



# Post-CAD Validation of High-Speed Serial Designs

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# Overview

- Design Flow Introduction
- Crosstalk Wizard
- SATA 3 Gbps Design
- Conclusion



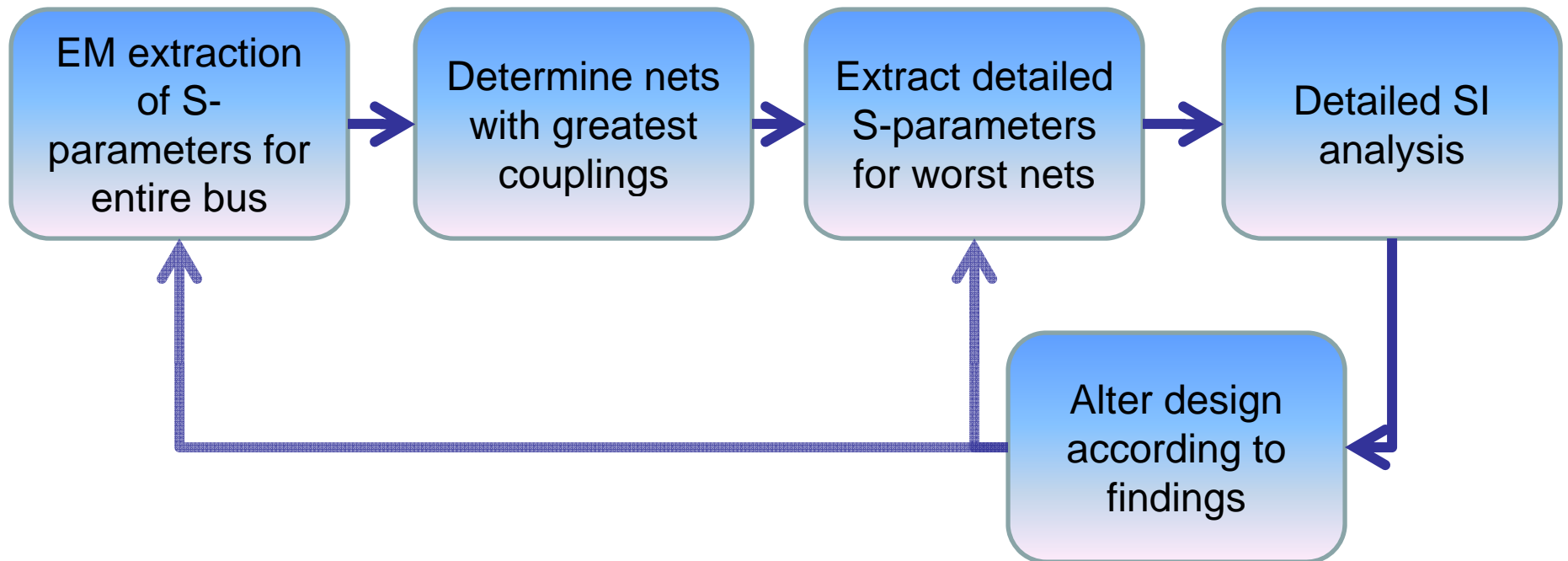
# Problem Statement

- Today's parallel and multi-lane serial buses use large numbers of signal lines
- Design flow must handle large numbers of measurement points and guide the detailed analysis of “worst” differential pairs

