Differential buffer using IBIS models for PDN simulations

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Outline

This is a case study for differential pair buffers in Power Delivery Network (PDN) simulations

- Motivation

- Review IBIS PDN feature for single-end buffer

- Power currents using non-PDN IBIS model and IBIS with PDN feature for differential pair buffer in simulation

- Average-Out approach for differential buffer PDN simulation

- Summary

Motivation

- Many times we need to do a PDN simulation with differential pair buffers in the network using IBIS models

- IBIS Spec doesn't include how to make IBIS PDN model for differential pair buffers

- Seeking a reasonable solution for differential buffer PDN simulation using existing IBIS modeling specification
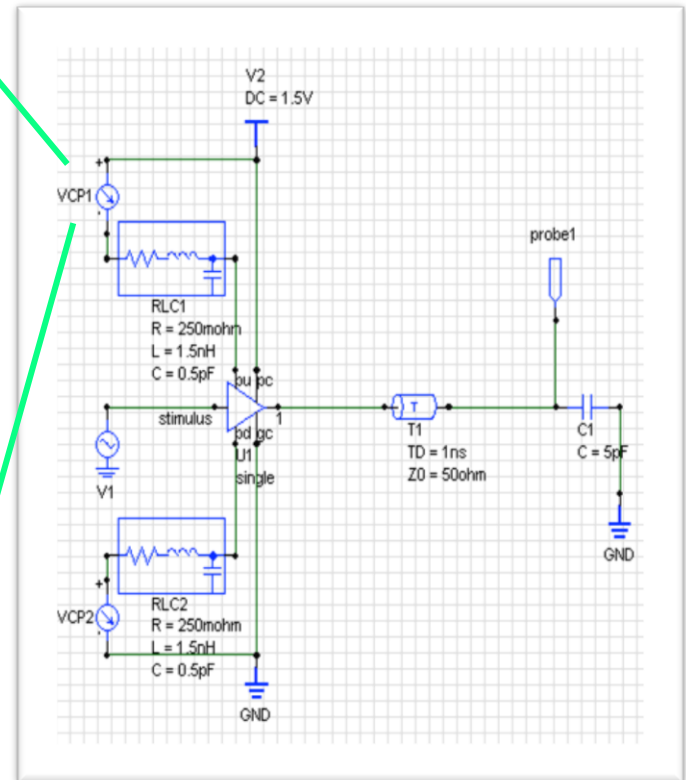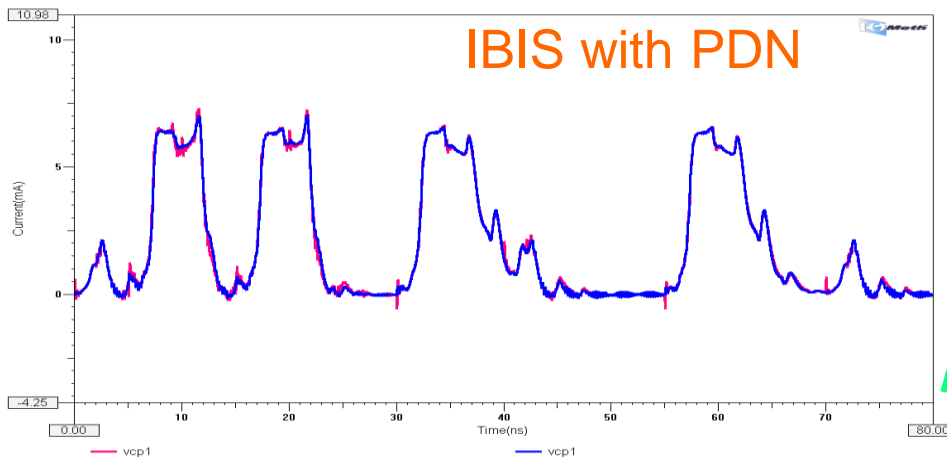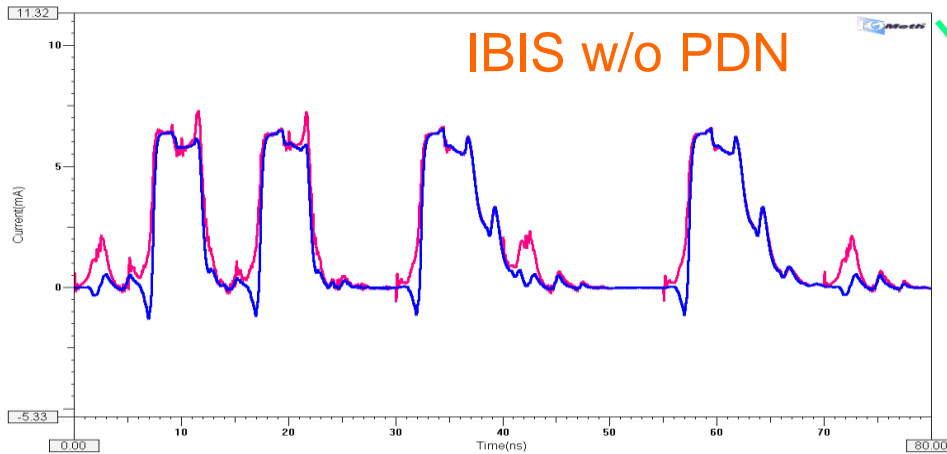
The test case

