Differential buffer using IBIS models for PDN simulations

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Asian IBIS Summit – Taipei
Nov. 17th, 2014

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

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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

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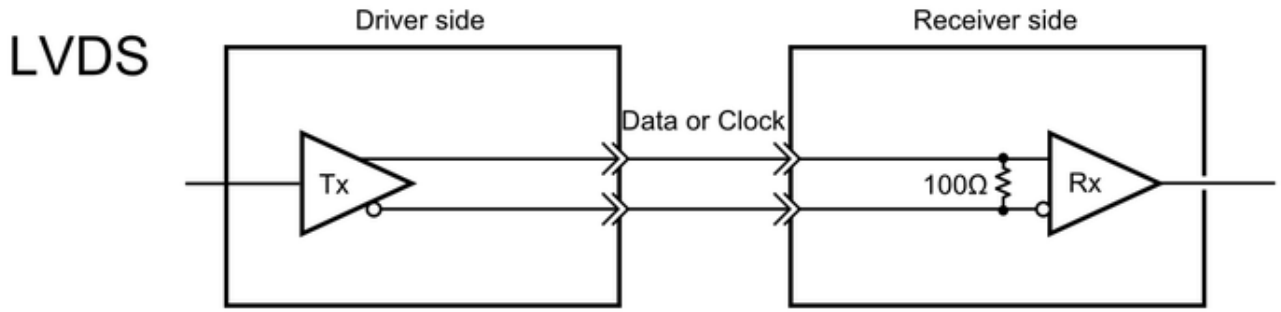
The test case

- 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



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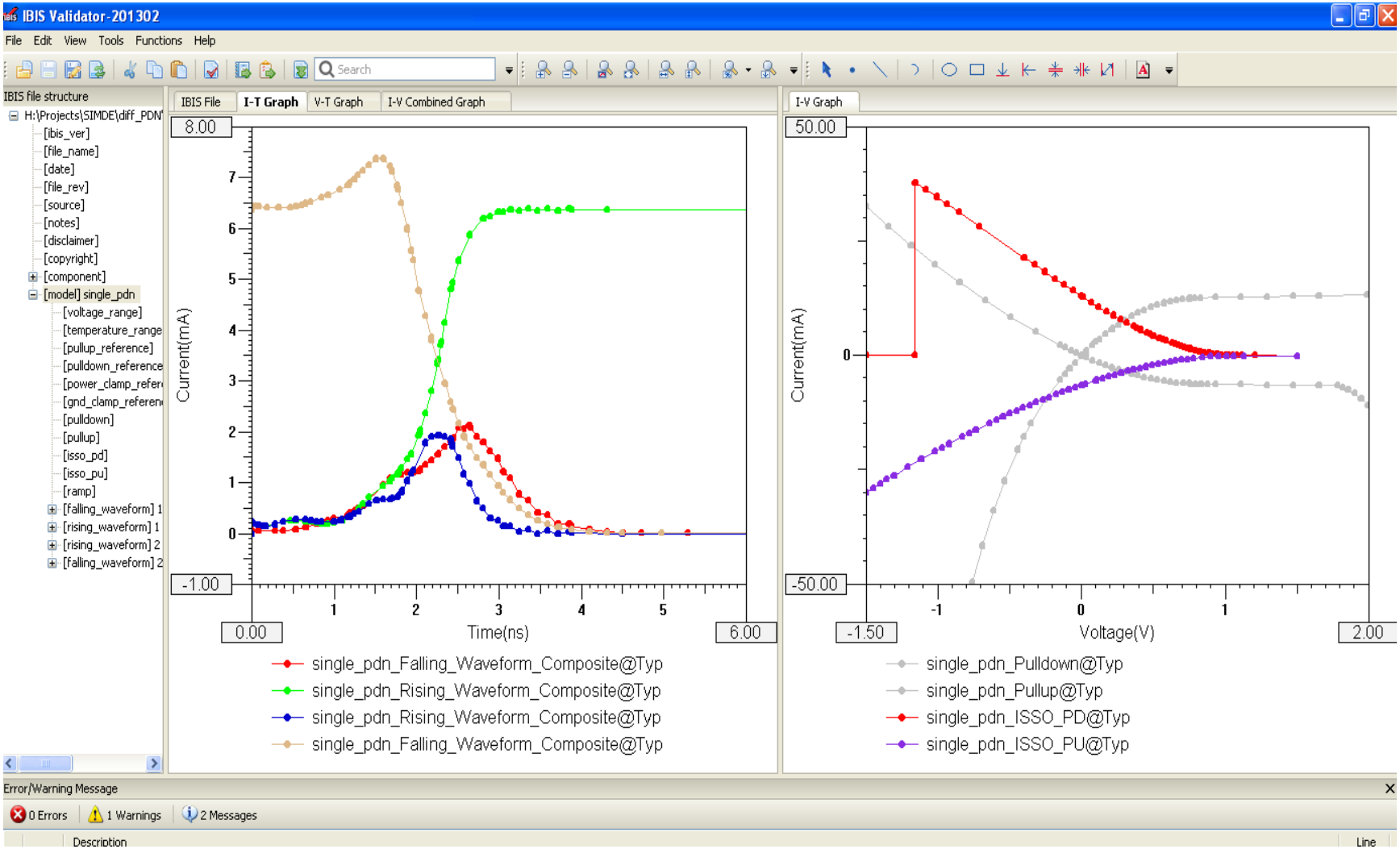
Review of IBIS PDN Feature