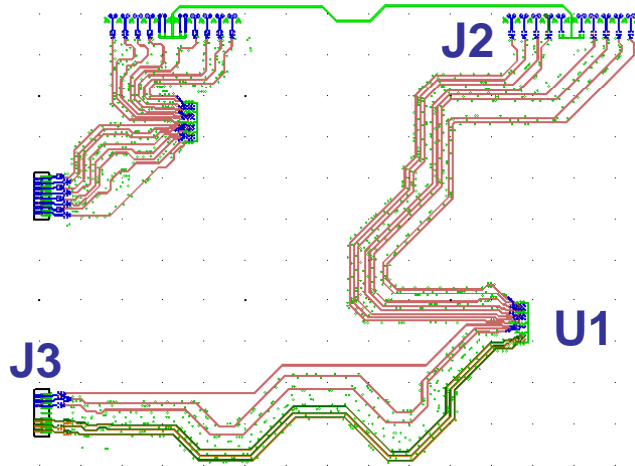


# Crosstalk Analysis Flow

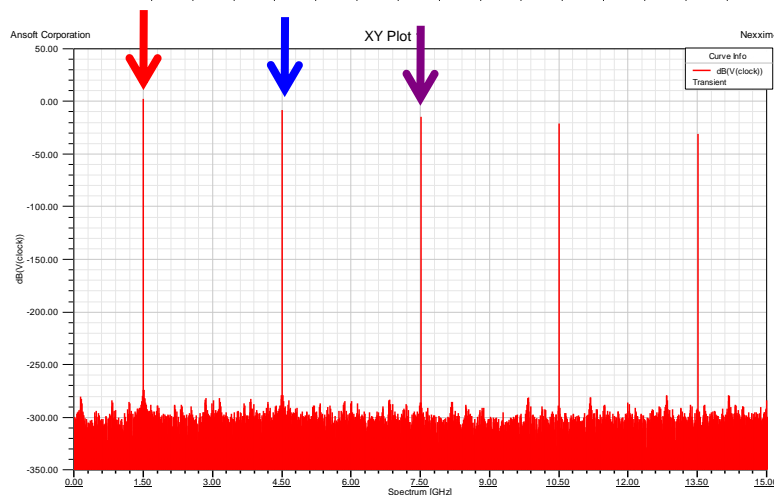
*Finding the needle in the haystack*



# Extract Limited S-parameters for Entire Bus



- SATA controller to external connector
- 14 differential pairs in total
- Extract S-parameters for entire bus, from data fundamental (1.5 GHz) to 10<sup>th</sup> harmonic

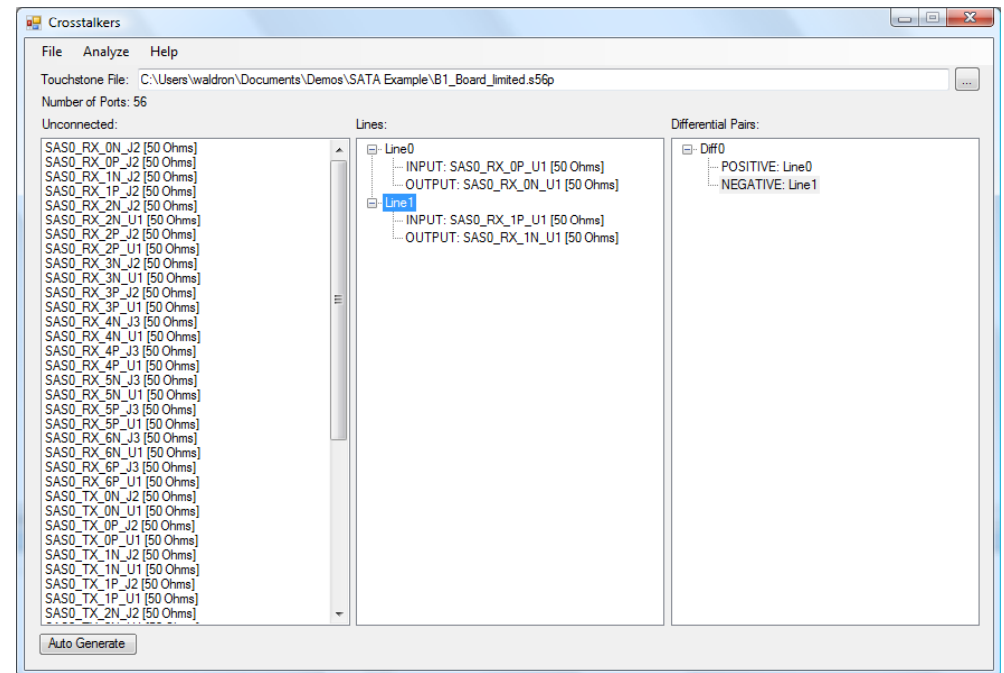


**1.5 GHz**  
**4.5 GHz**  
**7.5 GHz**



# Determine Nets with Greatest Coupling

- Using S-parameters extracted for entire bus
- Crosstalk wizard “Crosstalkers” developed by Isaac Waldron and Chris Herrick
  - Determines which nets exceed crosstalk threshold



