Validation for IBIS Models

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Agenda

- IBIS Quality Issue
- One test result
- How to improve current IBIS model qualities?

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- **IBIS Quality Issue**

- One test result

- How to improve current IBIS model qualities?

IBIS (I/O Buffer Information Specification)

- Public Standard
  - ANSI
  - EIA-656-A
- Well known behavioral buffer model specification
- There are about 300+ companies provide IBIS models, thousands of companies use IBIS for their designs

IBIS faces quality issues

- IBIS model quality is poor in general
  - “70% of IBIS models on the web are JUNK” quoted a few years ago
  - “More than 50% of IBIS models are not accurate” quoted recently
  - “the IBIS simulation results are different using different simulators” quoted a long time ago. But it is still TRUE ……
- How to solve these issues?

The things we are doing

- IBIS Committee efforts
  - Quality Sub-committee
  - Model Review Sub-committee
  - Educational seminars done by companies and individuals
- But, the MOST Important thing for your design and analysis is:

  Validate the IBIS models before your design and analysis

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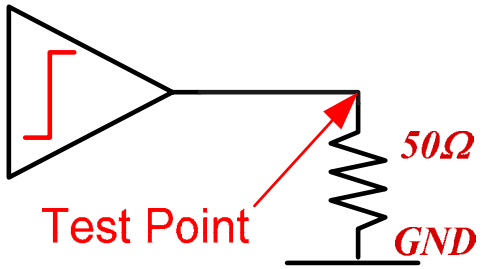
- **One test result**
- How to improve current IBIS model qualities?

Test Implementation

For validating C_comp and Ramp data with VT curves

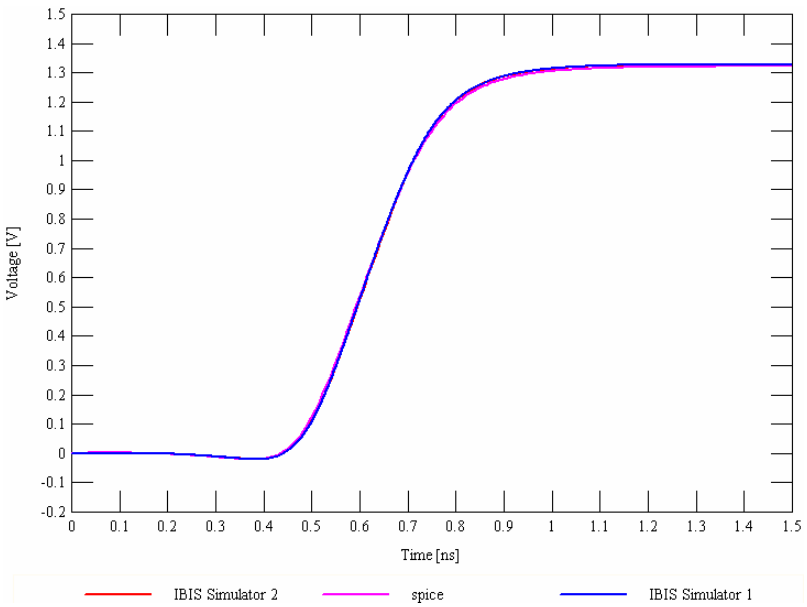
- Output buffer with 50 Ohm resistor to GND
- 0.1ps rising and falling edge for stimulus
- Probe the output pad of driver
- Keep C_comp constant, sweep Ramp data
- Keep Ramp data constant, sweep C_comp
- Simulate in two different IBIS Simulators