- LVDS 1.5v true-differential buffer
- We have access to each pin/buffer power supply
- Positive and negative pin buffer are identical
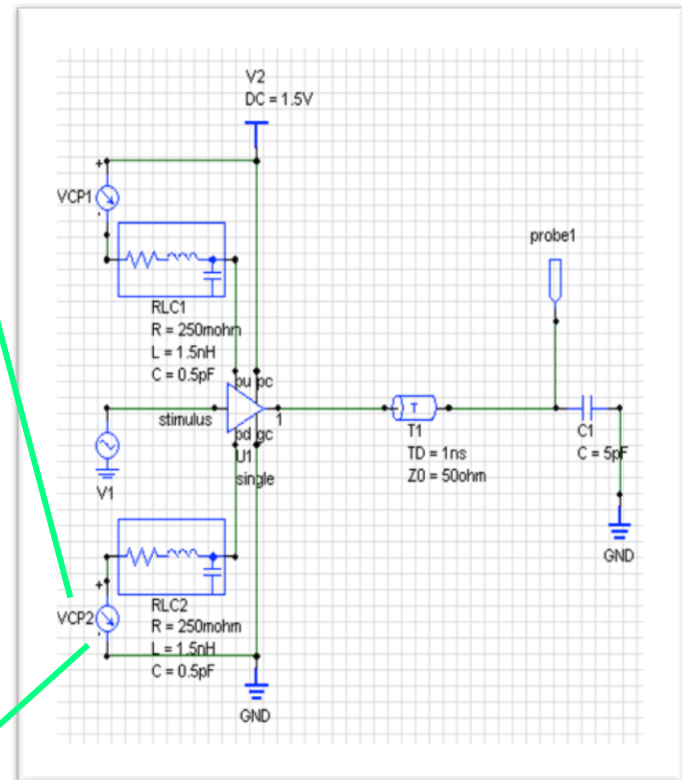- Push-up and Pull-down are almost even
- We are checking on Driver side only