# Crosstalkers

The screenshot shows the Crosstalkers software interface. The window title is "Crosstalkers". The menu bar includes "File", "Analyze", and "Help". The Touchstone File path is "C:\Users\waldron\Documents\Demos\SATA Example\B1\_Board\_limited.s56p". The Number of Ports is 56. The Unconnected ports list includes various SAS0\_RX and SAS0\_TX ports (e.g., SAS0\_RX\_0N\_J2, SAS0\_RX\_0P\_J2, SAS0\_RX\_1N\_J2, SAS0\_RX\_1P\_J2, SAS0\_RX\_2N\_J2, SAS0\_RX\_2P\_U1, SAS0\_RX\_3N\_J2, SAS0\_RX\_3P\_U1, SAS0\_RX\_4N\_J3, SAS0\_RX\_4P\_U1, SAS0\_RX\_5N\_J3, SAS0\_RX\_5P\_U1, SAS0\_RX\_6N\_J3, SAS0\_RX\_6P\_U1, SAS0\_TX\_0N\_J2, SAS0\_TX\_0P\_U1, SAS0\_TX\_1N\_J2, SAS0\_TX\_1P\_U1, SAS0\_TX\_2N\_J2). The Lines panel shows two lines: Line0 (INPUT: SAS0\_RX\_0P\_U1 [50 Ohms], OUTPUT: SAS0\_RX\_0N\_U1 [50 Ohms]) and Line1 (INPUT: SAS0\_RX\_1P\_U1 [50 Ohms], OUTPUT: SAS0\_RX\_1N\_U1 [50 Ohms]). The Differential Pairs panel shows Diff0 (POSITIVE: Line0, NEGATIVE: Line1). Blue arrows indicate the workflow: from the Unconnected list to the Lines panel, and from the Lines panel to the Differential Pairs panel. An "Auto Generate" button is at the bottom left.

1. Drag/drop ports to create lines
2. Drag/drop lines to create differential pairs
3. Analyze menu provides data mining options

# Crosstalkers

Crosstalk List

Frequency: 1500000000 Threshold: -40 dB  SE-SE  SE-Diff  Diff-Diff

Near-End Crosstalk:

- Diff4 <-> Diff5 -38.07 dB @ 1,500,000,000 Hz
- Diff4 <-> Diff6 -38.76 dB @ 1,500,000,000 Hz
- Diff11 <-> Diff12 -38.14 dB @ 1,500,000,000 Hz
- Diff11 <-> Diff13 -37.98 dB @ 1,500,000,000 Hz

Far-End Crosstalk:

- Diff4 <-> Diff5 -37.79 dB @ 1,500,000,000 Hz
- Diff4 <-> Diff6 -39.31 dB @ 1,500,000,000 Hz
- Diff11 <-> Diff12 -37.53 dB @ 1,500,000,000 Hz
- Diff11 <-> Diff13 -36.47 dB @ 1,500,000,000 Hz

