Differential buffer using IBIS models for PDN simulations

Lance Wang
Asian IBIS Summit – Taipei
Nov. 17th, 2014
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

© 2006-2014 IO Methodology Inc.
Test circuit and results (Ground)

IBIS w/o PDN

IBIS with PDN

RED: Spice  BLUE: IBIS

© 2006-2014 IO Methodology Inc.
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

RED: Spice  BLUE: IBIS
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

Extracted from combined power source

\[ \text{Composite Current} = 1 + 2 \]

\[ \text{Composite Current} = 3 + 4 \]
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

IBIS with PDN

© 2006-2014 IO Methodology Inc.
Result for combined GROUND pin

IBIS w/o PDN
- Current: 8.0 mA
- Time: 0 - 70 ns

IBIS with PDN
- Current: 8.1 mA
- Time: 0 - 70 ns

© 2006-2014 IO Methodology Inc.
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