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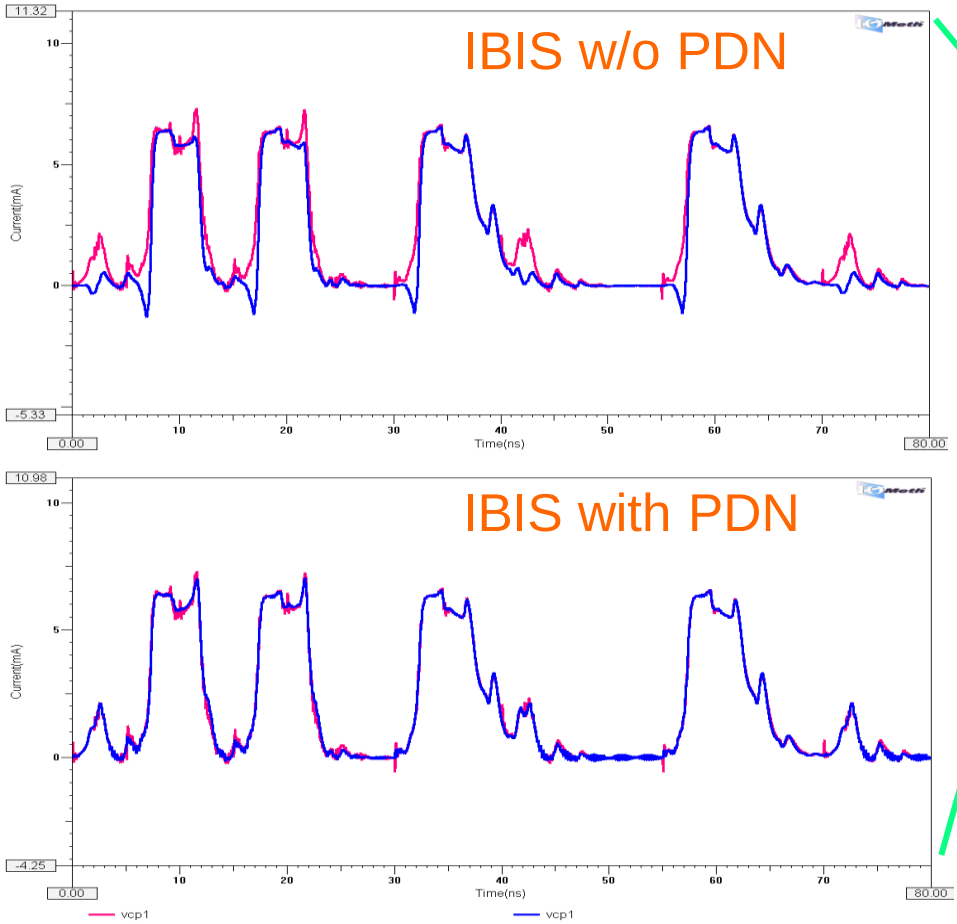
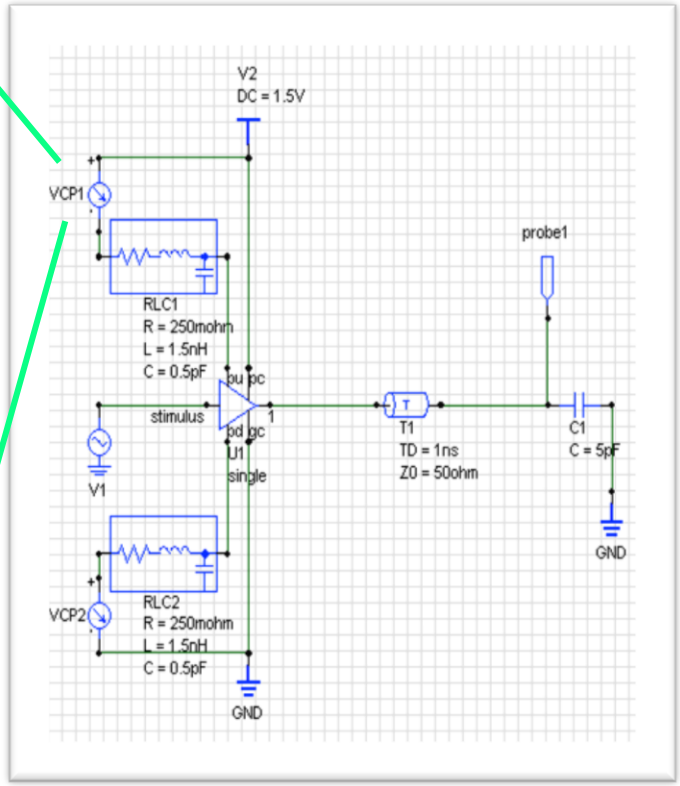
Test circuit and results (Power)