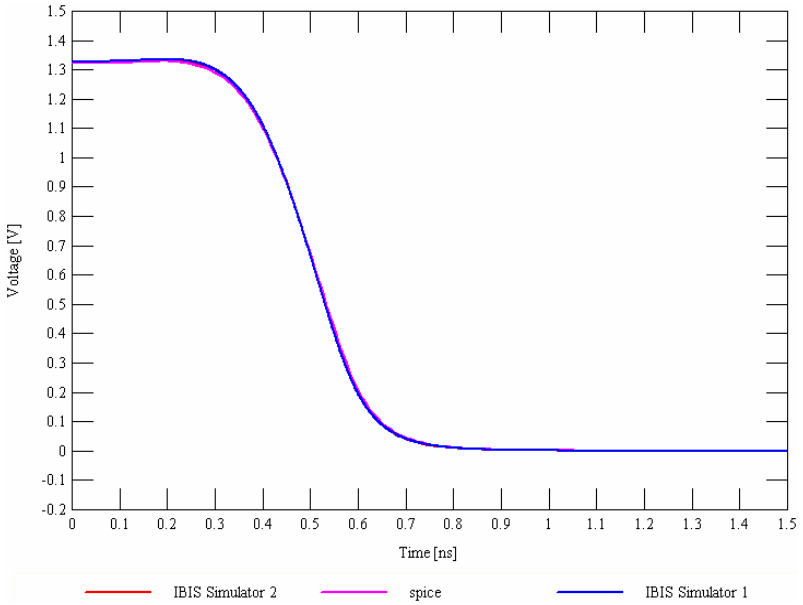


Correlation spice and IBIS model with 4 VT

The Max DAI between two simulators is 0.525%

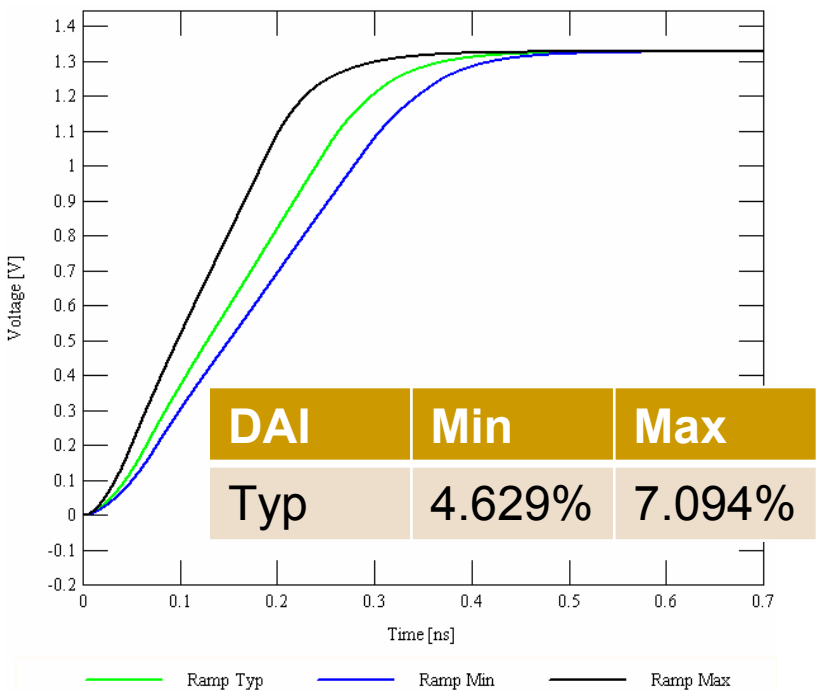
Showed perfect matching



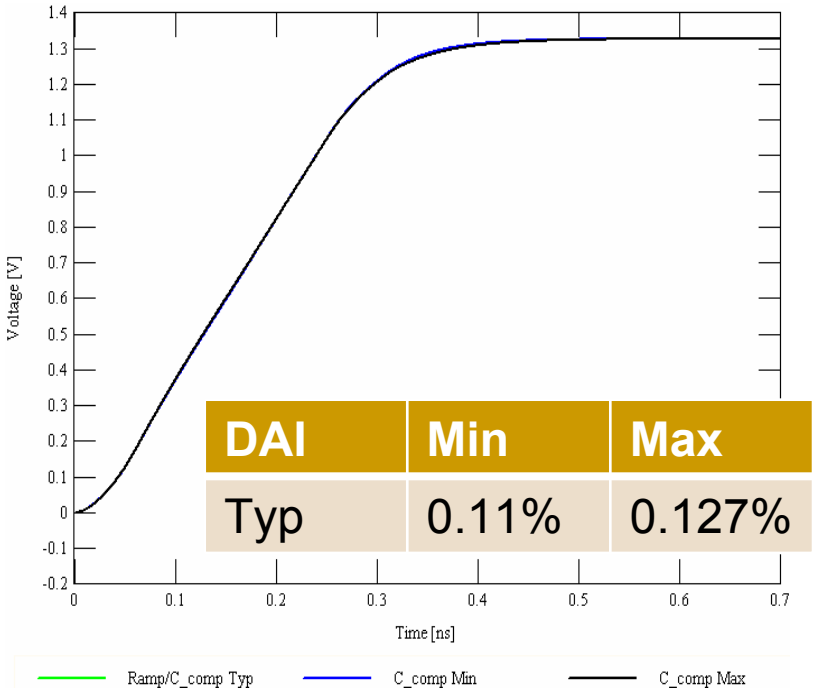


IBIS Simulator1 /wo VT (Rising)

- Keep C_comp constant, sweep Ramp data, the maximal DAI is 7.094%
- Keep Ramp data constant, sweep C_comp, the maximal DAI is 0.127%
- At rising edge, Ramp data is the main factor in Simulator1



