Freescale Semiconductor Uses Tektronix IConnect®
for Modeling a Transmitter

Customer Solution Summary

Challenge

Freescale Semiconductor establishes a new approach to the usual methodology adopted in modeling a Transmitter. The transmitter was modeled using only one port (TDR) and assuming lossless Package and Board Transmission line

Solution

Unlike the traditional form of modeling, the modeling conducted with the Tektronix DSA8200 Digital signal Analyzer, 80E08 TDR module, and IConnect proved very successful. IConnect helped create eye diagrams from the measured TDR data while correlating with the actual measured eye.

Benefits

The implementation of IConnect has enabled Freescale Semiconductor to extract the package discontinuities directly from the measurements. Apart from modeling the package, it also facilitated Freescale to arrive at a die's parasitic behavior and Tx/Rx actual terminations.
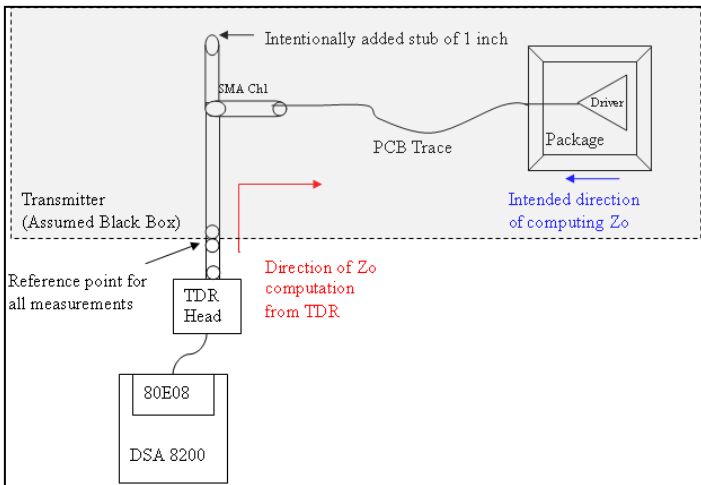

Figure 1: Test setup

The Scenario

Companies have rolled out numerous marvels in Transmitters with great capacity and performance. New boundaries have been discovered in the developmental efforts while designing new standard compliances at their core. But in some cases, it is a mystery for engineers to understand the underlying measurement standard in transmission while modeling a transmitter.

Freescale Semiconductor, a global leader in the design and manufacturing of embedded semiconductors for the automotive, consumer, industrial and networking market, discovers and relates a new thought to the existing transmitter modeling method using Tektronix' unique IConnect software.

"It is simply amazing that we could run the method in a different way using IConnect. Design teams can now see actual Tx/Rx die terminations and board/package discontinuities of their systems," said Naresh Dhamija, Signal Integrity Engineer at Freescale Semiconductor. "Using IConnect, the measurement based models are extracted which are more close to actual silicon unlike the pure mathematical models extracted from simulation", he adds.

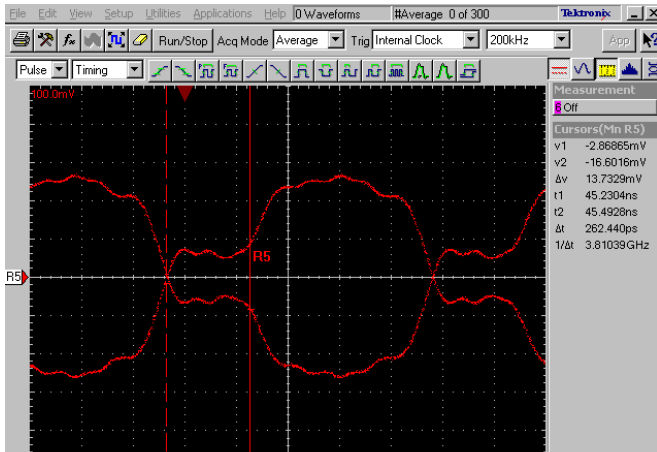# Freescale Semiconductor Uses Tektronix IConnect for Modeling a Transmitter

Figure 2: Measured Eye Diagram of the transmitter

Figure 3: Z-Line (True Impedance Profile) computed by IConnect

Operating on the DSA8200 TDR platform, IConnect is the efficient, easy to use, cost effective solution for measurement-based performance evolution of gigabit interconnects link and devices, including signal integrity analysis, impedance, S-parameter, and eye-diagram tests and fault isolation.

