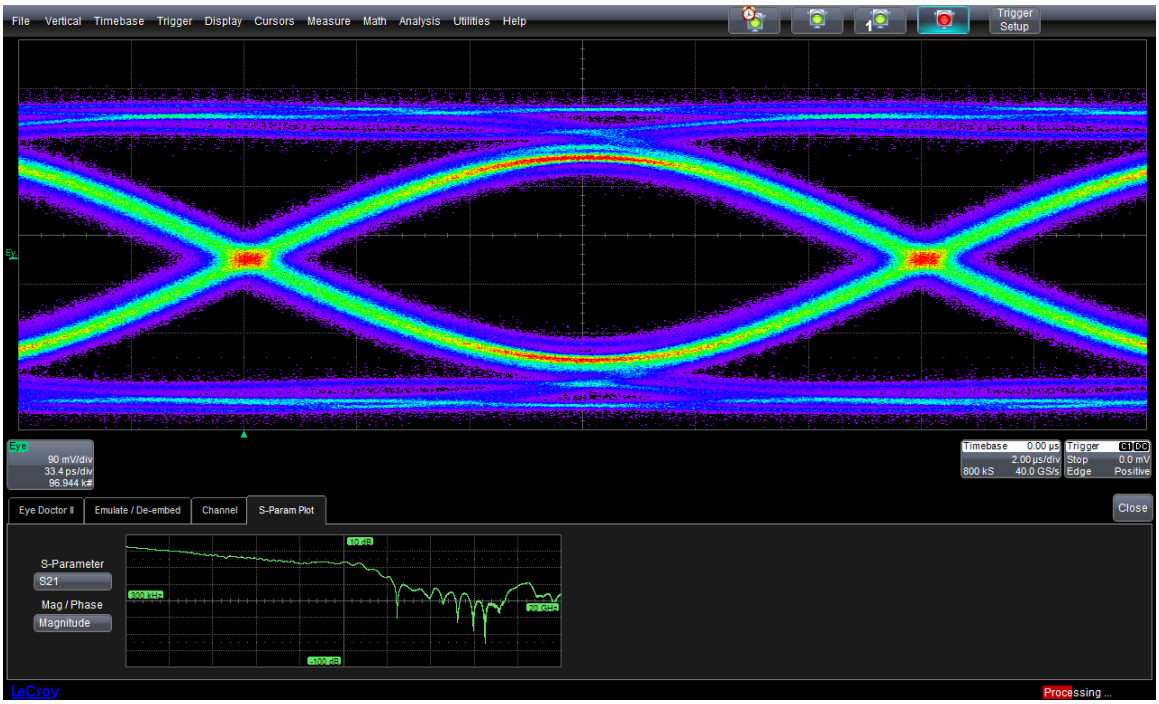

Figure 5: *The S-parameter plot tab allows the user to display a selected S-parameter's magnitude or phase as a function of frequency*

Even high quality test fixtures and cables have a negative impact on signal quality that increases with higher signal frequency. If the test fixtures and cables can be electrically quantified in terms of S-parameters, they can be removed from the measurement result.

S-parameter measurements and Touchstone files that are easily uploaded into Eye Doctor II as shown in figure 4.

The test fixtures, cables and channel need to be electrically quantified in terms of s-parameters or attenuation factors using Vector Network Analyzers (VNAs) or Time Domain Reflectometers (TDRs) With this information the electrical impact of the test fixture, cable or channels can be removed from the measurement result.

A selected s parameter can be viewed as a magnitude or phase plots as a function of frequency using the S-parameter plot tab as shown in Figure 5.

Serial data receivers often incorporate equalization to compensate for the impact of the serial data signal as transmitted over the serial data channel and input to the receiver. Thus, it is possible for a "closed-eye" serial data signal input at the receiver to be equalized within the receiver and result in a properly decoded signal. Eye Doctor II provides the ability to apply Feed Forward Equalization (FFE or Continuous Time Linear Equalization (CTLE) and replicate or model the receiver equalization. This would provide ability to view eye diagram and jitter performance on the signal as it is actually present at the receiver even though there was no way to access or probe the signal at the location of interest.

Figure 6 shows the Equalization tab controls for selecting and configuring receiver equalization.

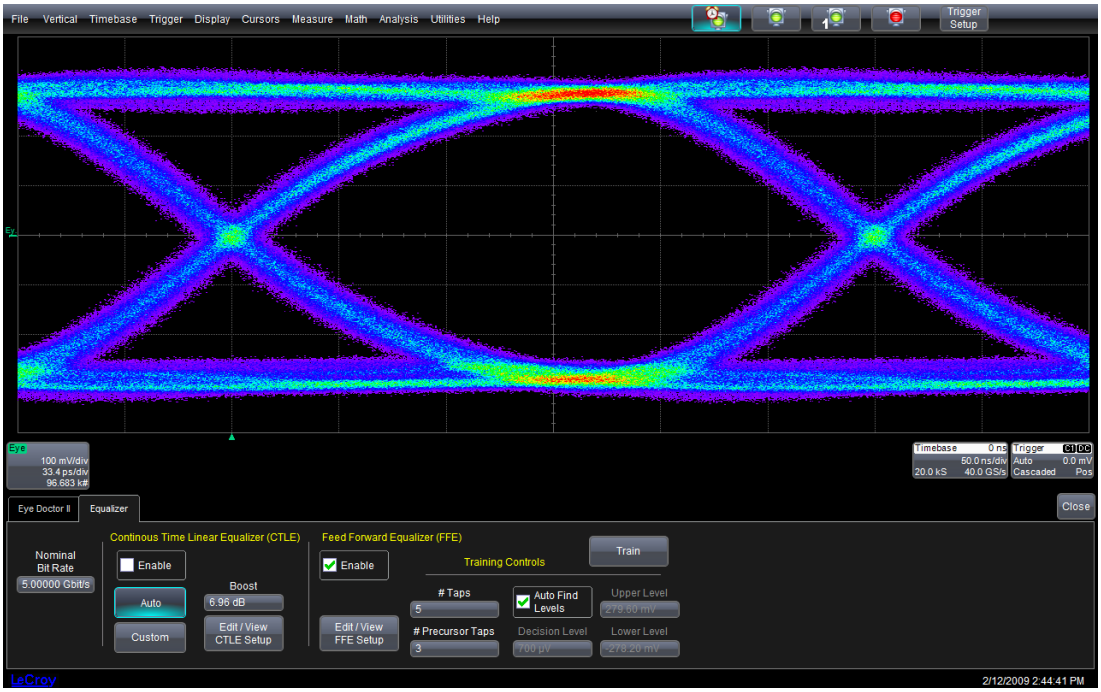

Figure 6: *The Equalizer tab showing the controls for selecting and configuring receiver equalization.*

LeCroy's Eye Doctor II Advanced Signal Integrity Tools adds precision to signal integrity measurements by allowing the subtraction of fixture effects, and the emulation of emphasis, serial data channels, and receiver FFE, and CTLE equalization effects while at the same time maintaining fast oscilloscope processing speed on unlimited record lengths. Processing speeds for eye diagrams can be as much as 50 times faster than in competitive instruments.