RED: Spice BLUE:IBIS

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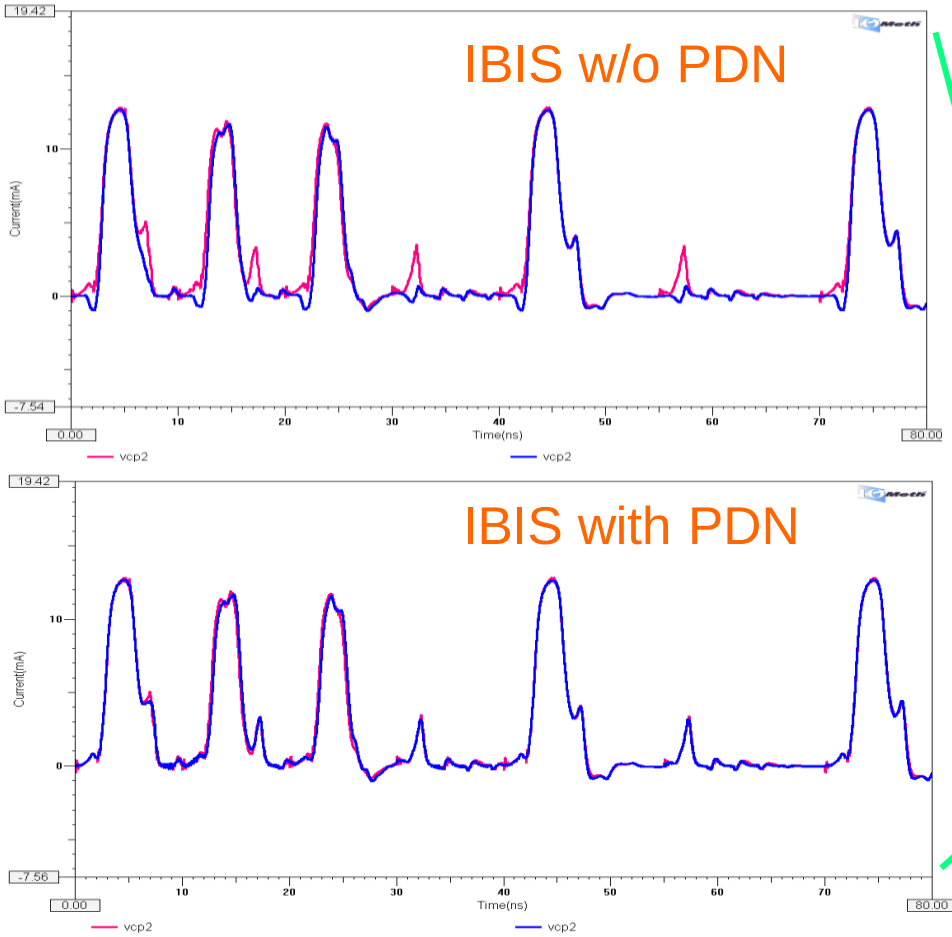
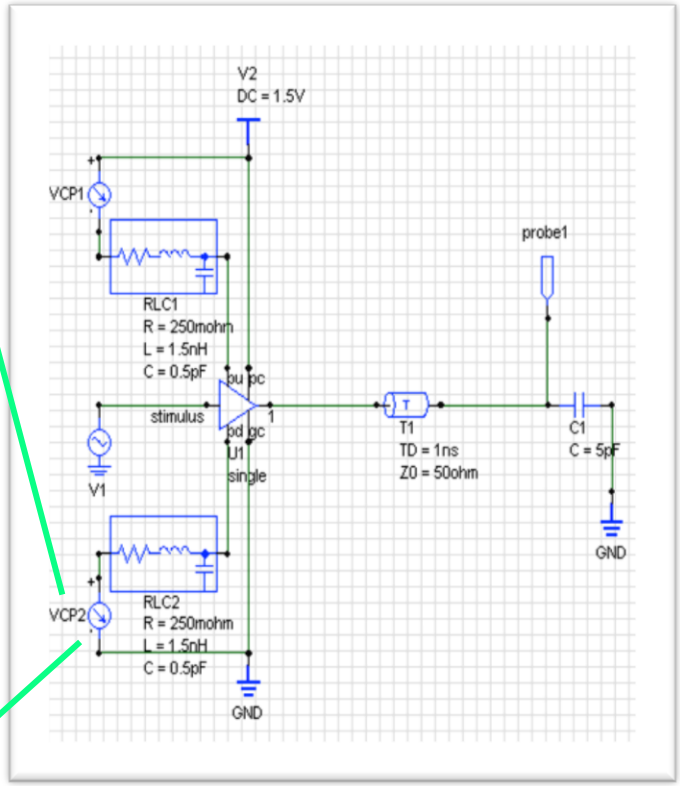
Test circuit and results (Ground)





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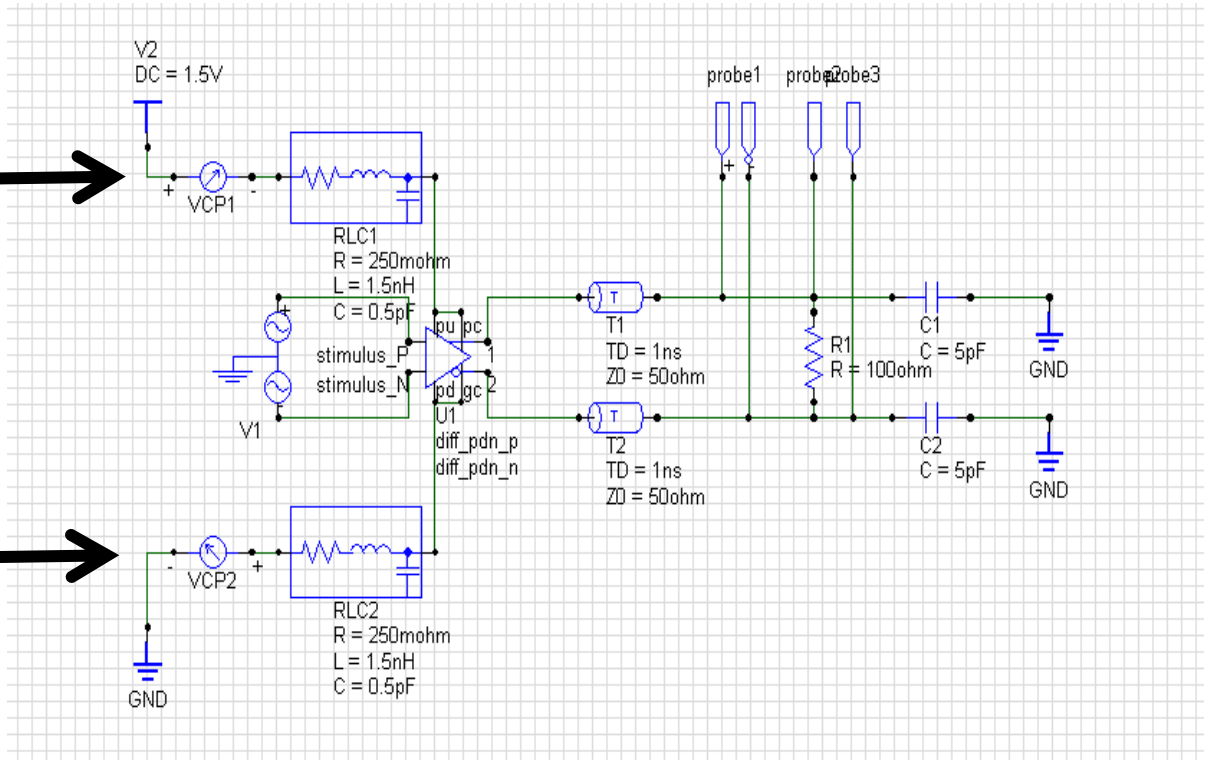
Differential pair buffer test circuit