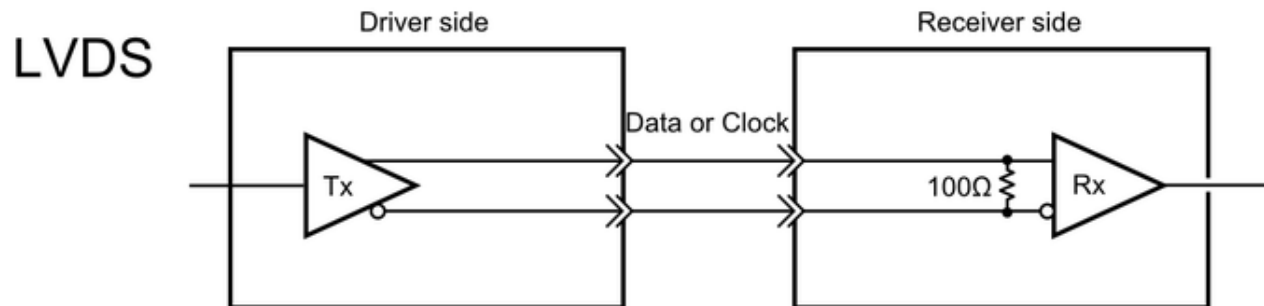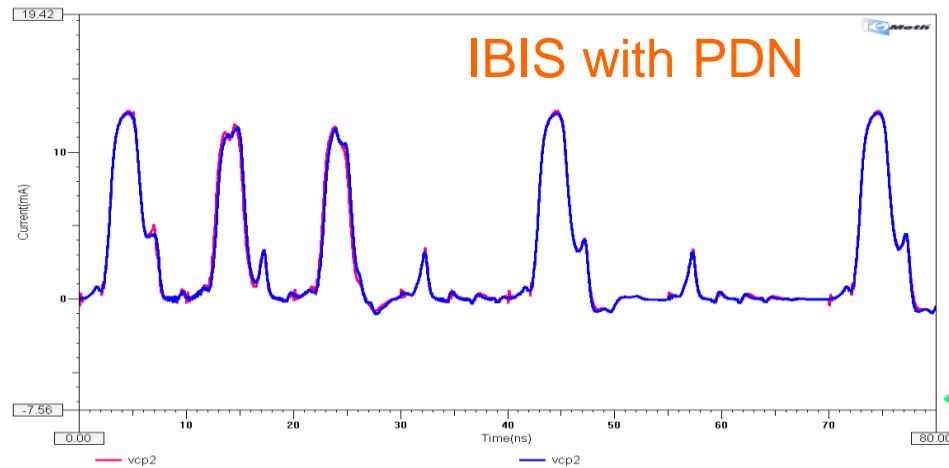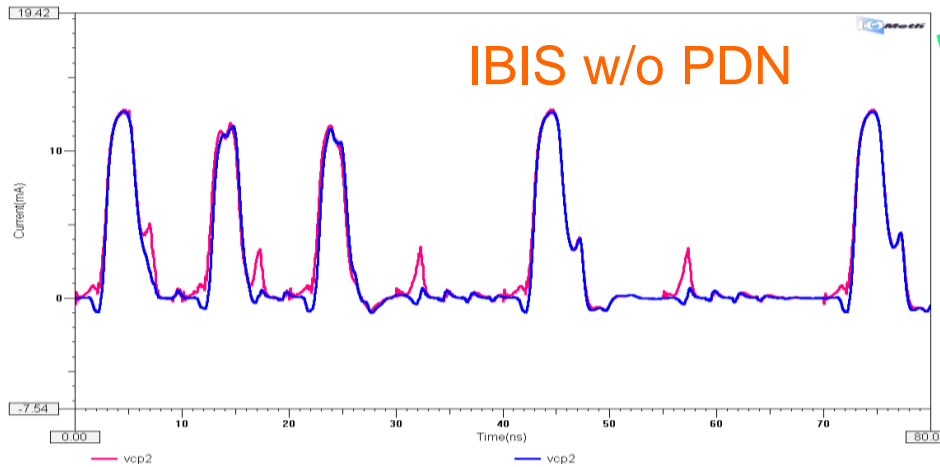
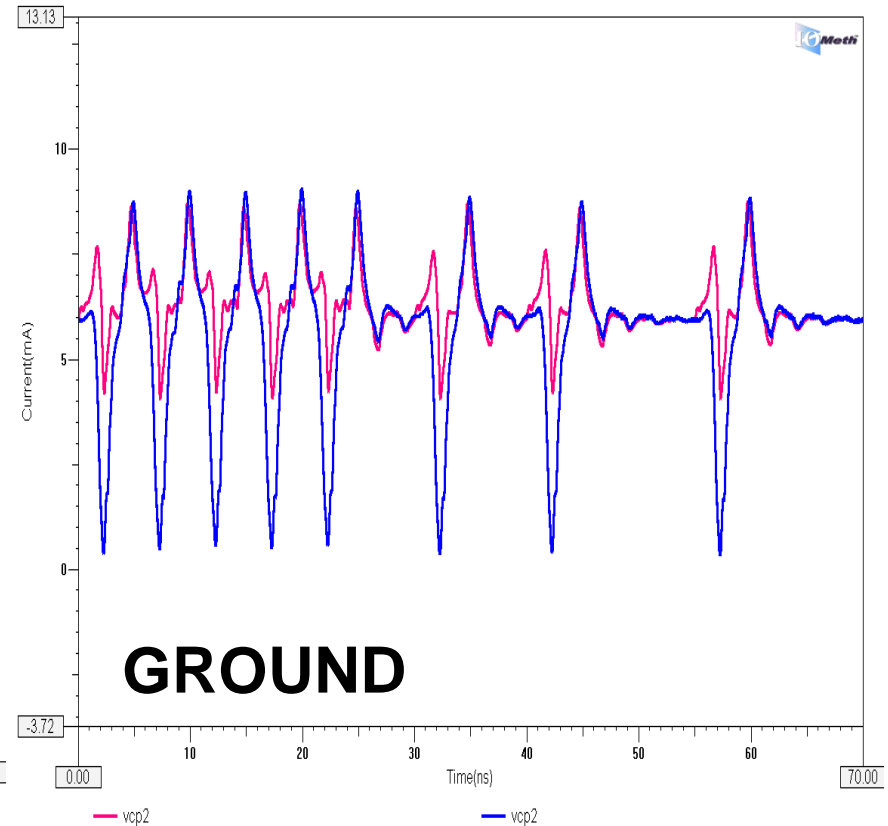# Review of IBIS PDN Feature
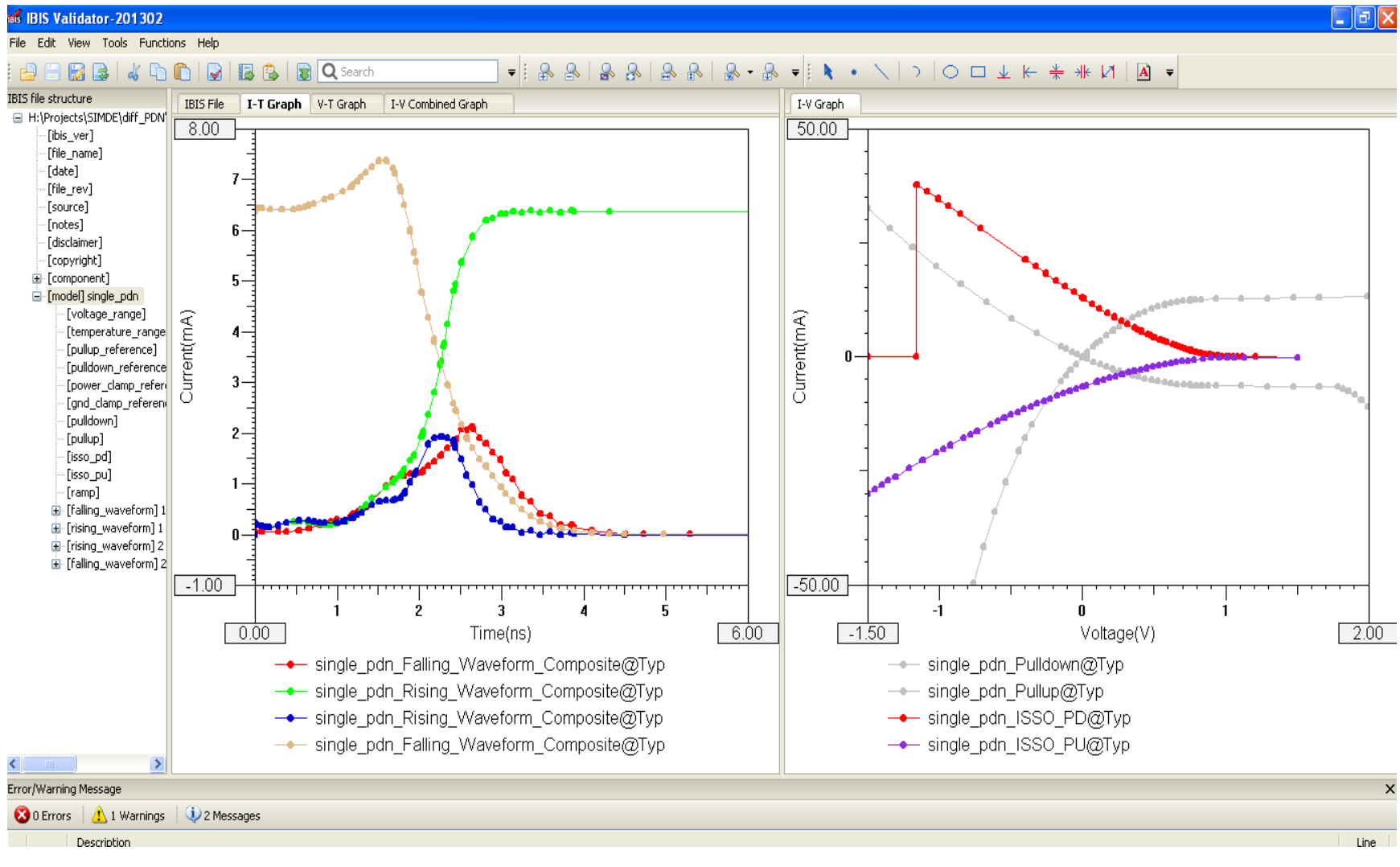
Test circuit and results (Power)

