IBIS Simulation Case Study: Unexpected glitch and Using C_fixture

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Outline

- Motivation
  - Unexpected glitch issue in the IBIS simulation
  - Seeking for solutions
- Case study and solutions
  - The root cause of glitch issue
  - Possible solutions
- Using C_fixture in IBIS V-T curves
- Conclusions
Motivation

- An unexpected glitch found when doing an IBIS model validation (transient analysis simulations)
  - An unexpected glitch found when we used < 450ps time step setting (called resolution setting in some EDA tools)
  - Everything is correct when we used bigger time step in the simulations
- Want to find out the root cause of this issue and solutions
The case study

- **IBIS buffer model**
  - This is normal I²C pad buffer (Open Drain type)
  - It is relatively low speed buffer
    - About 60ns for rising and 300ns for falling to be settled with 4.7K ohm load and 3.3v to pull up
The case study

- Simulation results with the same condition as V-T fixture settings

Diagram:

- ONLY appeared for Rising
- Unexpected glitch
- Using < 450ps time step
- Using bigger time step
- Normal
The case study

- A simulator bug?
  - We tried to use 5 different simulators and found all the results have the glitch issues. Only differences are the glitch levels

This is from another simulator
The case study

- **IBIS Model issue?**
  - IBIS curves are normal
  - 0 error, 0 warning from IBISCHK
  - Only Rising curve has a small “dip”
The case study

- We manually removed the “dip”. The simulation results are normal for all simulators
- So, this is the root cause. But WHY?
The root cause

Simulator works fine when the time step is bigger than the “dip down” period. It produces only 1 or 0 step in the “dip down” region. It would be “skipped” when it leads to a wrong direction.

Simulator got confused when the time step is less than the “dip down” period when it produces 2 or more steps in the “dip down” region. It leads to a wrong direction without any information from I-V curves.

The “dip” width is about 1.25ns. The dip down period is about 460ps.
Solutions

- Using large time step size in transient analysis
  - It could lead to an inaccurate result
  - The setting needs to be manually forced. A dynamic step setting feature might not work.
- Manually remove the “dip” area in IBIS Model
- Adding C_fixture to reduce or make the “dip” area “lighter” or to disappear
  - This method leads to another discussion topic in this presentation
C_fixture setting in IBIS V-T section

- C_fixture optionally can be used in IBIS V-T waveforms
- We normally do not recommend using C_fixture in V-T curves
C_fixture test case

- We used the same Spice netlist to create 2 IBIS Models. All settings are the same except C_fixture
  - Blue – without C_fixture (C_fixture = 0)
  - Orange – with C_fixture (C_fixture = 15pf)
C_fixture test case

- Use both Models with this topology

Without capacitance load

With capacitance load
Both cases correlate well with Spice simulations for C_fixture=0 IBIS Model
C_fixture test case

- The result from the load with capacitance correlate well with Spice simulations for C_fixture=15pF IBIS Model

Red – Spice  Blue – IBIS
The slight difference in results from the load without capacitance for $C_{fixture}=15\text{pF}$ IBIS Model.
C_fixture test case

- **C_fixture** can be used in IBIS V-T curves
- Simulators need to use a de-capacitance algorithm when **C_fixture** is present in the V-T curves. **C_fixture** may reduce simulation accuracy
- It is better that IBIS V-T curves only have resistance load (linear load)
Supporting C_fixture in simulations

- This is a surprise!

3 out of 6 major simulators don’t support C_fixture in IBIS Model. It got ignored!
In some simulations for a slow IBIS model, we found unexpected glitch in the result
- It is due to a “dip down” area and it could be solved by using larger time step size (resolution value)
- The “dip down” period could be removed manually or use C_fixture to reduce “dip down” area (size)

Be careful when using C_fixture
- It might cause some inaccurate simulation result
- Some simulators do not support C_fixture in IBIS model
- Recommend using linear load for V-T curves in IBIS model.