POWER

GROUND



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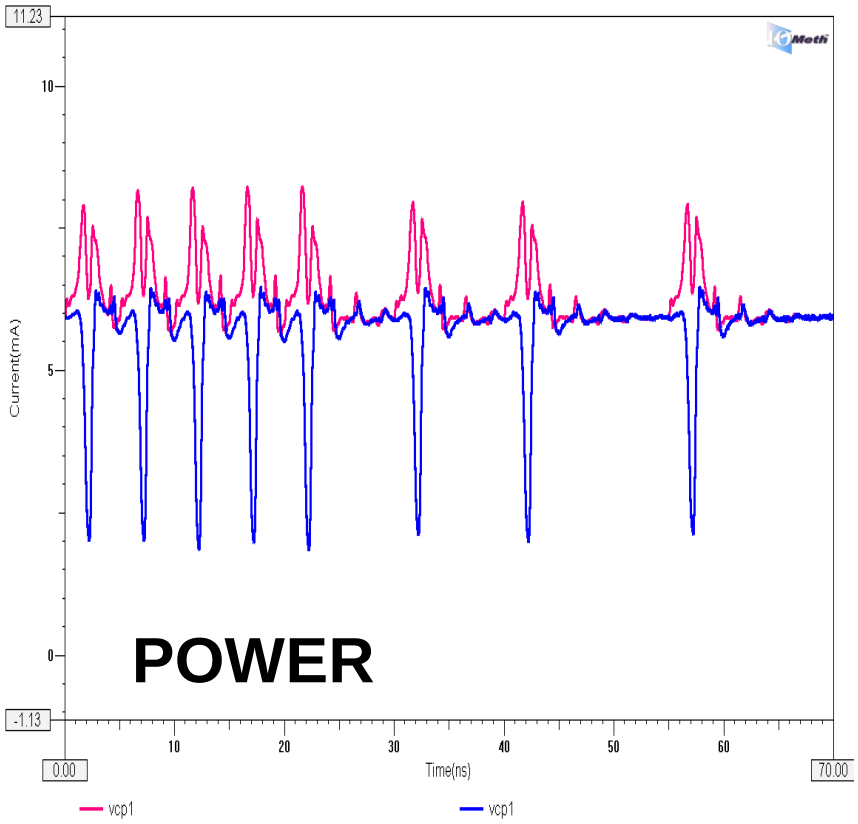
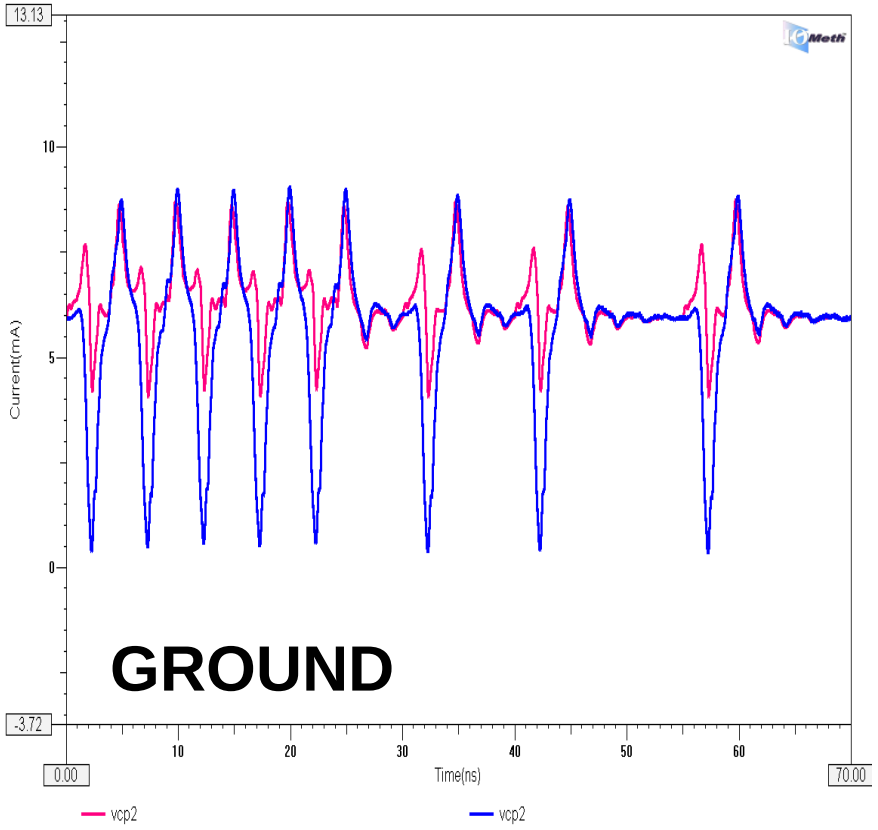
Differential pair buffer result (IBIS without PDN feature)