The Process Undertaken

Figure.1 shows the test setup used for the measurement. Here every element inside the gray boundary is a part of the transmitter and is considered as the Device under test with Tektronix IConnect used in DSA8200 with TDR Head.

Using this setup with the TDR and transmitter generating 1010.... (clock pattern) of amplitude 100mV pk-pk as input to the 80E08 sampling head, averaging of 300 acquisitions is done in the DSA8200 to filter out transmitter's switching noise. With the above captured input, Z-line is computed taking 50 ohms as Zo reference. The impedance profile will see 50 ohms at the left most side and right most side will be the transmitter's output impedance of 42.5 ohms as shown in the figure 3 captured in IConnect. This is the input impedance of the transmitter as seen from TDR head side. The DUT will be seeing the other side- the output impedance seen from the transmission side.

To see the output impedance, the Z-line has to be flipped and taken as an input in modeling, but modeling does not accept Z-line as input. The flipped Z-line of actual DUT is kept ideal for future reference. For input we flip the voltage waveform of DUT and call it as flipped DUT. At this time, we computed the Z-line of
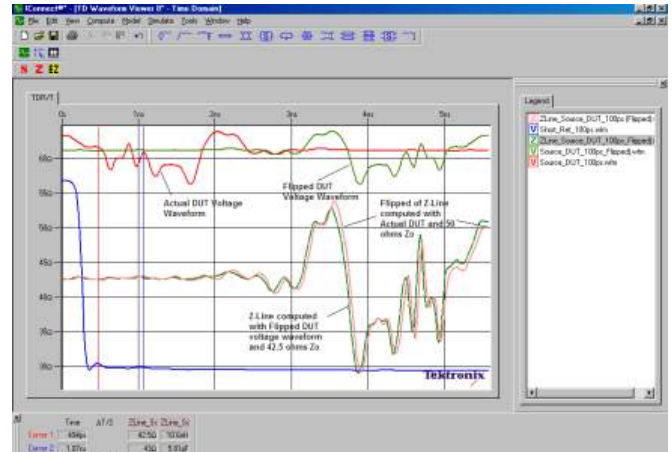
the flipped DUT voltage waveform with respect to the same short reference and Zo reference made to transmitter's output impedance 42.5 ohms instead of 50 ohms. This will coincide with the flipped Z-line of actual DUT as shown in figure 3

While modeling, single line model topology has been used as this is the only model which works with only reflected and reference short/open references. Once again the computed Z-line with same Flipped_DUT, same short reference and same 42.5 ohms Zo are used

> "It is simply amazing that we could run the method in a different way using IConnect. Design teams can now have clear understanding of package discontinuities and Tx/Rx actual terminations of their systems as well as the other side of the transmission. Using the IConnect allows us to work unlike the traditional VNA-based method but a better authentic way while modeling a transmitter."
>
> Naresh Dhamija
> Signal Integrity Engineer, Freescale Semiconductor (India Design Centre)

As shown in Figure. 4, precision portioning has been used. Next the simulation is run on this model by pressing the simulate button and changing the termination to 50 ohms to get exact match of

simulated Vs flipped TDR voltage waveform as shown in the Figure 5.

The Eye Diagram options were set to 101010 patterns, voltage levels from -50mV to 50mV and the rise time to 70 ps. The Simulated Eye (Figure 6) created using IConnect looks similar to the measured eye in Figure. 2.

Rajeev Sharma, Signal Integrity Engineer at Freescale Semiconductor says, "TDT Measurements were tried using TDR measurements. The only missing thing is that we assumed R=G=0 in this model. This method is useful to extract the lossless package model and Tx/Rx actual terminations where we have only one port exposed. Using this method, we can predict the Eye shape distortion which could be caused by transmission line discontinuities which include board traces, connectors, sockets etc."