IBIS w/o PDN

IBIS with PDN

RED: Spice BLUE:IBIS

Test circuit and results (Ground)

IBIS w/o PDN

IBIS with PDN

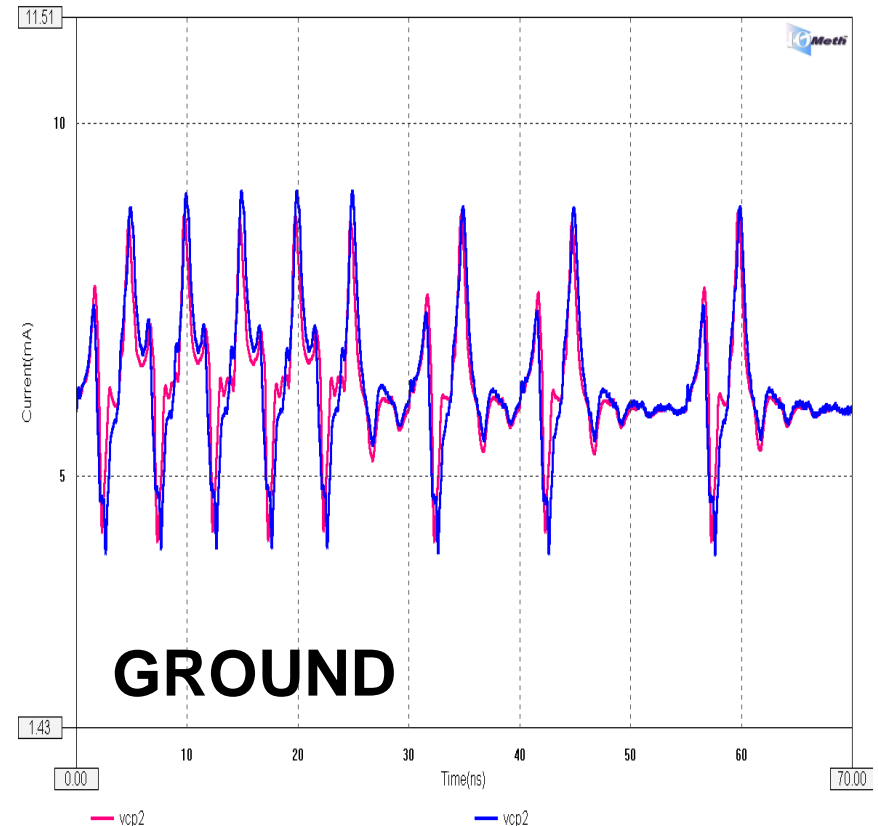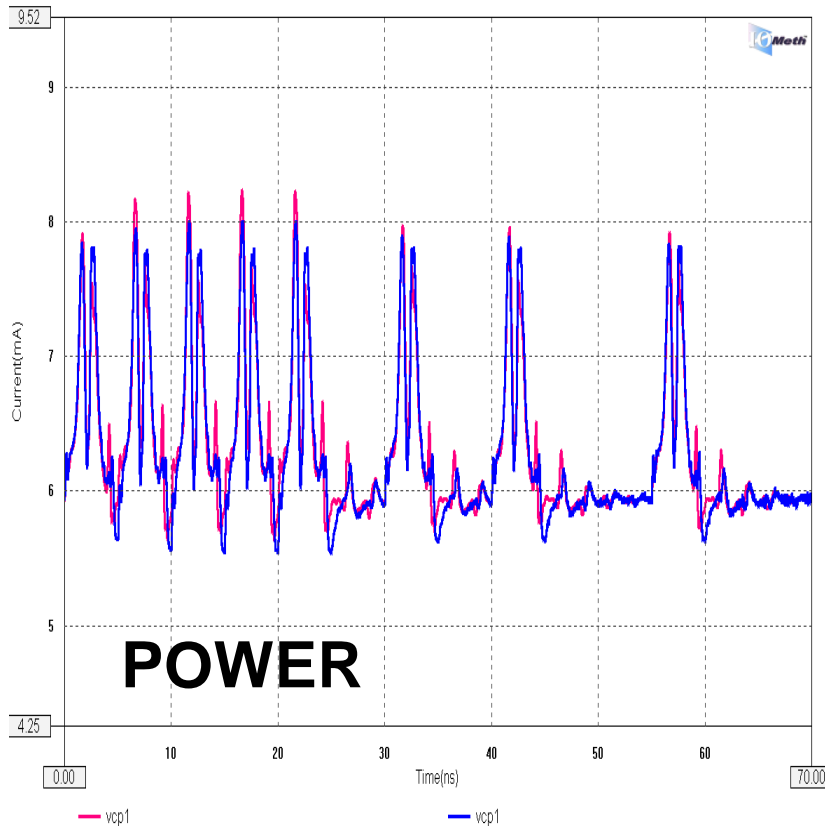RED: Spice BLUE:IBIS

Differential pair buffer test circuit

Differential pair buffer result (IBIS without PDN feature)