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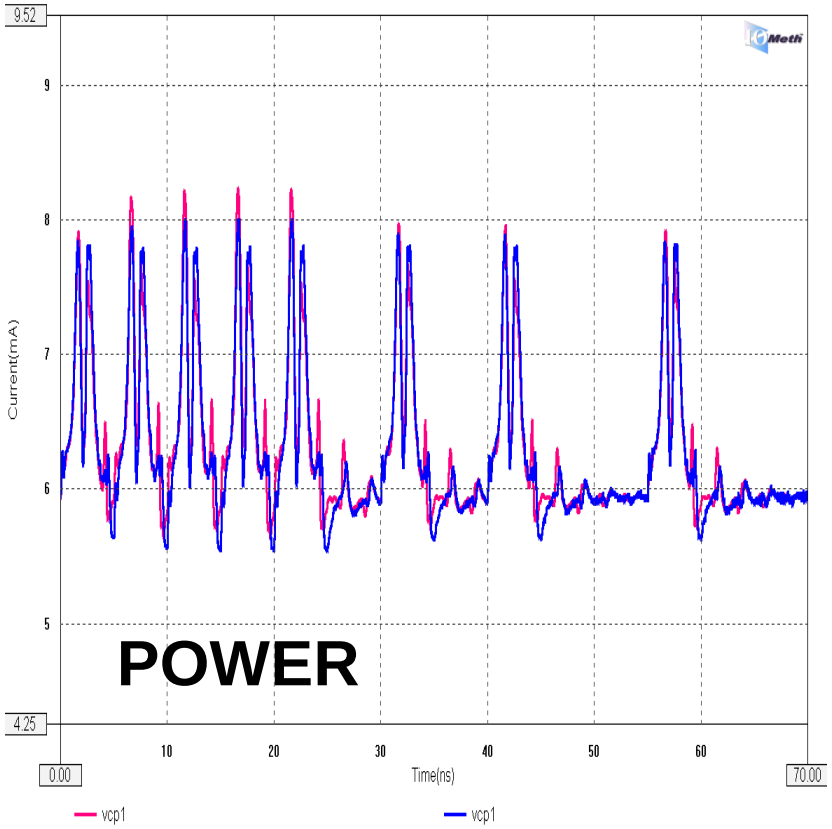
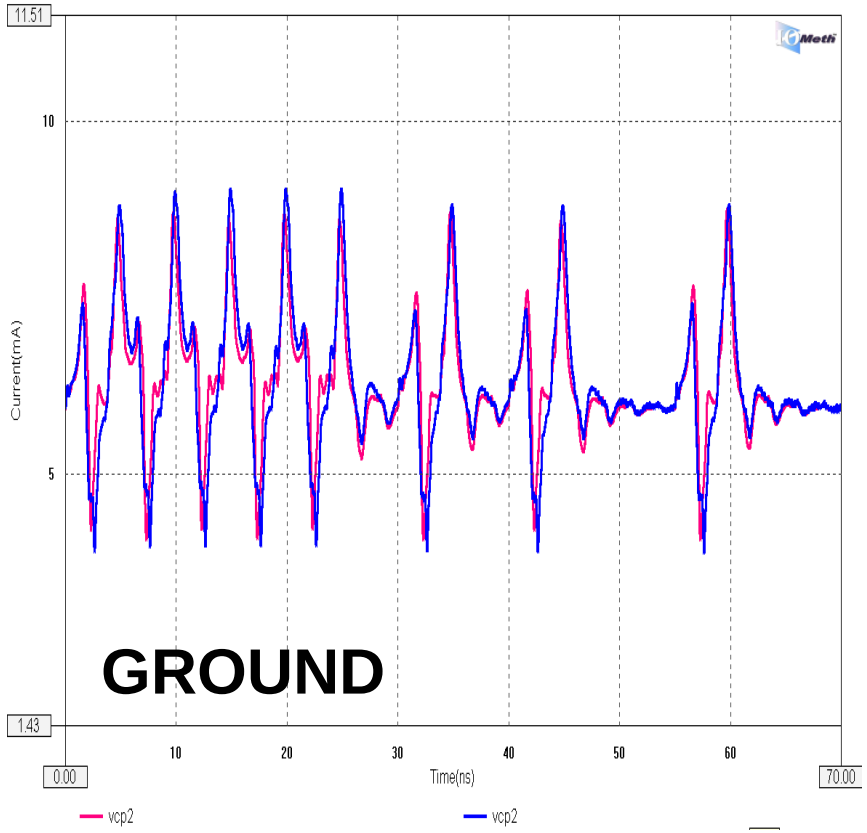
Differential pair buffer result (IBIS with PDN feature) – Extracted from single pins





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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?