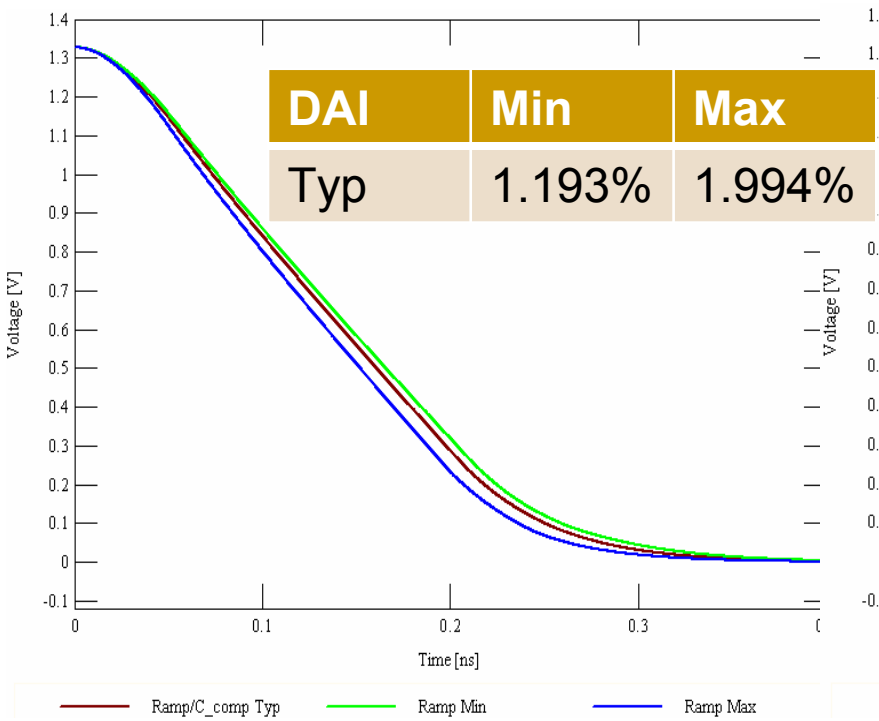
DAI	Min	Max
Typ	4.629%	7.094%

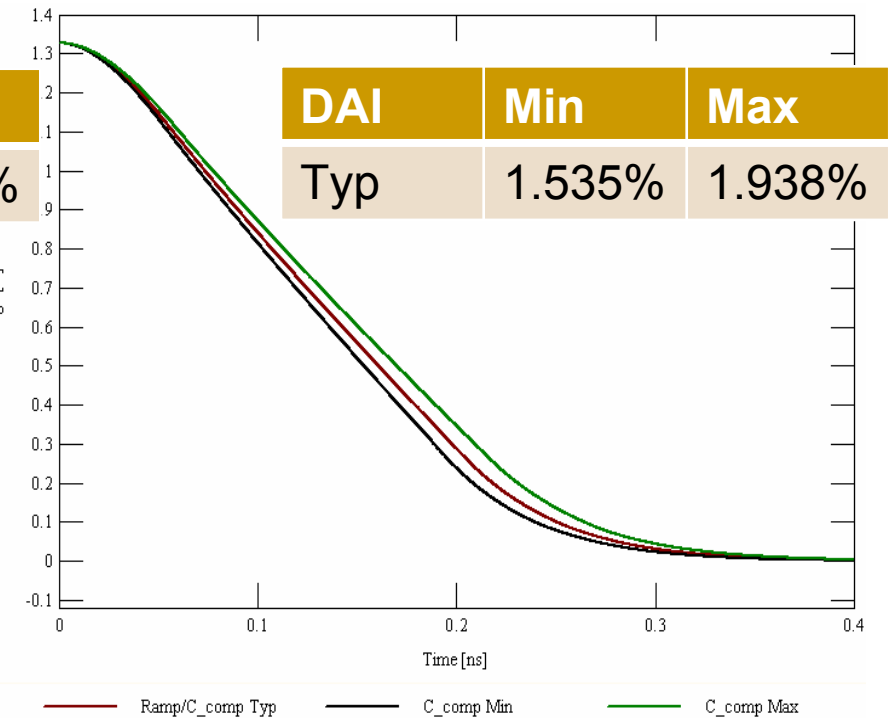


DAI	Min	Max
Typ	0.11%	0.127%

IBIS Simulator1 /wo VT (Falling)

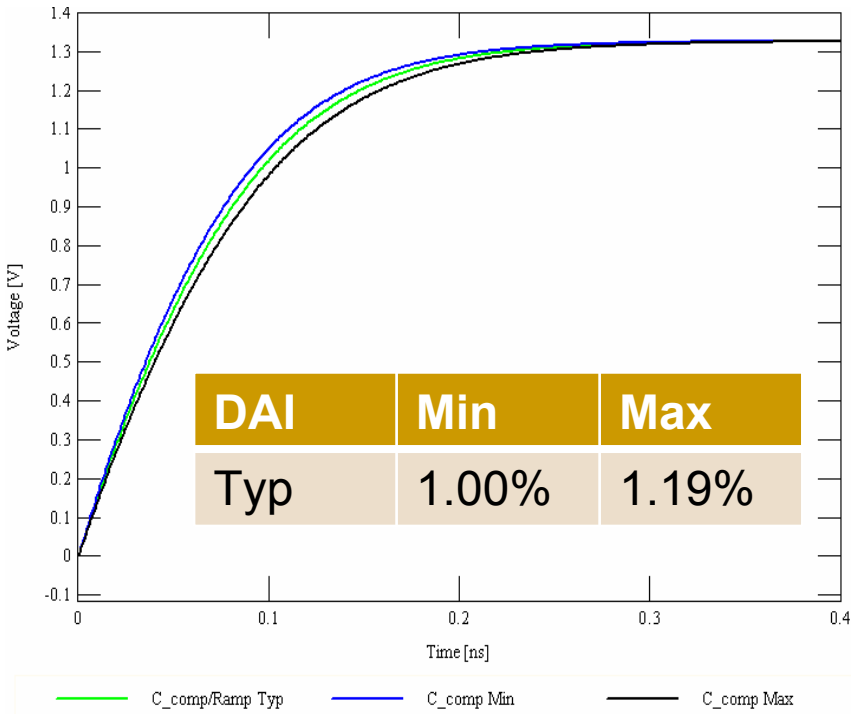
- Keep C_comp constant, sweep Ramp data, the maximal DAI is 1.994%
- Keep Ramp data constant, sweep C_comp, the maximal DAI is 1.938%
- At falling edge, Ramp and C_comp play almost the same role in Simulator1