POWER

GROUND
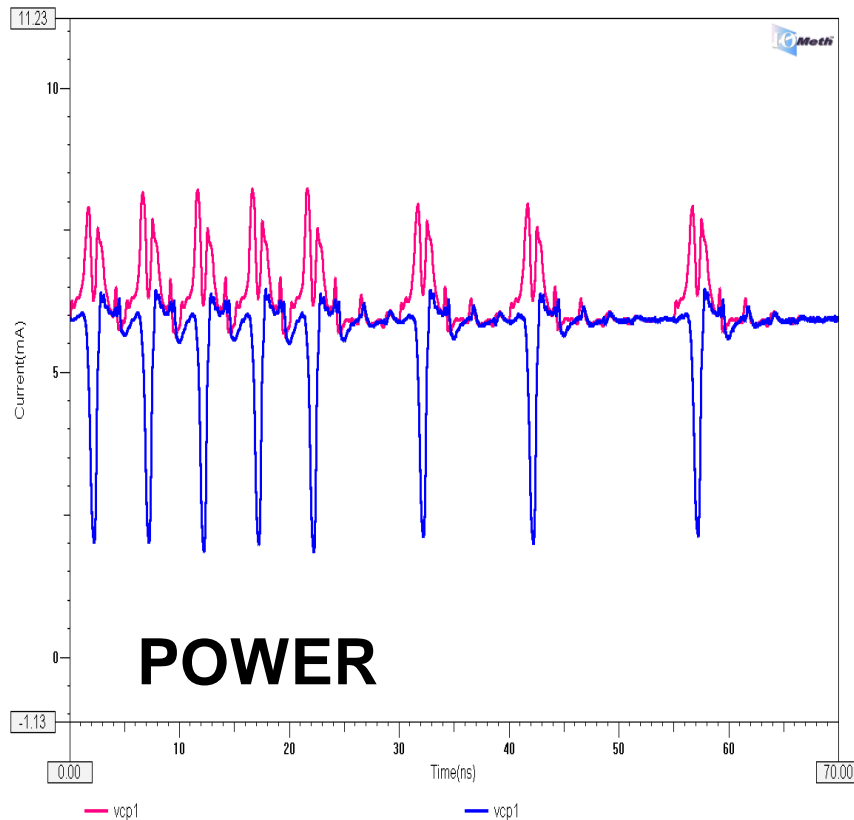
RED: Spice BLUE:IBIS

Differential pair buffer result (IBIS with PDN feature) – Extracted from single pins

POWER

GROUND

RED: Spice BLUE:IBIS

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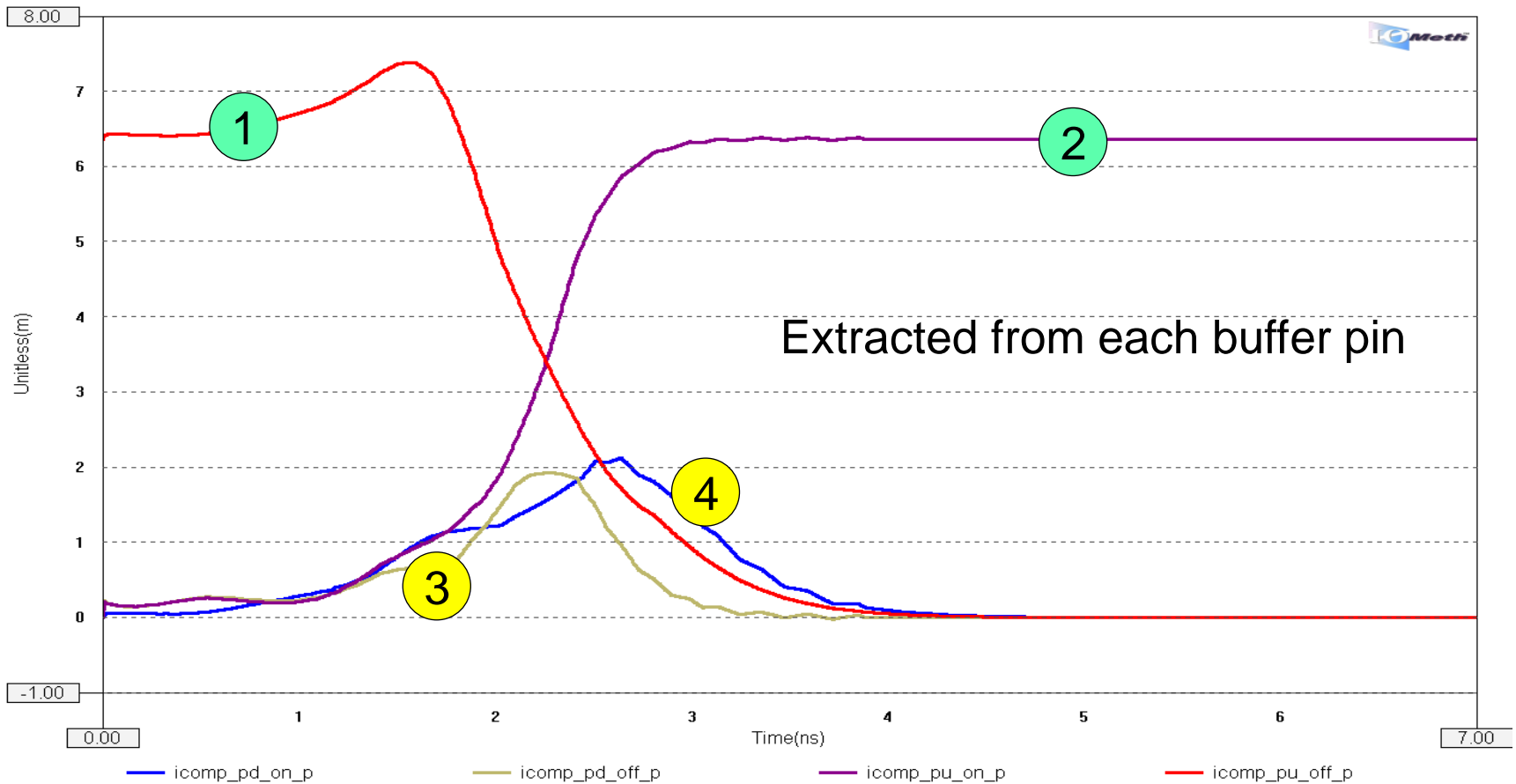
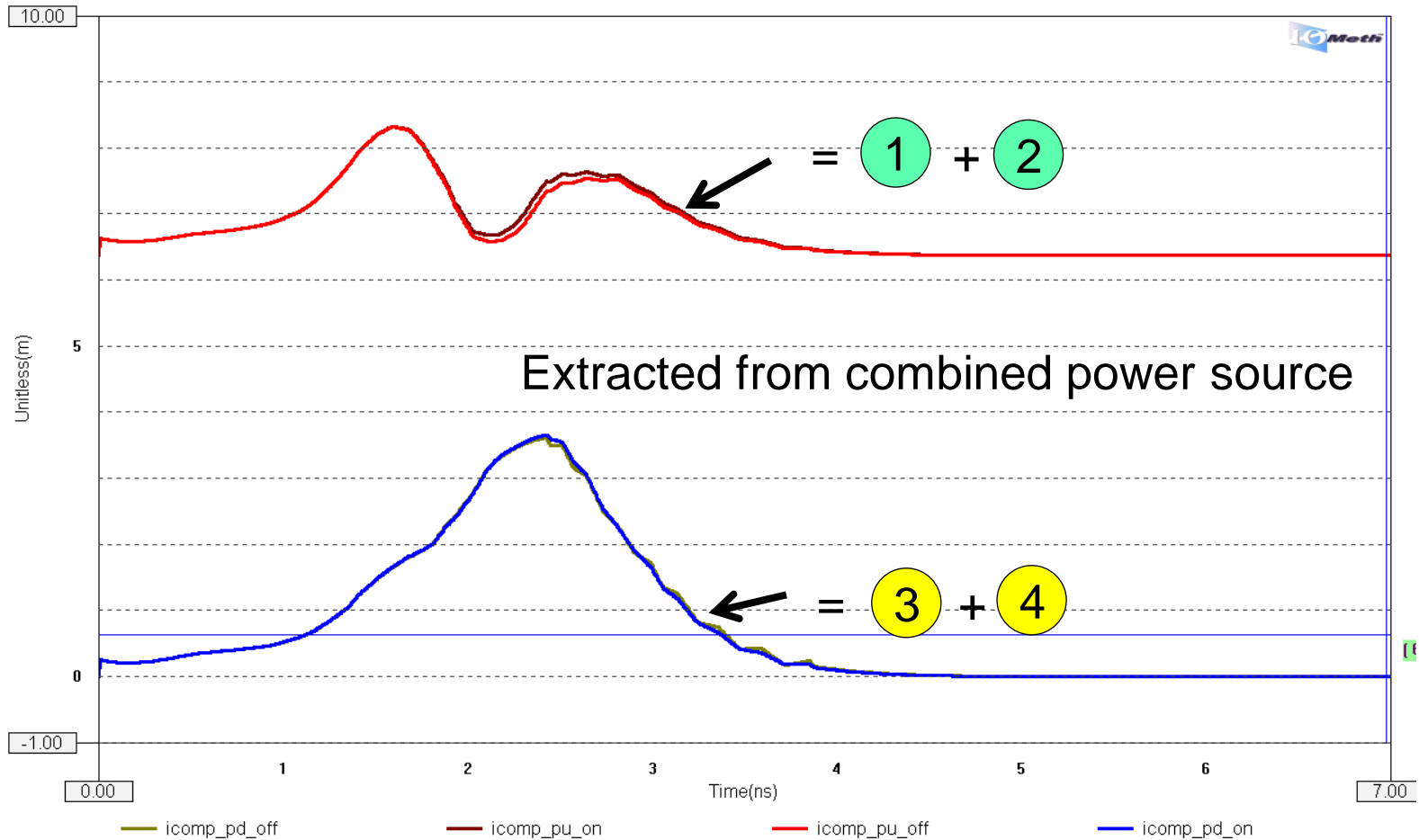# Differential pair PDN simulation analysis

