Pin-Pair Oriented Extraction Method for Differential Pair IBIS Modeling

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Outline

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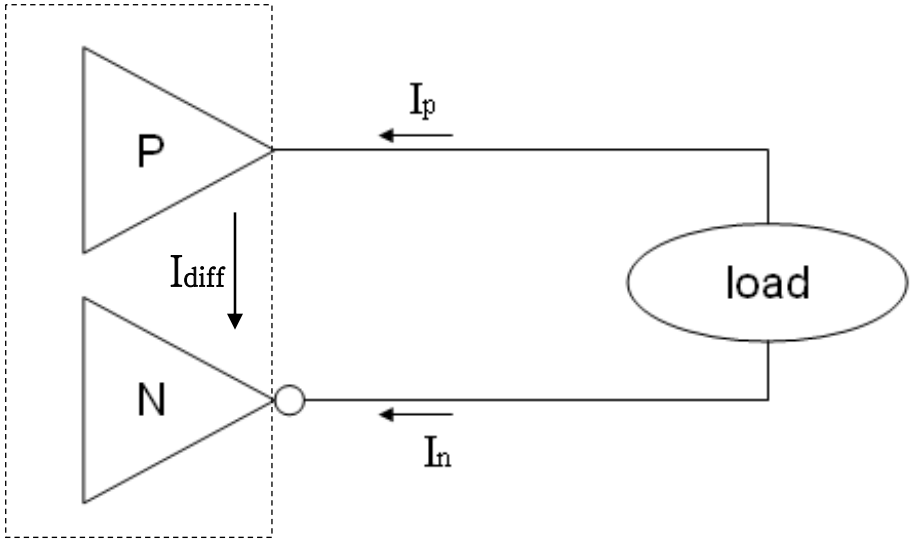
- Pin-Pair Oriented Extraction Method
- Test case and Correlations
- Conclusions

Motivations

- Differential-pair buffers are used popularly for High-Speed data-transfer designs
- IBIS is good for Pseudo differential-pair buffer by using [Diff Pin]
- Current introduced extraction methods are not easy or accurate for “True” differential-pair cases; And not all EDA tools support the models using additional features other than [Diff Pin]
- The expectations for new method
  - Easy to extract
  - All EDA tools support it if it supports basic IBIS models
  - Acceptable accuracy

Pin-Pair Oriented Extraction Method



$I_{load} = I_p - I_n$

The way to use differential pair signal is to monitor the subtracted currents between Positive-pin and Negative-pin.

The Pin-Pair Oriented Extraction method is following this real situation to focus on the subtracted currents rather than each separated pin currents.

Pin-Pair Oriented Extraction Method

- IBIS V-I data is used in the simulations as:

  $I_{out} = I_{pu} + I_{pd} + I_{pc} + I_{gc}$

  Where:

  I_{out} : the current on the pad;

  I_{pu} : the current from Pullup data table

  I_{pd} : the current from Pulldown data table

  I_{pc} : the current from Power clamp data table

  I_{gc} : the current from Ground Clamp data table

  All IBIS currents are the function (table lookup) results in the IBIS V-I data tables. They are:

  $I_{pu} = f(V_{pu})$

  $I_{pd} = f(V_{pd})$

  $I_{pc} = f(V_{pc})$

  $I_{gc} = f(V_{gc})$

  So: $I_{out} = f(V_{pu}) + f(V_{pd}) + f(V_{pc}) + f(V_{gc})$

Pin-Pair Oriented Extraction Method

- IBIS differential current should be:

$I_{load} = I_p - I_n$

$= f_p(V_{pu}, V_{pd}, V_{pc}, V_{gc}) + f_n(V_{pu}, V_{pd}, V_{pc}, V_{gc}) + I_{diff}$

Where

$f_p(V..)$ is the V-I function for single-end Positive-pin.

$f_n(V..)$ is the V-I function for single-end Negative-pin.

I_{diff} is the differential mode current between diff pin pairs internally.