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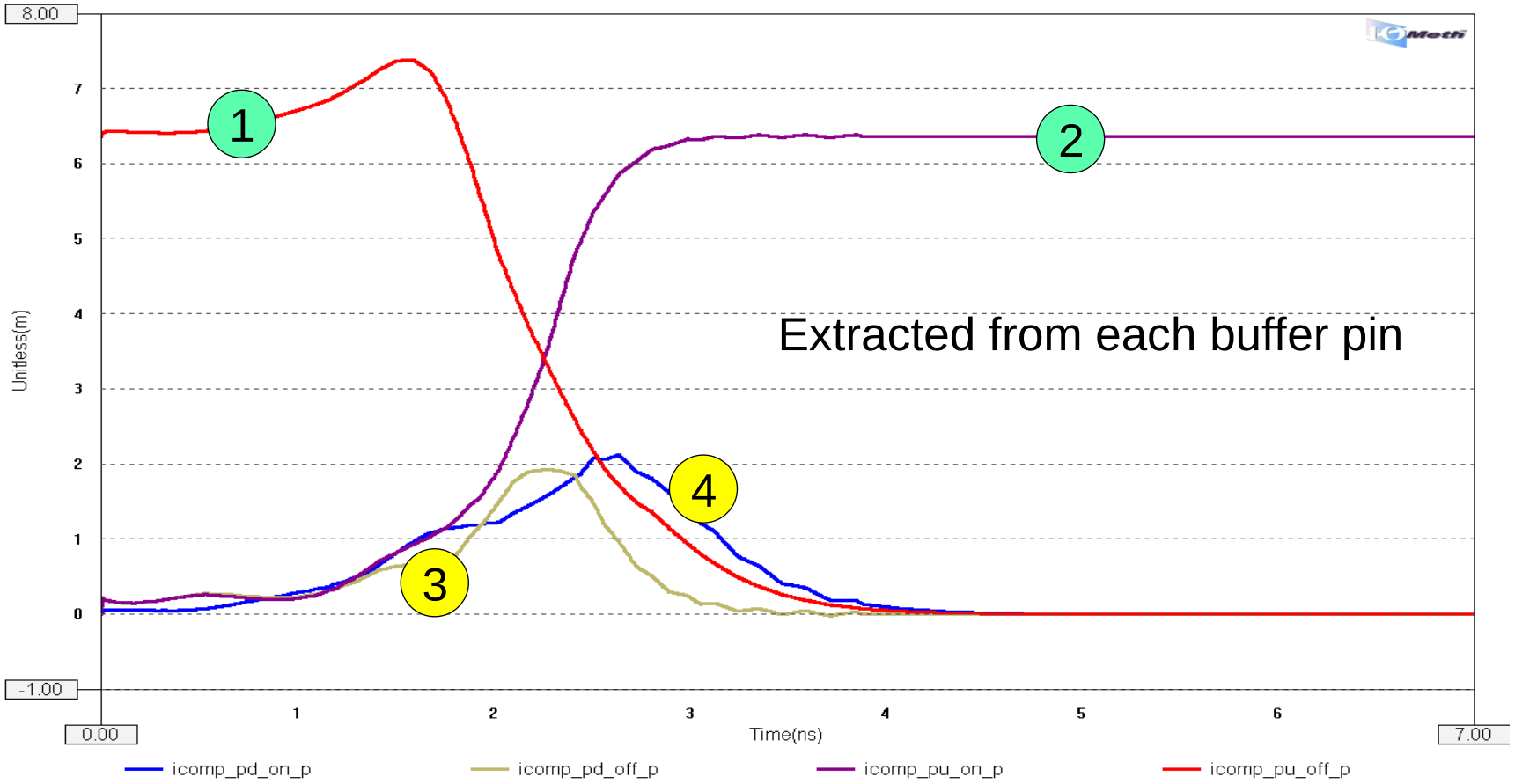
Look into the [Composite Current] curve



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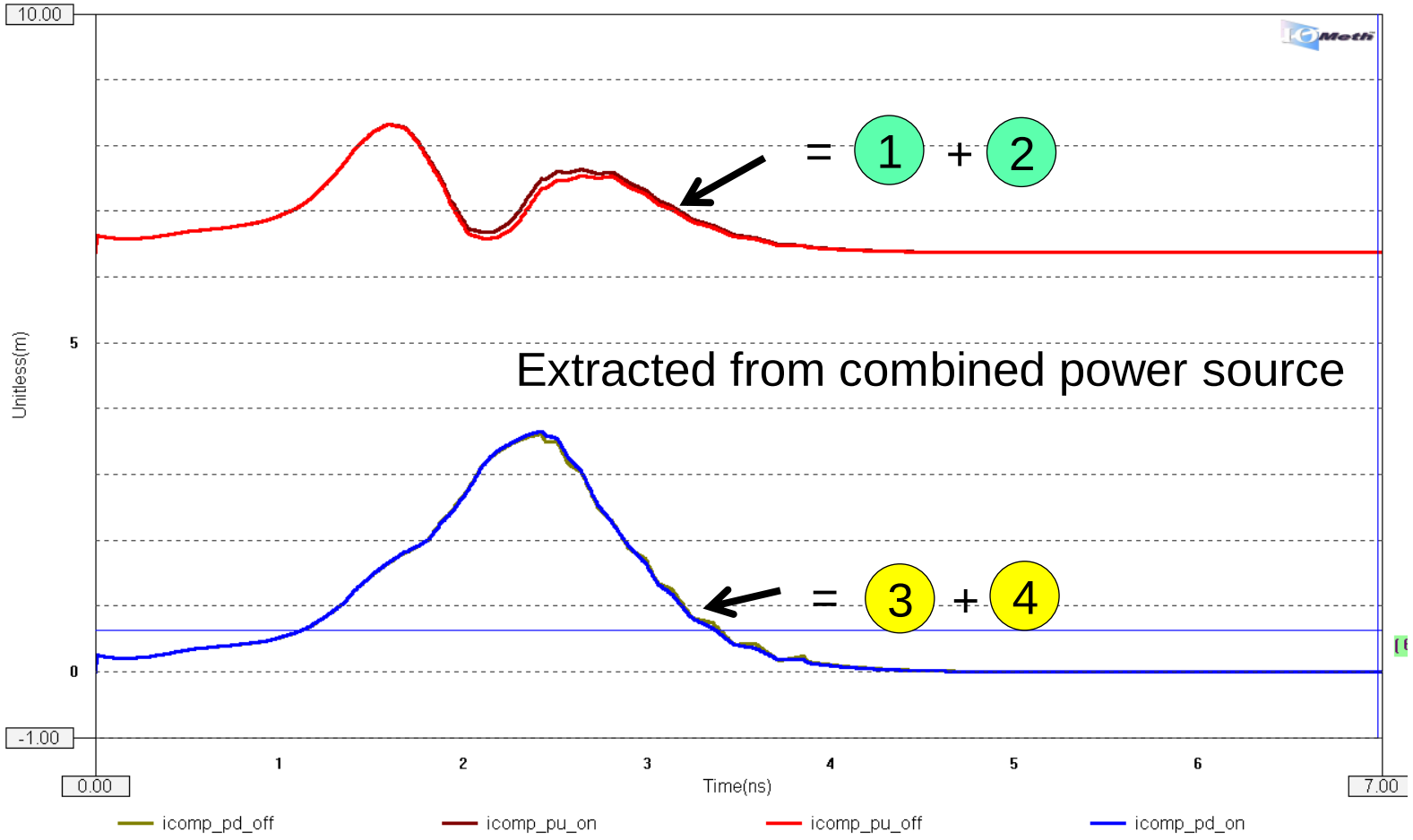
Look into the [Composite Current] curve