- Result using IBIS model without PDN features is not acceptable

- Result using IBIS model with PDN features is GOOD!

  - This result is using the IBIS model extracted from separate power source for each P/N pins

What if we don't have the access to each buffers power pins?
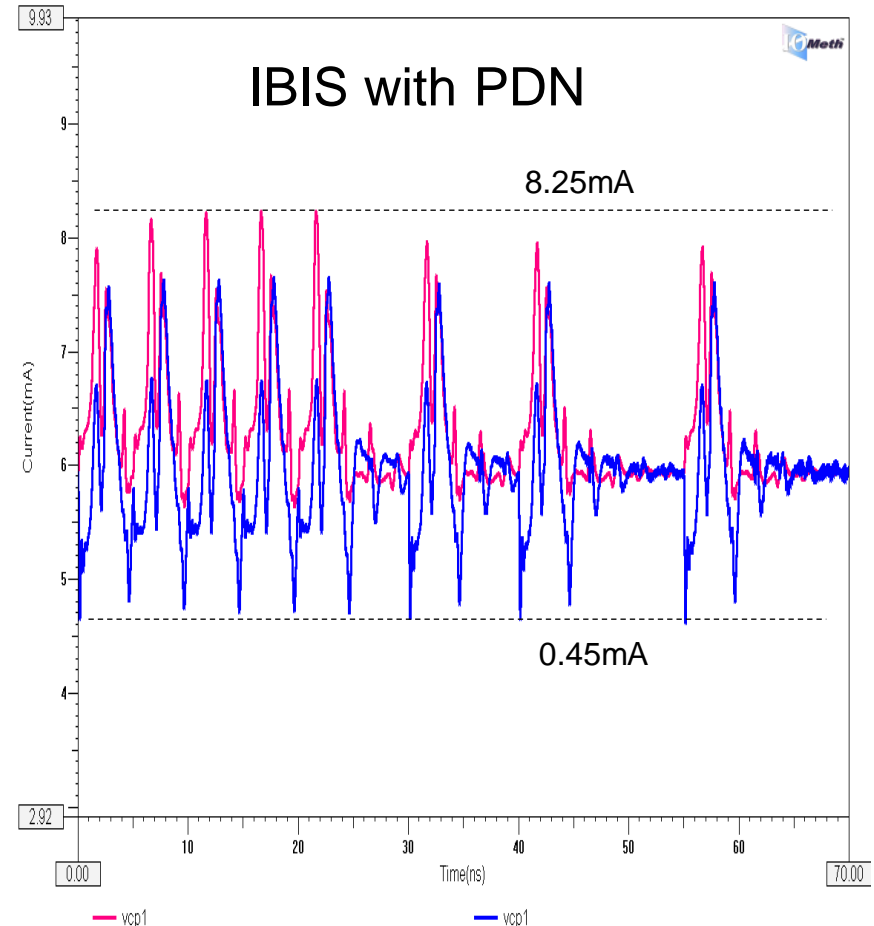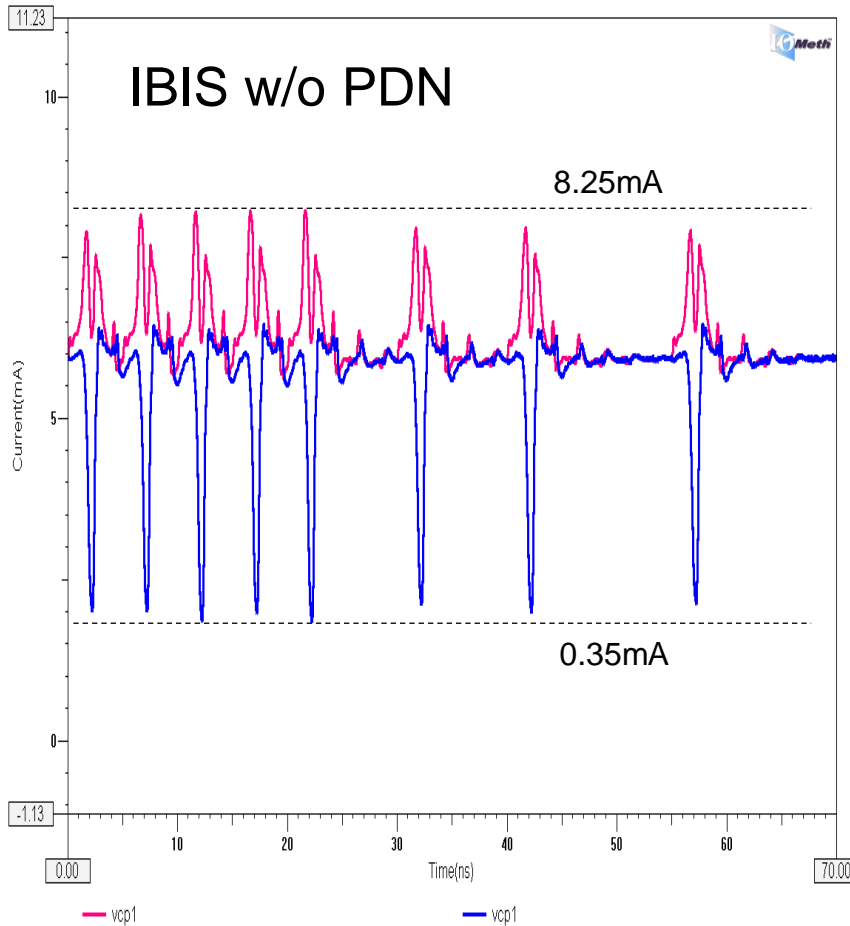
Look into the [Composite Current] curve