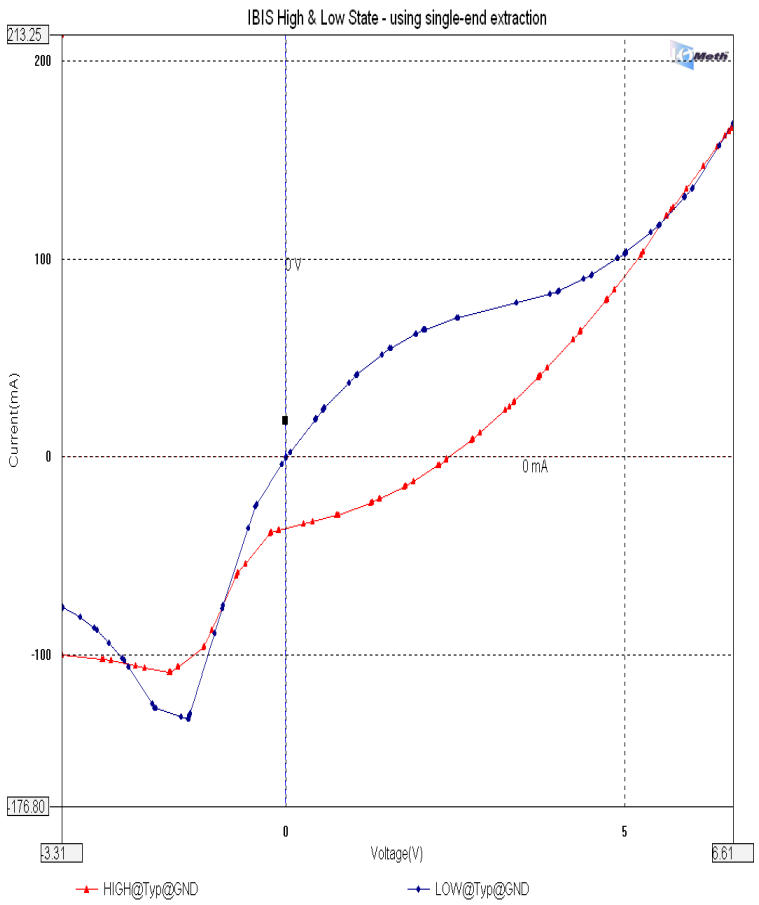
- We can put I_{diff} into both IBIS current curves

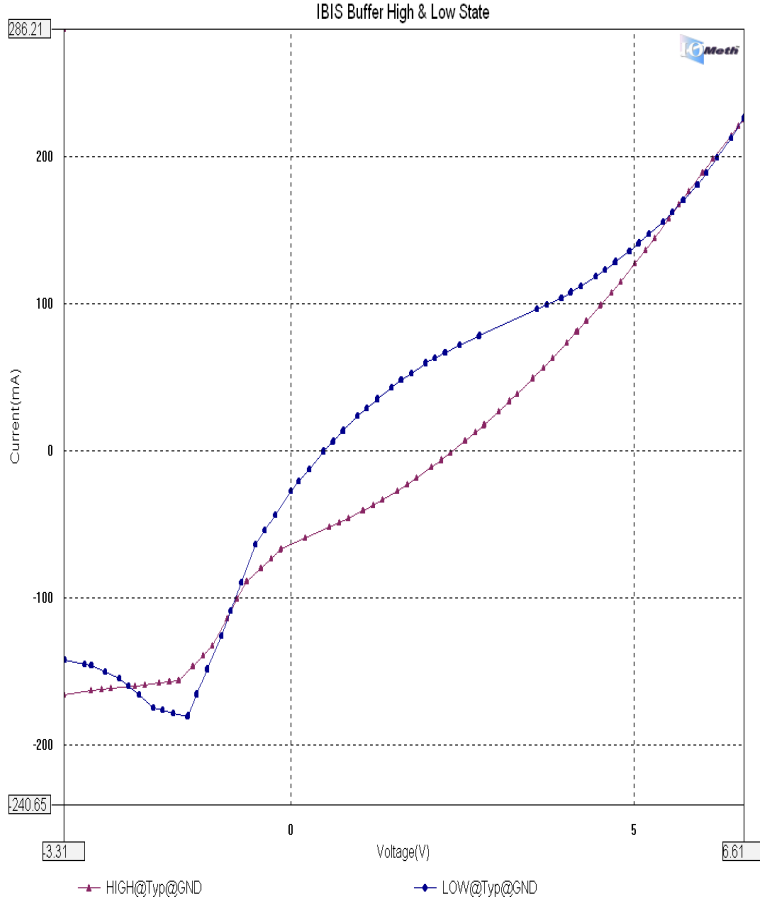
$I_{load} = I_p - I_n = (f_p(V..) + I_{diff\_partial\_p}) + (f_n(V..) + I_{diff\_partial\_n})$

$= f_{p\_combined}(V..) + f_{n\_combined}(V..)$

- The condition is to extract both pins at the same time in the real working condition!

