IBIS Simulation Case Study:
Unexpected Glitch and Using C_fixture

Lance Wang
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Outline

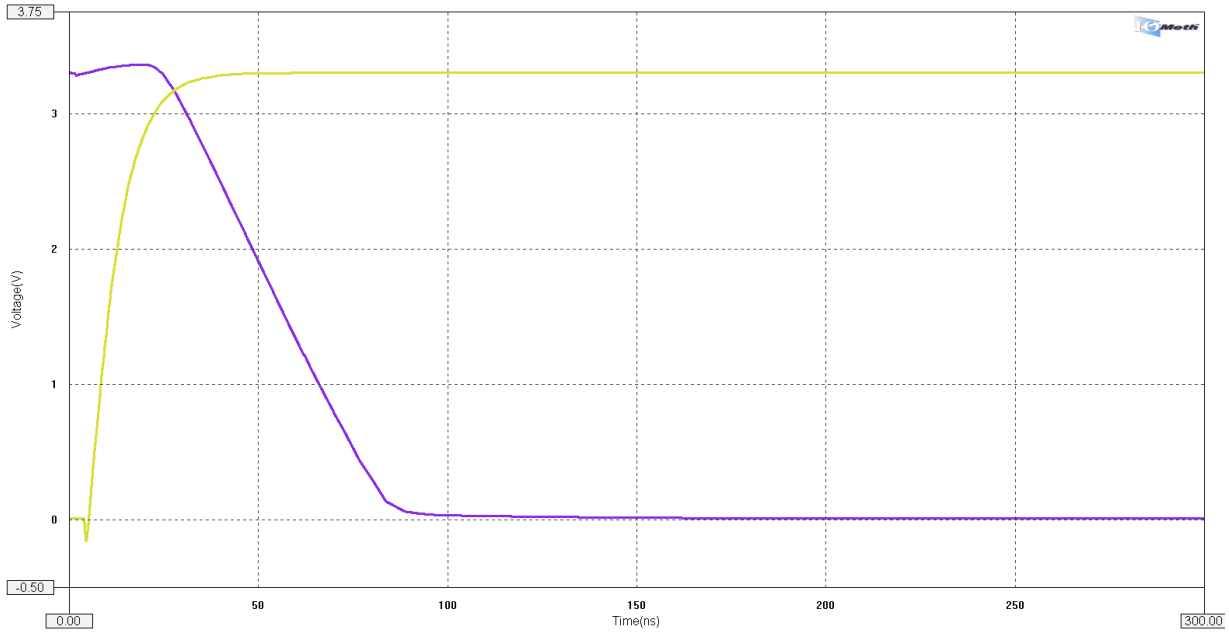
- Motivation
  - Unexpected glitch issue in the IBIS simulation
  - Seeking for solutions
- Case study and solutions
  - The root cause of glitch issue
  - Possible solutions
- Using C_fixture in IBIS V-T curves
- Conclusions