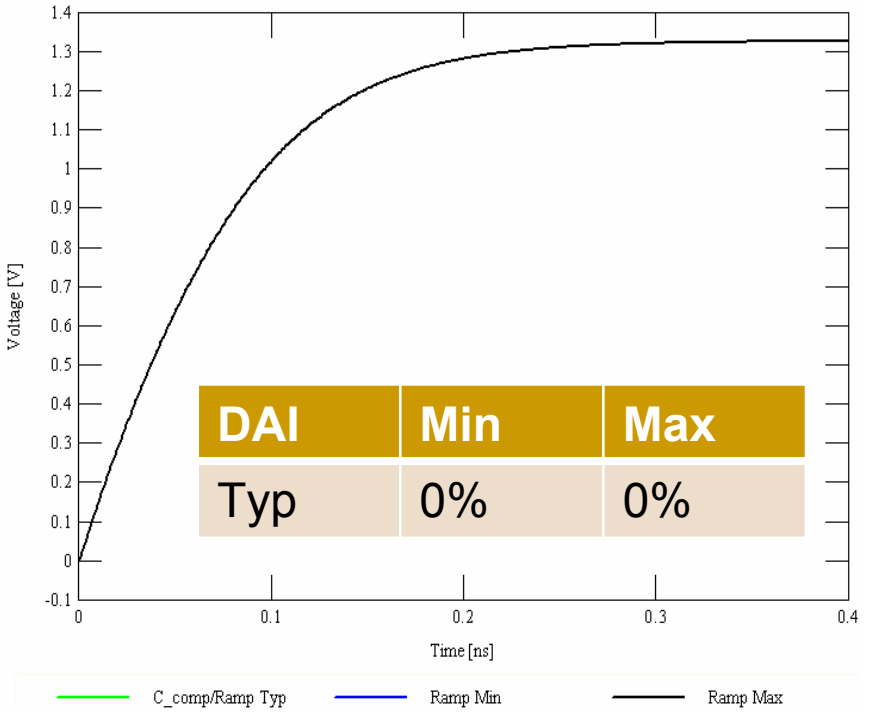


IBIS Simulator2 /wo VT (Rising)

- Keep Ramp constant, sweep C_comp, the maximal DAI is 1.19%
- Keep C_comp constant, sweep Ramp, there is NO difference
- At rising edge, C_comp is the main factor in Simulator2