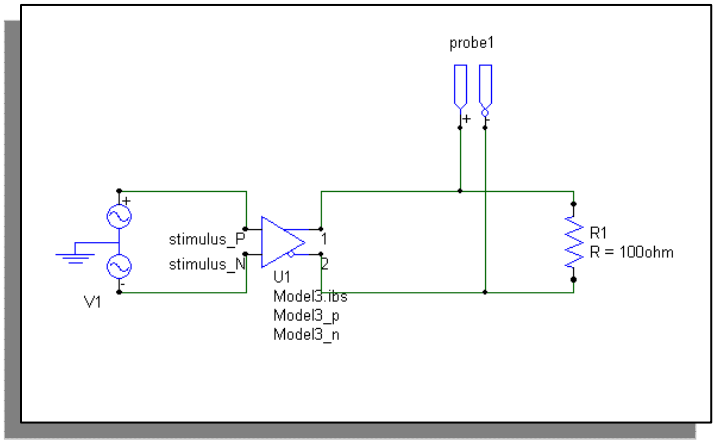
Example of V-I curves with I_{diff} embedded



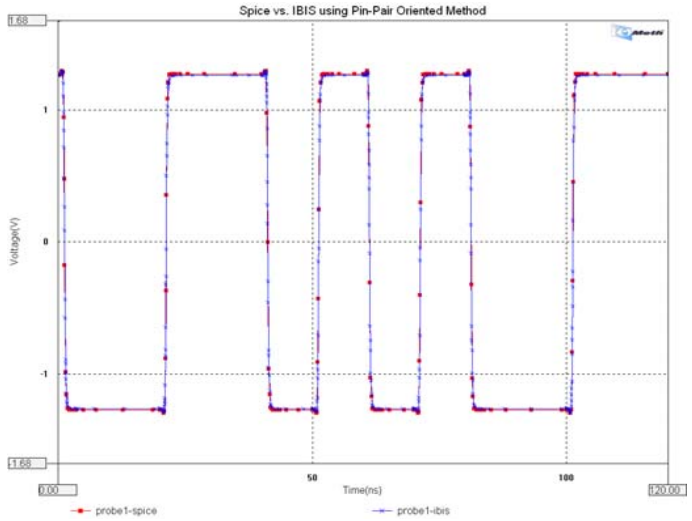


Test case and Correlations

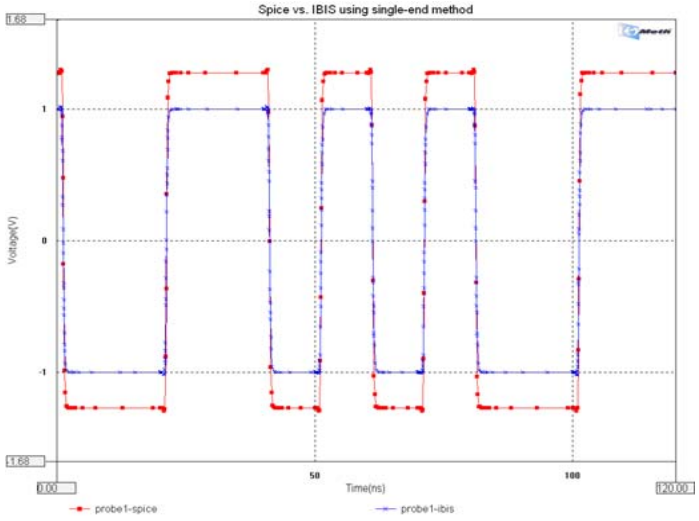
Differential Average Index (DAI) – Spice vs. IBIS
Probe 1:
0.63% using Pin-Pair Oriented Method
10.55% using Single-end extraction method