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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

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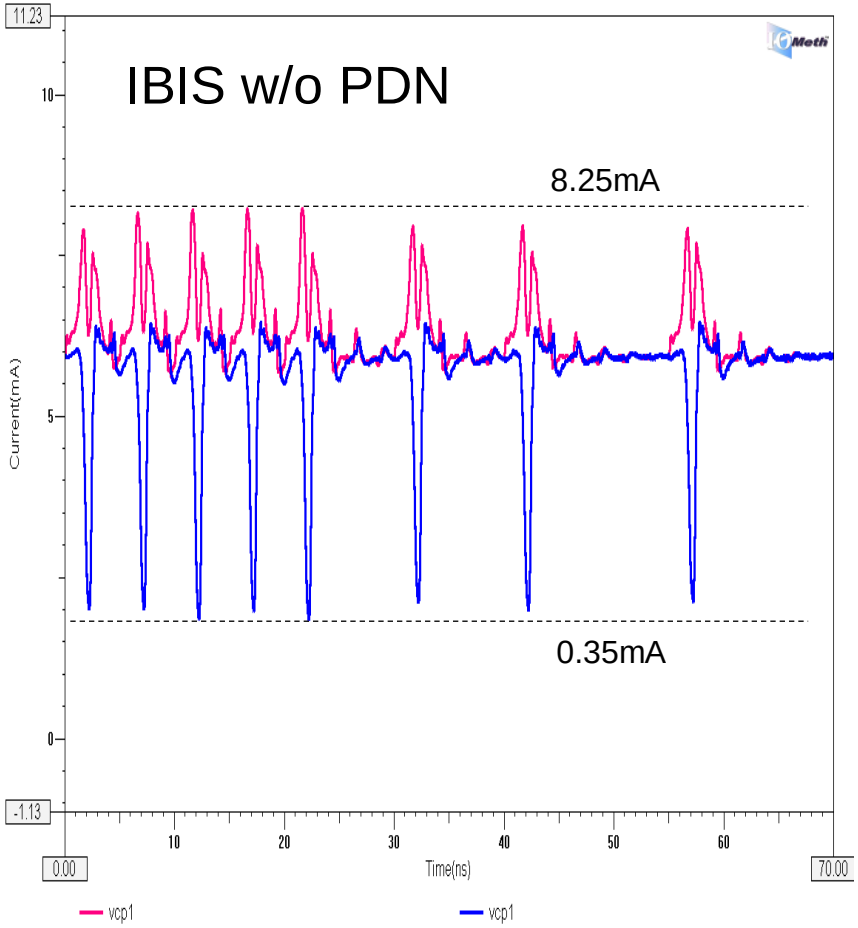
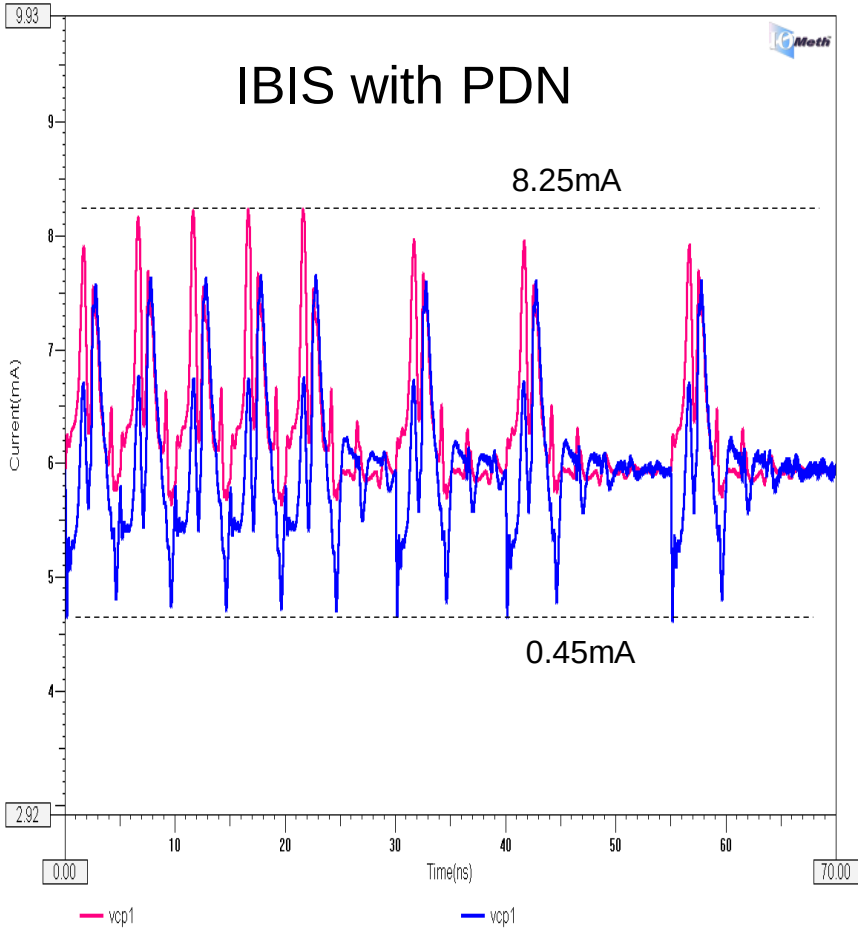
Result for combined POWER pin