Extracted from each buffer pin

Look into the [Composite Current] curve

= 1 + 2

Extracted from combined power source

= 3 + 4

Legend: icomp_pd_off, icomp_pu_on, icomp_pu_off, icomp_pd_on

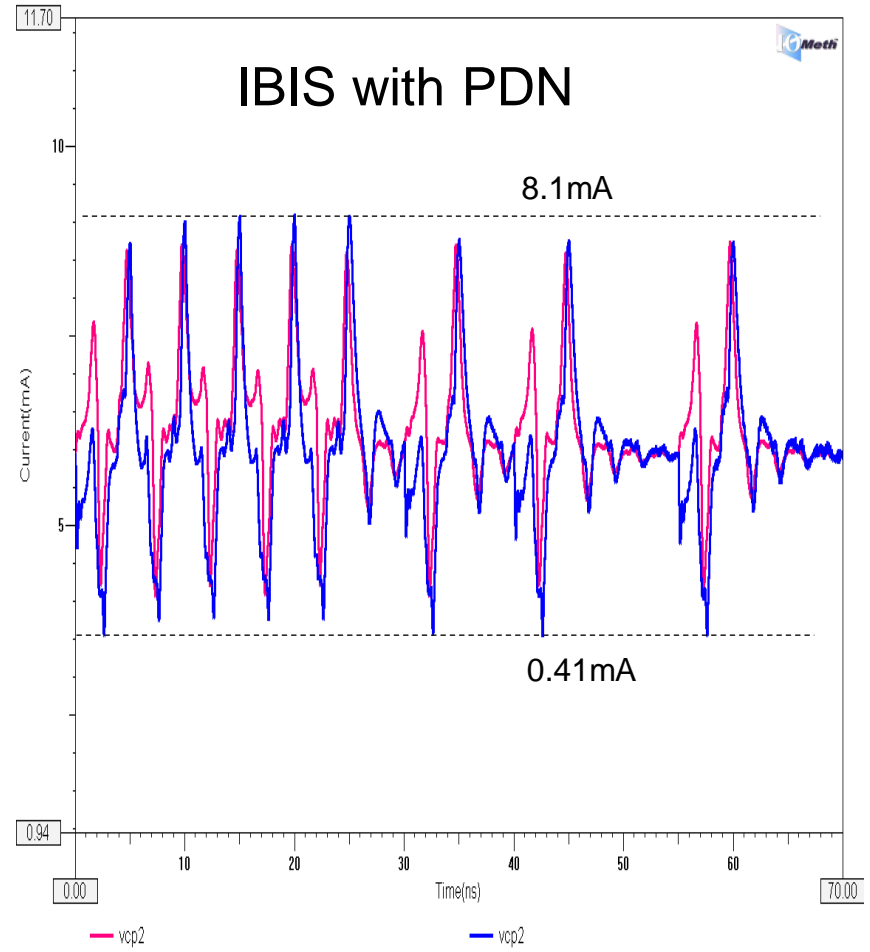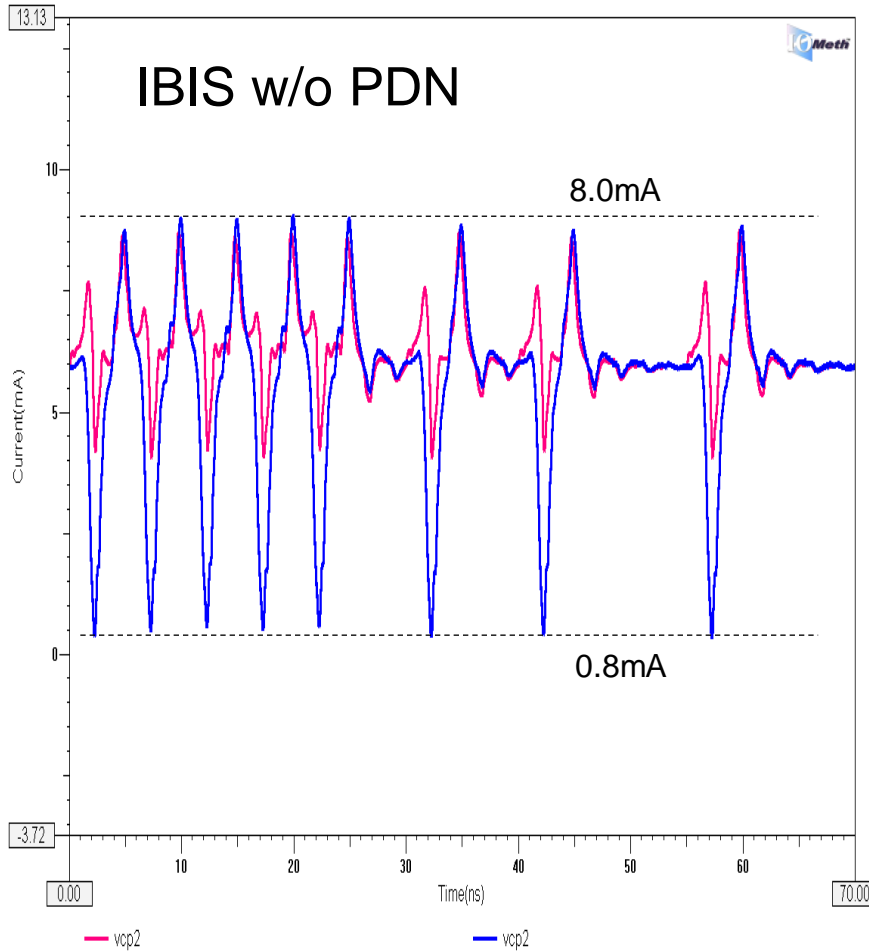# ISSO* and Composite Current curves for combined power source