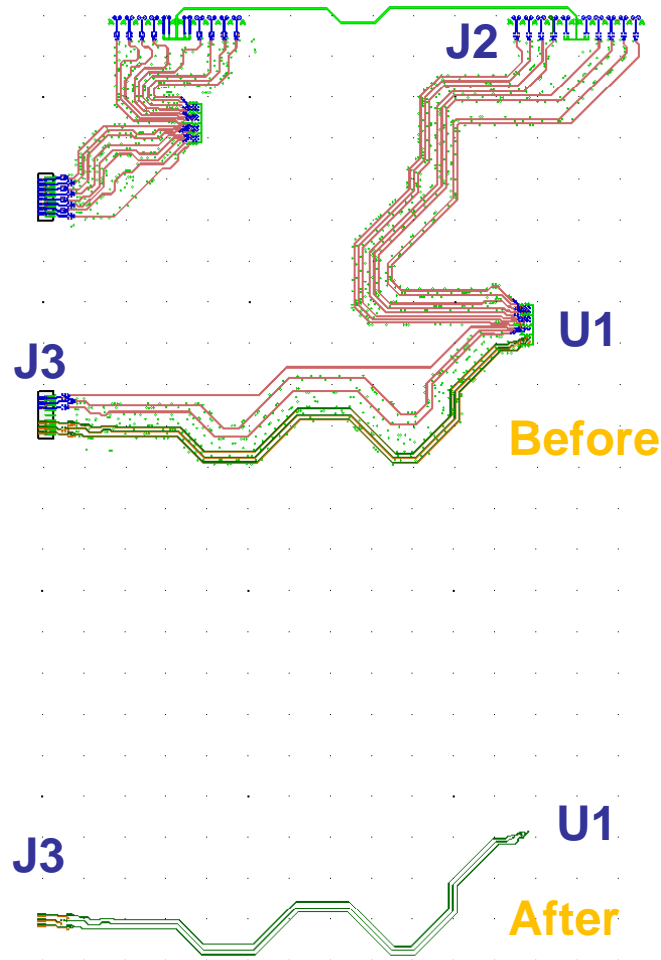
1. Select frequency
2. Enter threshold in dB
3. Select line types to analyze
4. Near and far-end crosstalk violations appear

# Crosstalk Wizard Results

- RX5 and RX6 are potential aggressors to RX4
  - RX5 → RX4 -37.79 dB FEXT
  - RX6 → RX4 -39.31 dB FEXT
- Need to extract these lines in more detail and simulate in the time domain



# Extract Detailed S-parameters for worst nets/planes



- Extraction reduced from 28 to 6 lines
  - *Directs attention for more detailed SI analysis*
- Next step: extract detailed S-parameters (DC to 15 GHz)

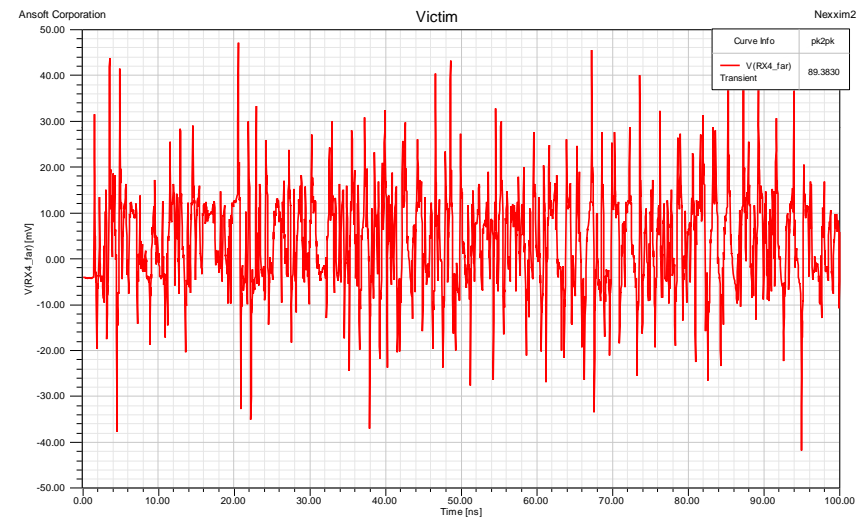
# SI Analyses

- S-parameters are useful in all types of signal integrity analysis:
  - Insertion and return loss
  - **Crosstalk**
  - Simultaneous switching noise (SSN)
  - Eye diagram analysis
  - Bit error rate (BER) analysis
- Circuit simulation offers ability to subject channel to various conditions:
  - Jitter (random, deterministic, periodic)
  - Duty-cycle distortion