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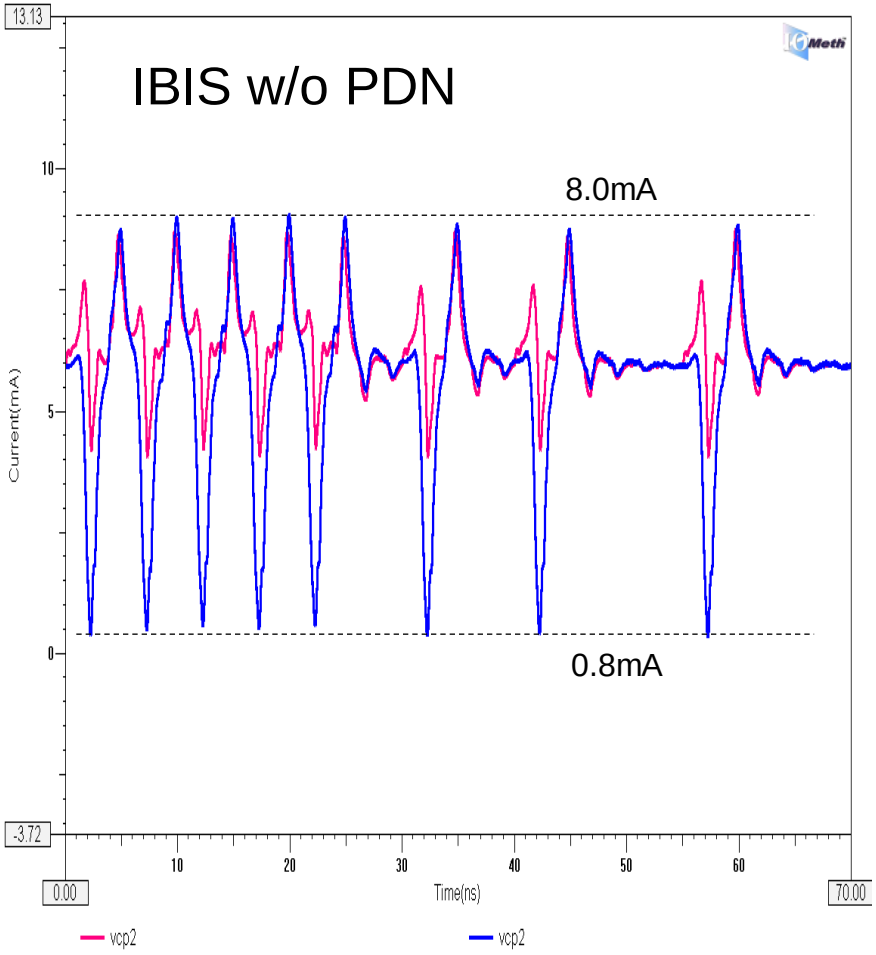
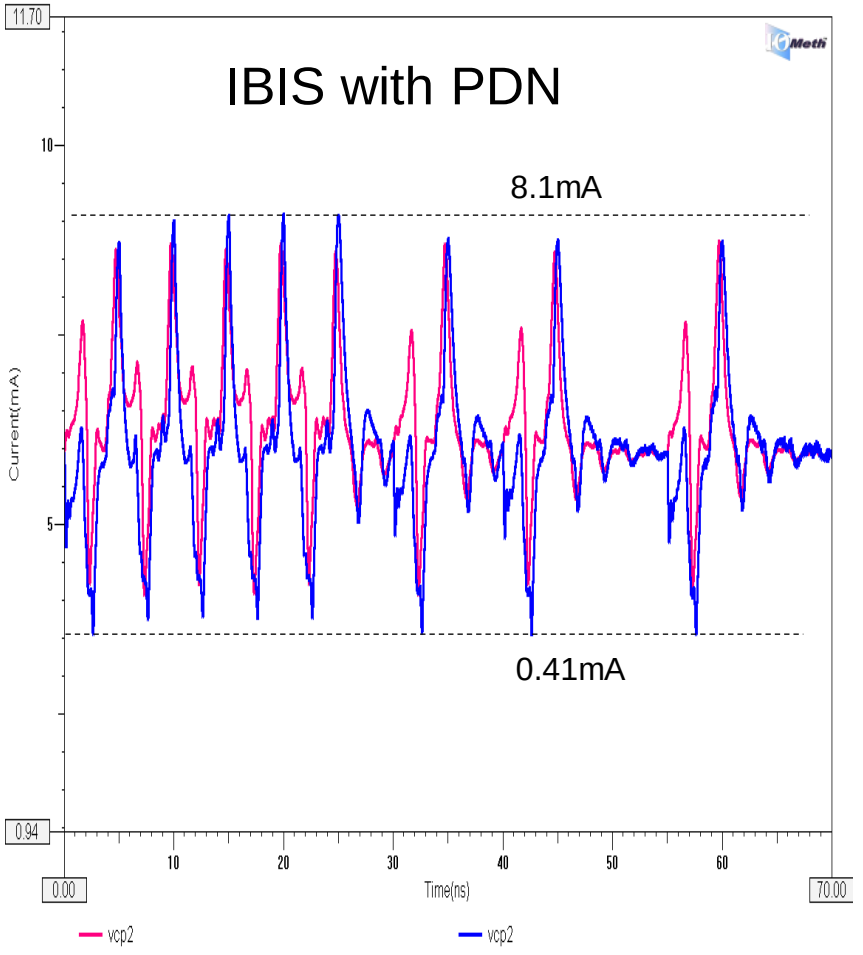
Result for combined GROUND pin





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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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