Tektronix: Enabling Innovation in the Digital Age

Unique to the industry, the Tektronix IConnect software is just another example of facilitating innovation in this rapidly changing Digital Age. It is an absolutely essential asset for modeling a transmitter which enabled Freescale Semiconductor to create a true impedance profile as seen from the transmission side. The flexibility offered by IConnect is just simply amazing that there is boundless scope to experiment with.

Naresh Dhamija, Senior Design Engineer, Freescale Semiconductor asserts, "IConnect helped us to get the impedance profile from the driver towards the board trace and received key benefits like modeling the package and die parasitics' behavior. In fact, when it comes to efficiency level of the transmission generated, it is indeed needless to say that wave shapes seen on a oscilloscope is same as the one witnessed on the IConnect modeled Eye".

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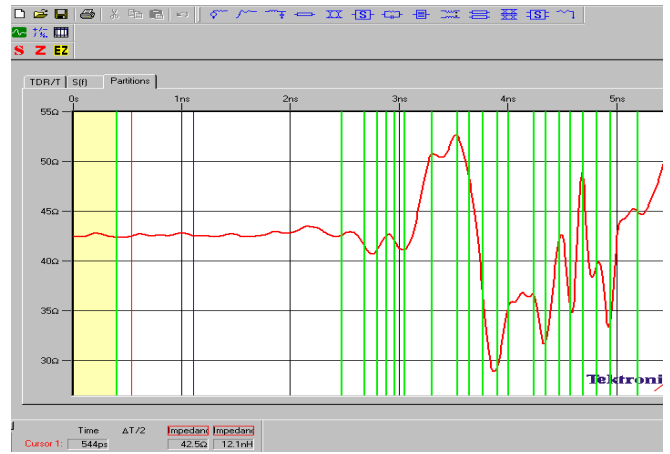

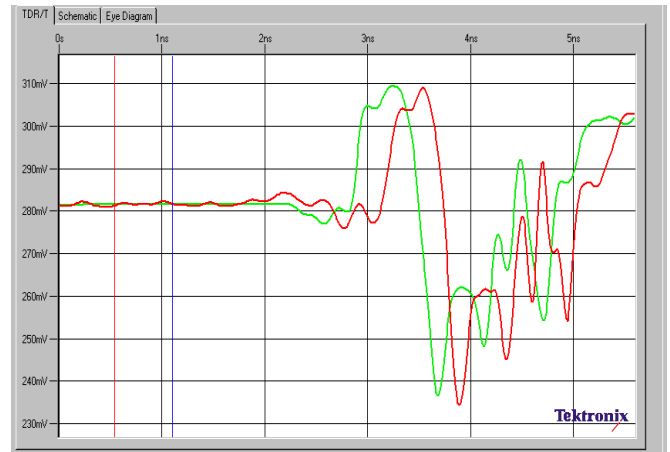Figure 4: Precise Partitioning in Iconnect

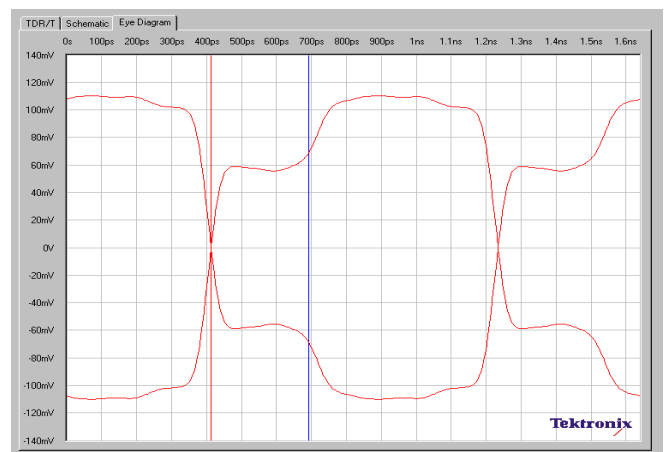Figure 5: Simulated (Green) and Measured (Red) flipped TDR waveforms.

Figure 6: Eye made out of Simulation almost matches with that of Direct measured Eye as seen in Figure 2