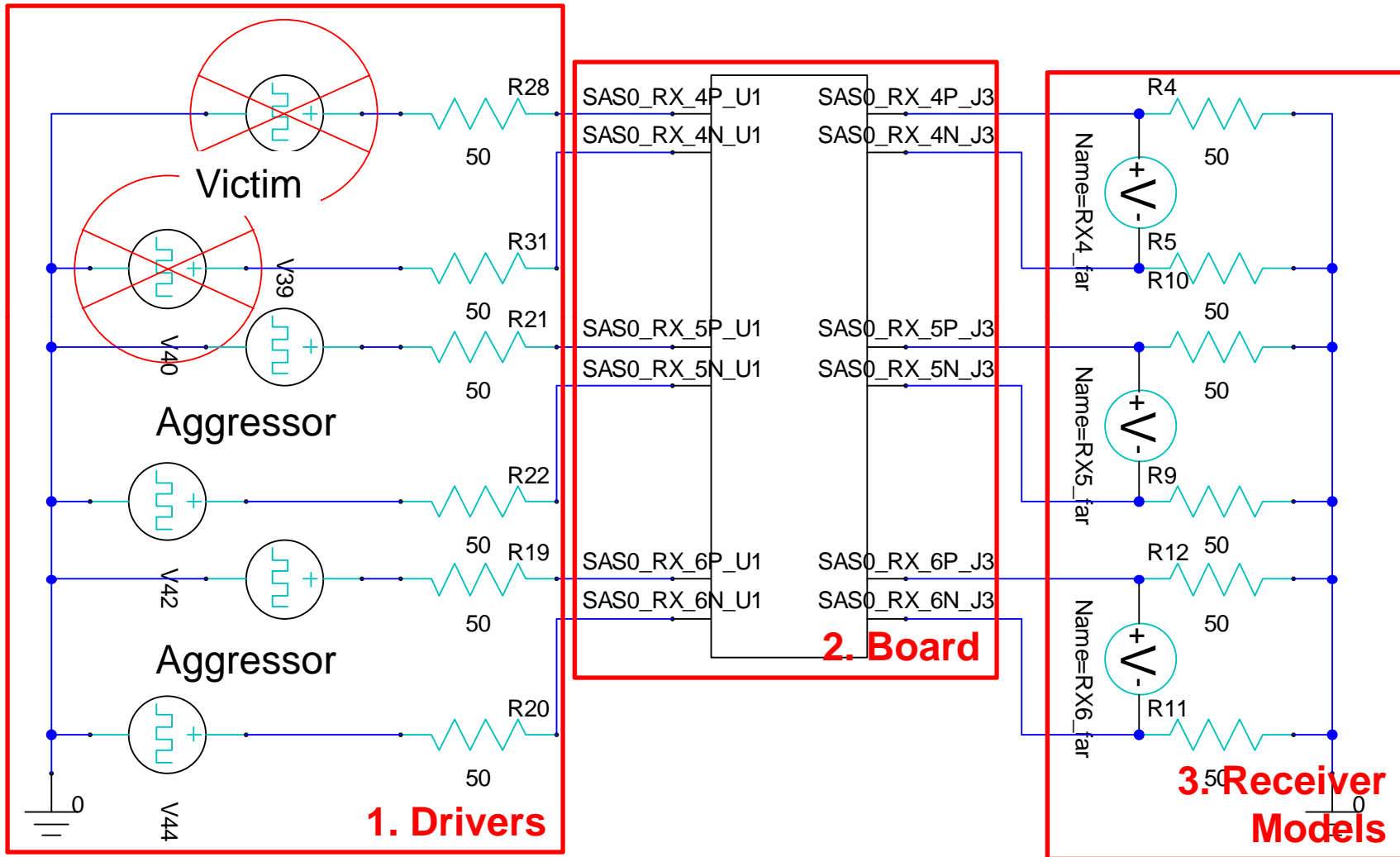


# Crosstalk Analysis

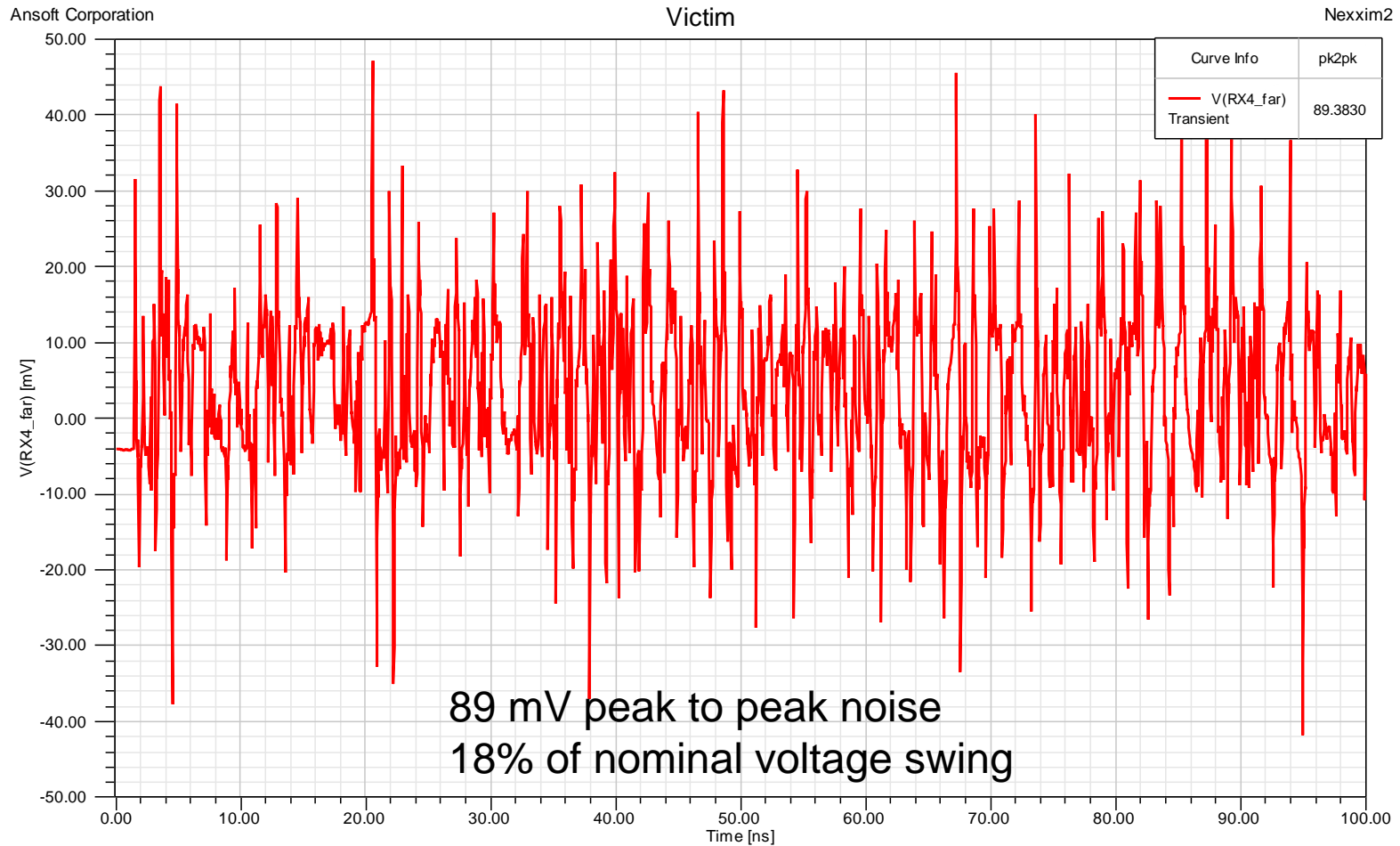
- Time-domain crosstalk analysis is performed by driving a signal onto one or more aggressors and observing the response on a terminated victim line
- Ensures that noise on victims will be sufficiently low



# Crosstalk Schematic



# Noise on RX4 (Victim)



# Crosstalkers Demo



# Conclusion

- Design flows for today's high speed serial challenges must handle large numbers of measurement points and guide the detailed analysis of "worst" differential pairs
- Ansoft provides a design flow that includes Crosstalkers, a utility for determining the most strongly coupled differential pairs in a design
- Ansoft's state of the art electromagnetic extraction and circuit simulation enable high speed serial design



# Getting Crosstalkers

- Crosstalkers is available now
- E-mail Isaac Waldron at [iwaldron@ansoft.com](mailto:iwaldron@ansoft.com) for more information