DAI	Min	Max
Typ	1.00%	1.19%

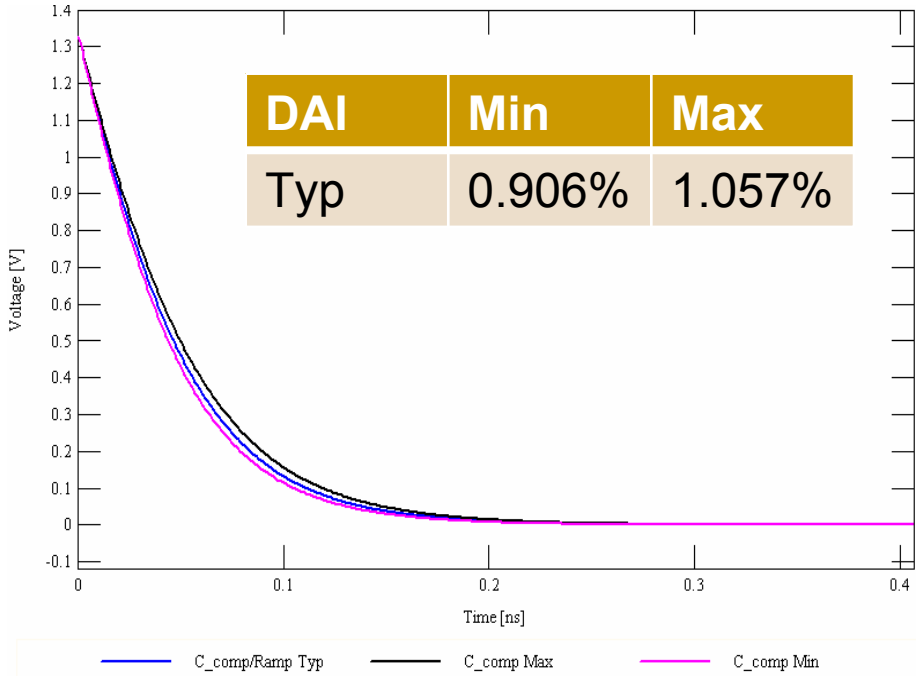


DAI	Min	Max
Typ	0%	0%

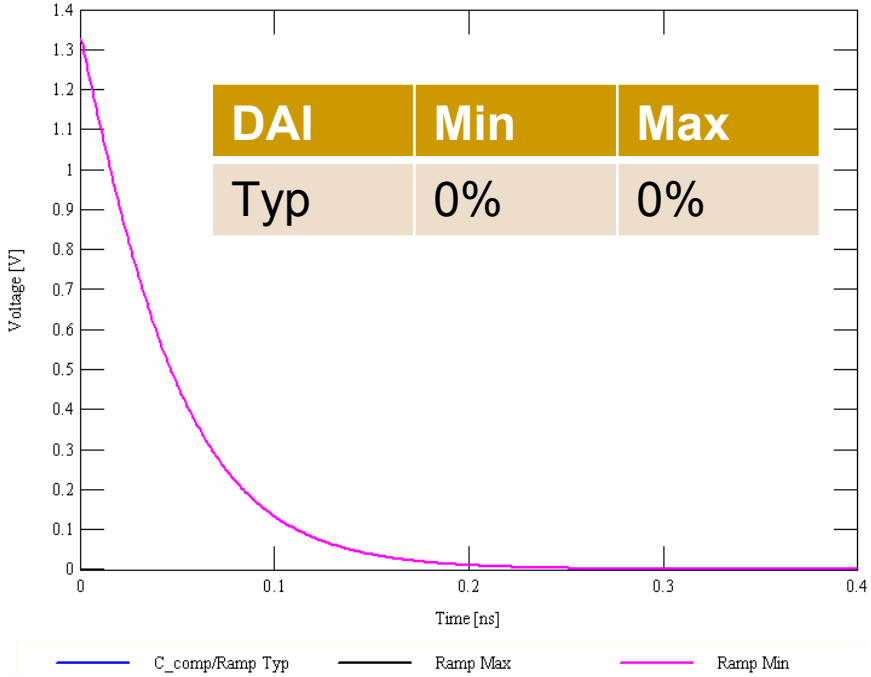
IBIS Simulator2 /wo VT (Falling)

- Keep Ramp constant, sweep C_comp, the maximal DAI is 1.057%
- Keep C_comp constant, sweep Ramp, there is NO difference
- At falling edge, C_comp is the main factor in Simulator2

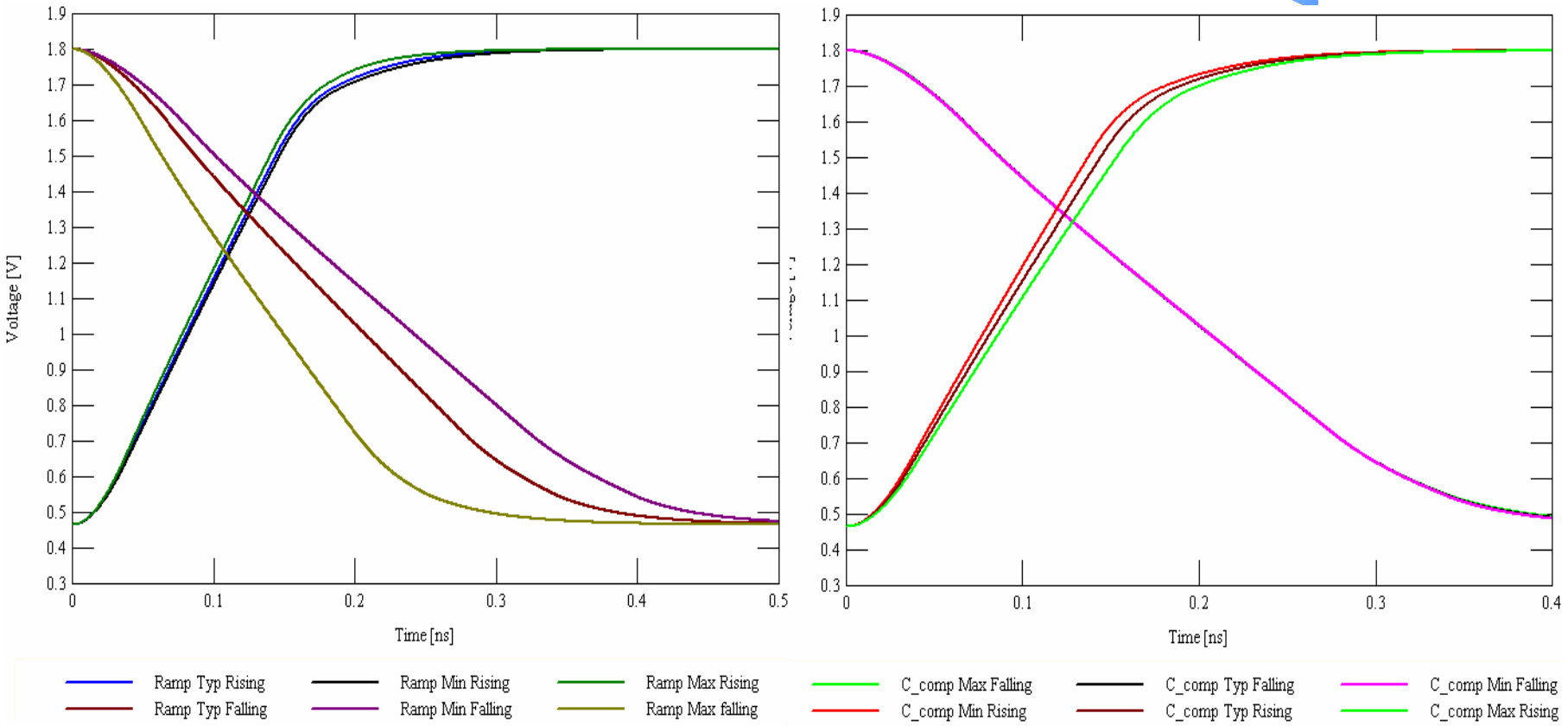
DAI	Min	Max
Typ	0.906%	1.057%



DAI	Min	Max
Typ	0%	0%



How about 50 Ohm resistor to VCC in the same simulations?