- We can get combined ISSO* by setting up both Pullup or Pulldown then take the average for each buffer

- Due to actual P/N pins take one pullup and one pulldown at the same time for differential pair, Composite Current we get is (1)+(2) and (3)+(4)

  - We can also do an average-out to see if it would close to the Spice simulation results

Result for combined POWER pin

IBIS w/o PDN

8.25mA

0.35mA

IBIS with PDN

8.25mA

0.45mA

RED: Spice BLUE:IBIS

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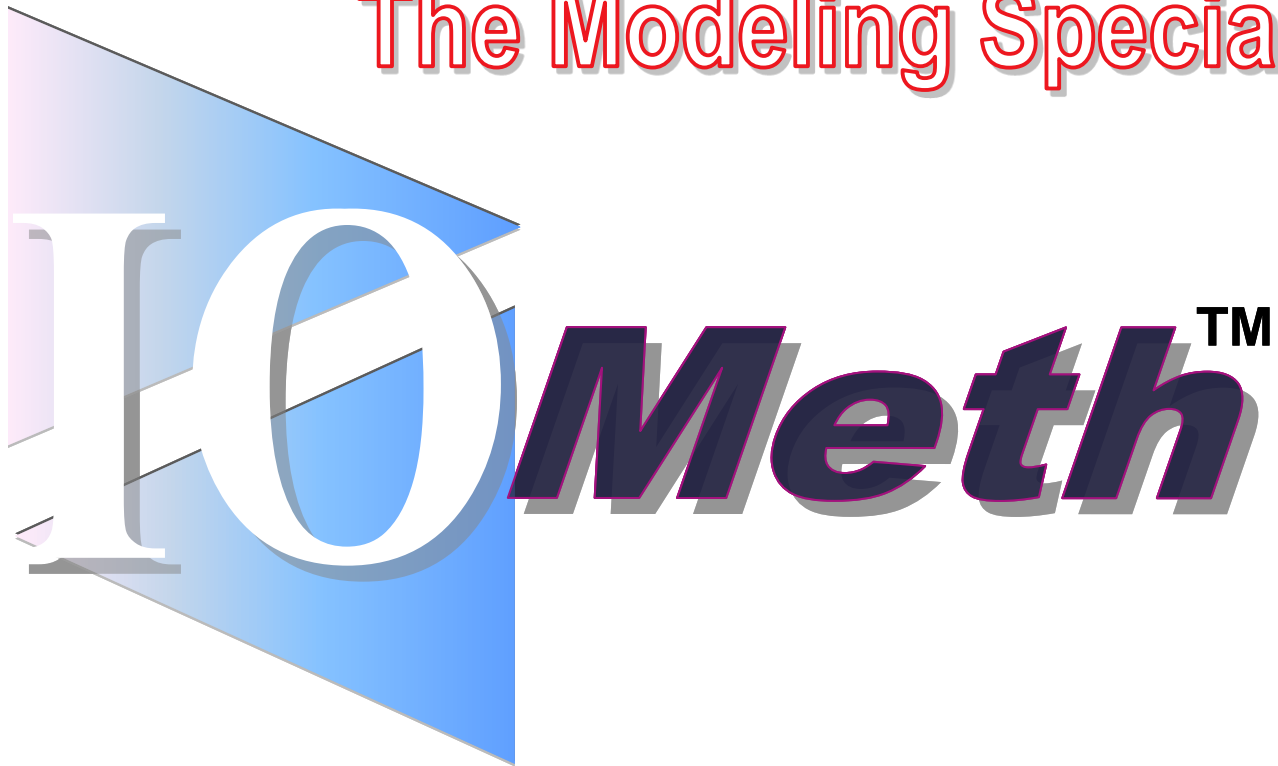
Result for combined GROUND pin

RED: Spice BLUE:IBIS

Summary

- IBIS PDN feature helps to have more accurate result for single-end buffer PDN simulation

- IBIS model without PDN features is not acceptable for differential pair PDN simulations

- If we can access to each P/N pin power source separately, the IBIS model with PDN feature can be used in differential pair PDN simulations accurately

- If we only can access to combined power source pins, the average-out method could be workaround to use in IBIS differential pair PDN simulations

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