Pin-Pair Method

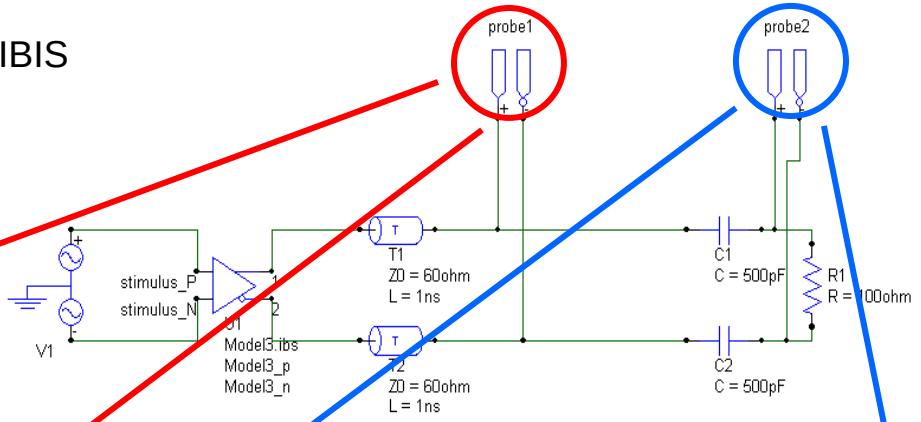


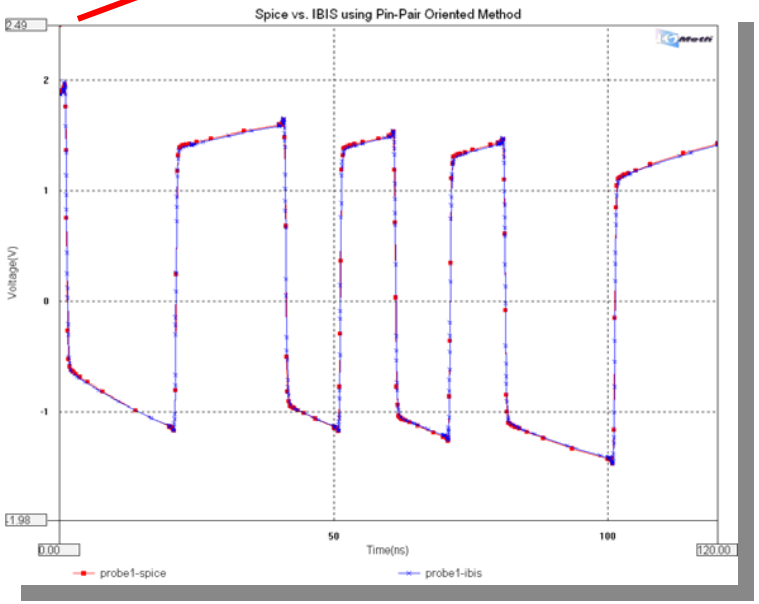
Single-end Method

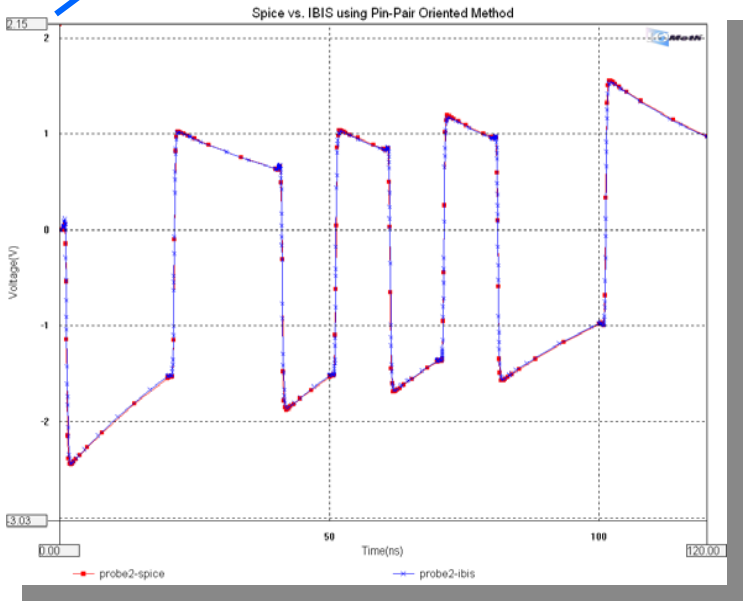


Test case and Correlations

Differential Average Index (DAI) – Spice vs. IBIS
Probe 1:
0.96% using Pin-Pair Oriented Method
Probe 2:
0.73% using Pin-Pair Oriented Method







Conclusion

- Pin-Pair Oriented Extraction method is a straight forward method for differential pair IBIS buffer extractions.
- It is accurate and easy to operate.
- It uses the same IBIS basic syntax but combines differential current in both Pos/Neg IBIS I-V curves. It works for all simulators that support IBIS basic models.
- Both Pos/Neg IBIS buffer models need to be used at the same time for differential pair applications. It may not be accurate if it is out of the condition when extracted.

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