The effect is reversed for the previous simulations in Simulator1 while Simulator2 has the same effect as the previous simulations.

Test Conclusions

- Simulators are giving the different results due to different implementations for IBIS simulations
- Another words, even the same IBIS model, you may get different results when you used the different simulators

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IBIS Validation Process

- Steps
  - Develop a proper validation method
  - Contact vendor(s) to get the Golden source (results)
  - Run the tests using IBIS simulators
  - Compare the results
  - You are lucky if the results are aligned with each others
  - Or, contact vendor(s) if the results are not correlated – both simulator and model vendors are needed
  - *You might have to repeat many steps to get it done*
- Concerns? Problems?

Concerns and Problems in IBIS Validation Process

- Too long
  - Average is more than 8 business days
- Not accurate enough
  - Lack of the knowledge for the device technologies, IBIS and EDA tools
- This is a Model Librarian job
  - Not all SI engineers have enough model and tool knowledge for this process
  - Not every company has the model librarian

IBIS Certification Program (IBISCP)

A Vendor Neutral Program

- Motivations
  - Provide a solution for IBIS users to have GOOD models for their high-speed designs
  - Provide a solution for IBIS vendors to have GOOD models for their customers
- Target
  - To have IBIS as a primary industry standard on behavioral IO modeling for High-Speed Signal Integrity analysis
  - To allow designers make faster, cheaper and more reliable electronic products

IBISCP:
Purposes and Goals

- Provide a professional IBIS model validation results to IBIS users and vendors
- Provide a multi-simulator validation results to IBIS users, IBIS vendors and EDA vendors
- Provide a on-going validation process based on requests from IBIS users and IBIS vendors
- Provide statistical reports about IBIS feature usages, feedbacks and enhancement requests to IBIS Open Forum
- Provide IBIS quality reports to IBIS Open Forum, IBIS Quality Sub-committee and IBIS Model Review Sub-committee
- Provide IBIS feature support reports to EDA vendors

IBISCP.ORG will be launched in the middle of September, 2007

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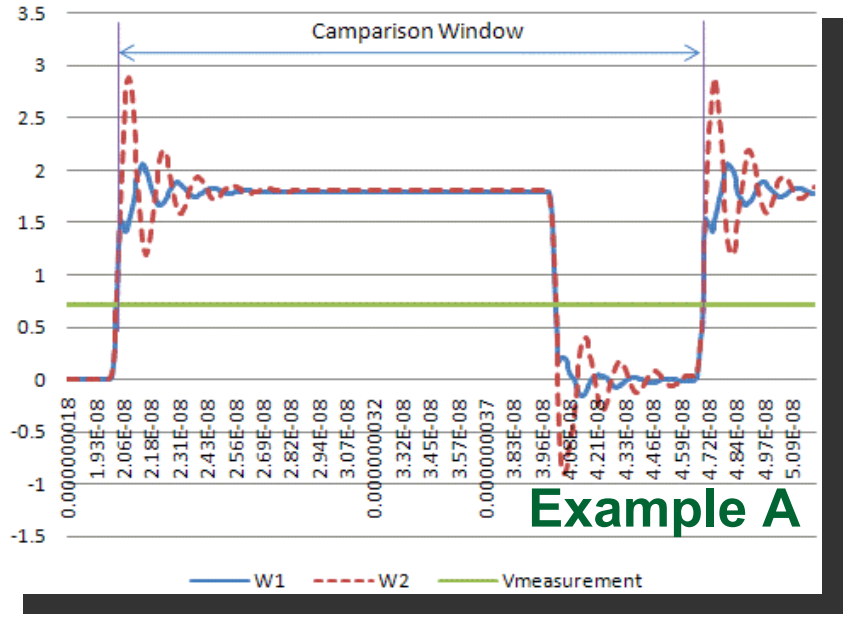
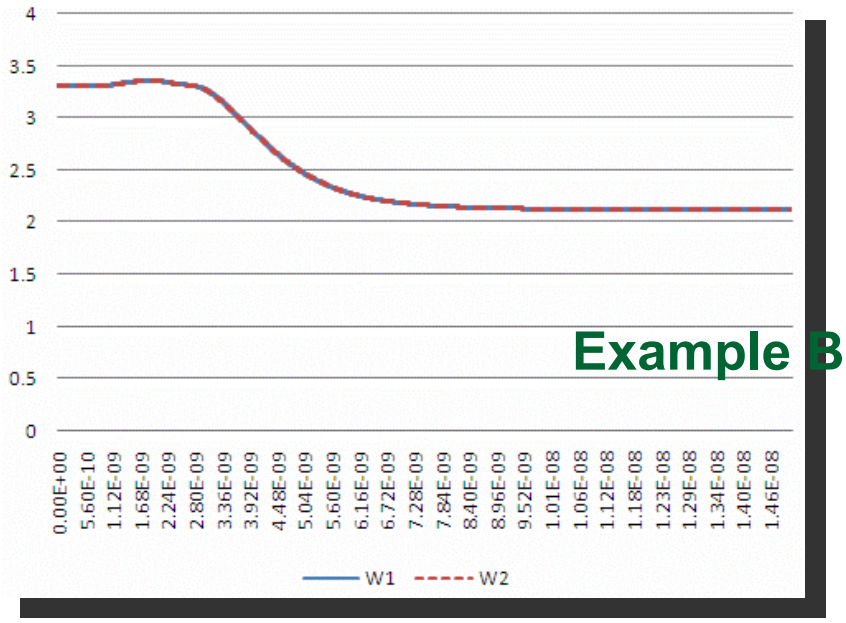
Waveform Differential Index

An technical invention patent hold by IO Methodology Inc. (Shanghai LiKai)

Problems Existed



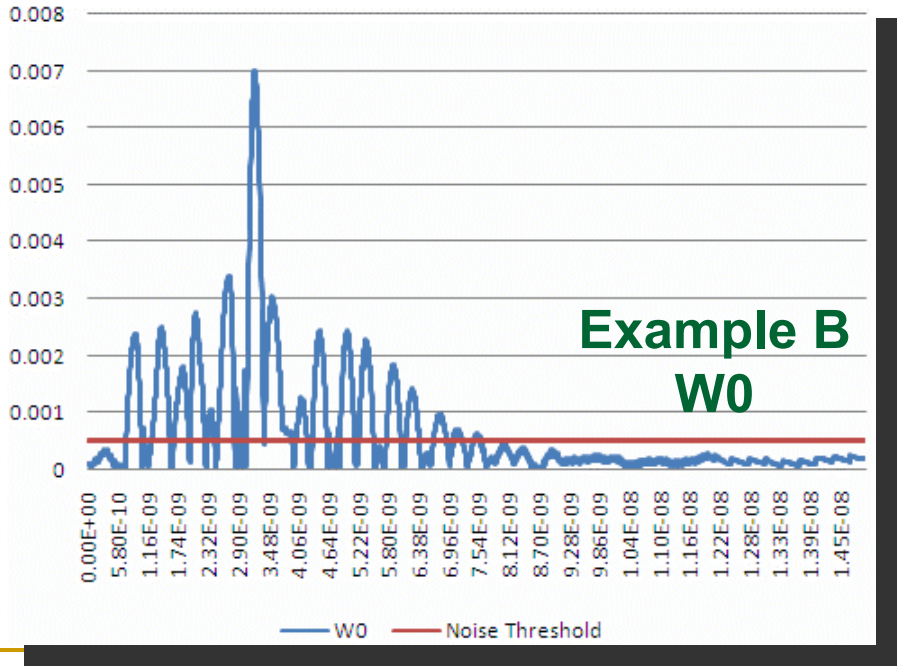


- How to compare the two waveforms? (Eye Inspection? Parameterization?)
  - Example A
    - Significant differences are in a relative small range.
  - Example B
    - No significant differences.

Noise Threshold Definition

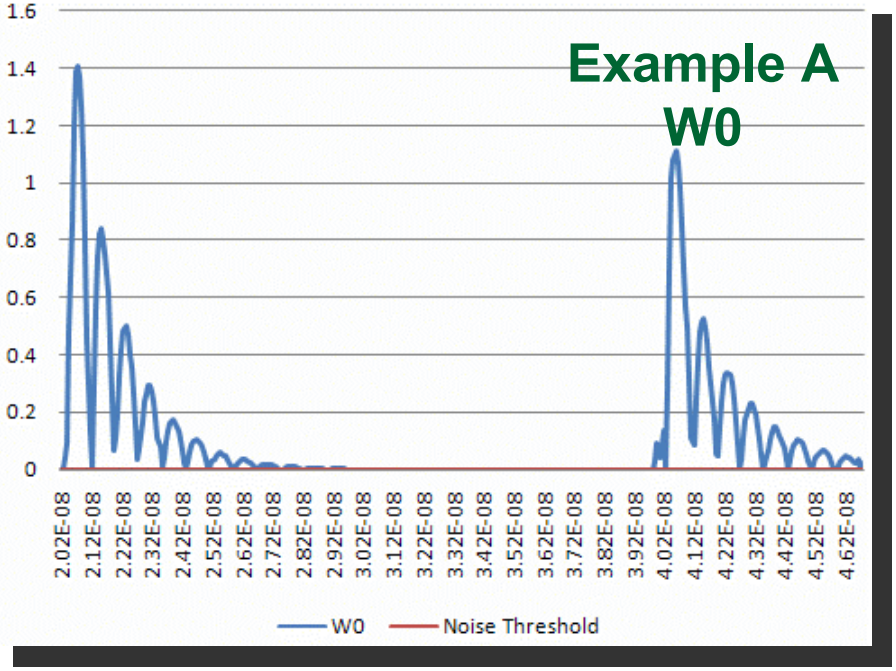
- Waveform differences curve W0 is
  - W0=|W2-W1|, where t is from [Tstart, Tend]
  - Comparison Window: [Tstart, Tend]
- NT is 0.5mV by default for the voltage waveforms, and 0.1mA by default for the current waveforms.
- Waveforms differences smaller than NT will be ignored.

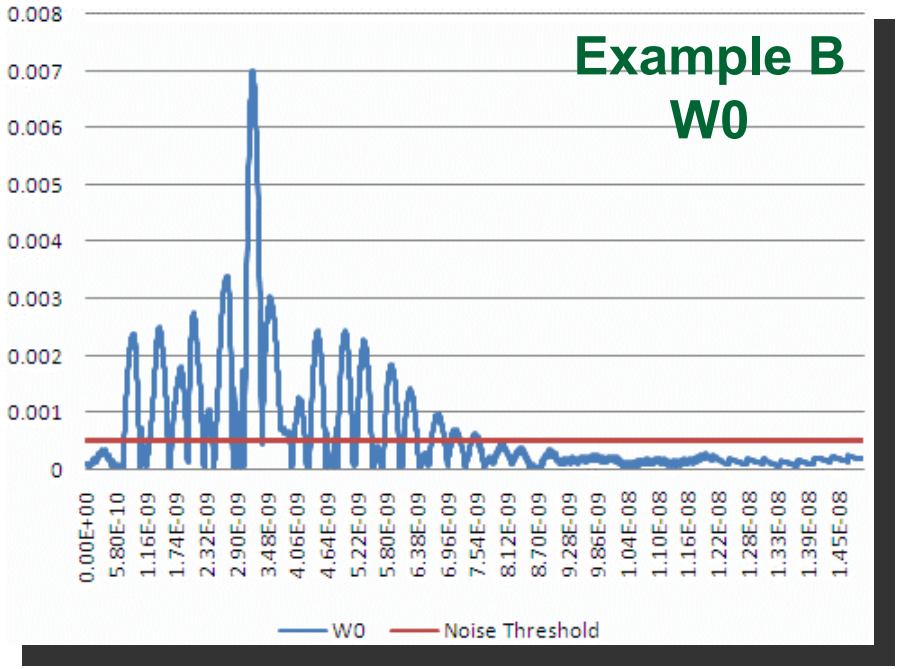
- For the right figure (Example B), the red curve is NT curve.
- Significant region includes several small regions.



Differential Index (DI)

- DI includes,
  - DP (Differential Peak) and DPI (Differential Peak Index)
  - DA (Differential Average) and DAI (Differential Average Index)



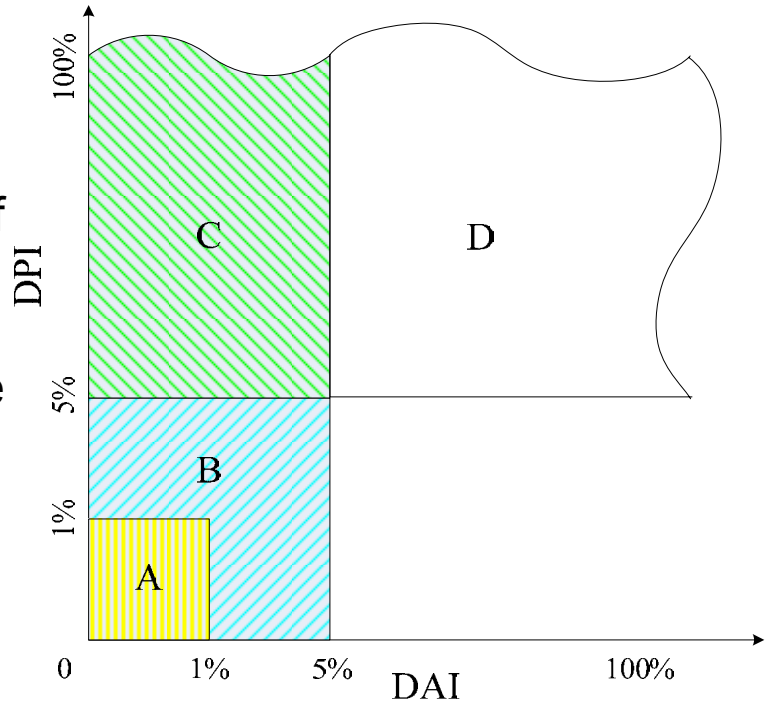


- DP= 1.404863V; DPI=63.36%
- DA=165.6156mV; DAI=7.47%.

- DP= 6.999076mV; DPI=0.57%
- DA= 1.666122mV; DAI=0.13%.

DAI, DPI & Waveform Differences

- Region A: Perfect Matching
- Region B: Acceptable Matching
- Region C: Two waveforms match in most of the region, there are one or more points which the differences are significant. Glitches or pulse noise are appeared in one of the waveforms.
- Region D: Unmatched.



Timing DI

- Timing DI includes,
  - TDP (Timing Differential Peak), TDA (Timing Differential Average) and TDL (Timing Differential Length)

- Use to get the timing differences between two waveforms.

- TDP=0.254ns
- TDA=0.249ns
- TDL=1.3V