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

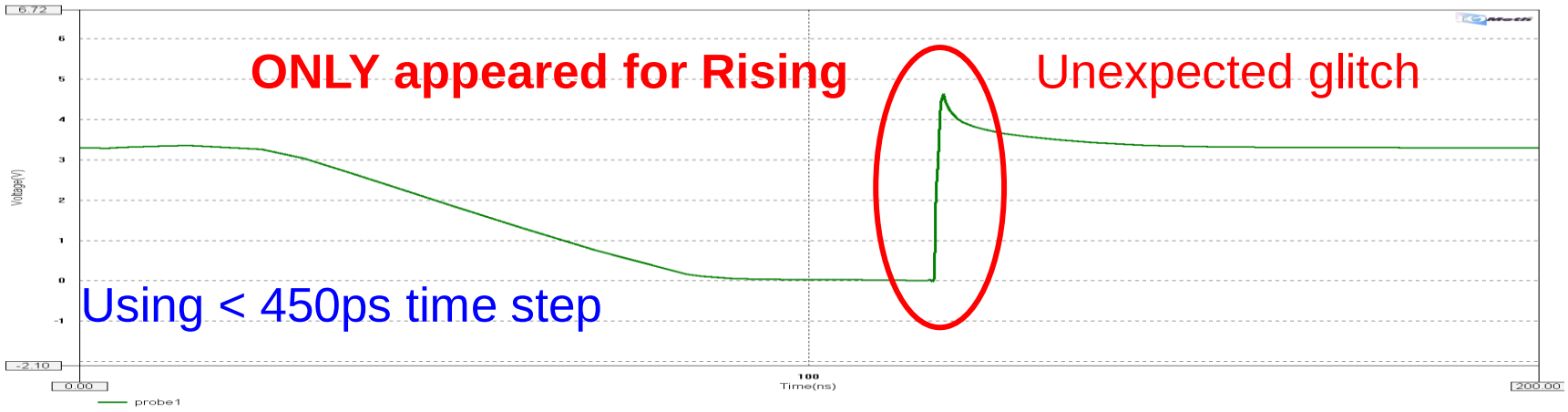
The case study

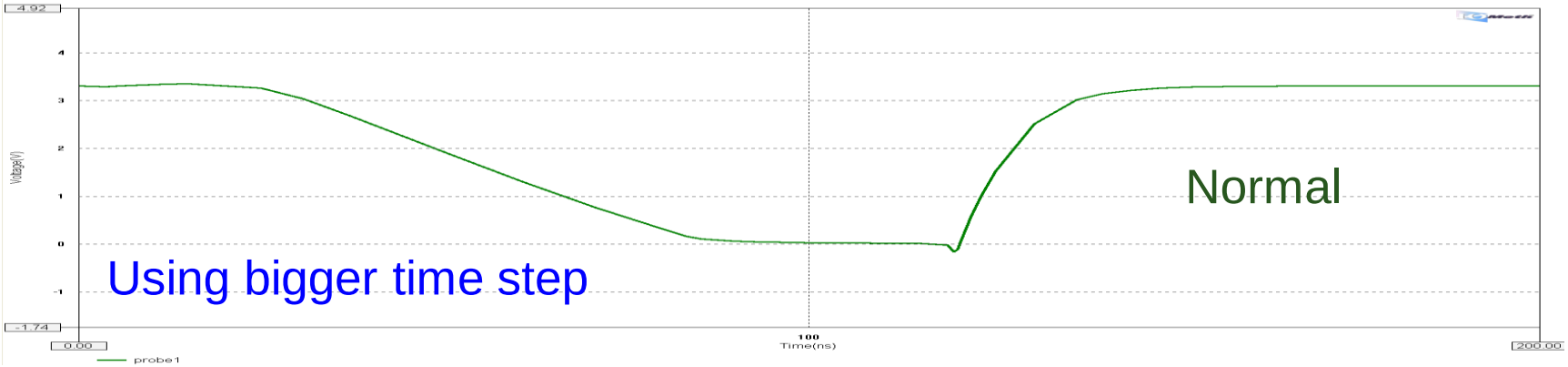
- IBIS buffer model
  - This is normal I^2C pad buffer (Open Drain type)
  - It is relatively low speed buffer
    - About 60ns for rising and 300ns for falling to be settled with 4.7K ohm load and 3.3v to pull up



The case study

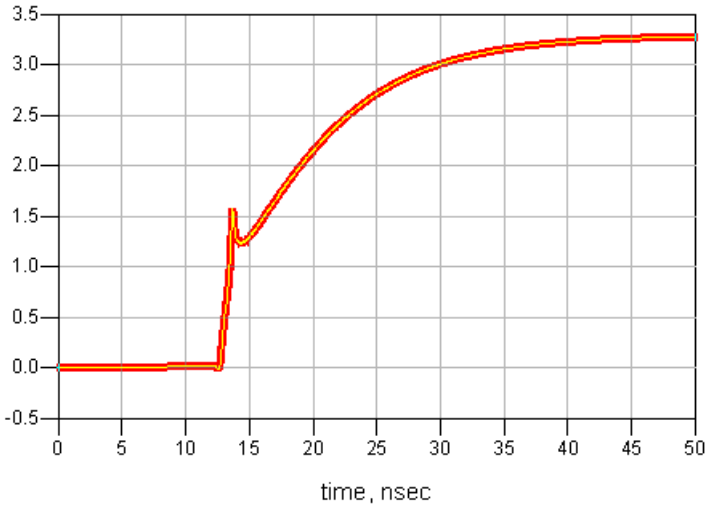
- Simulation results with the same condition as V-T fixture settings





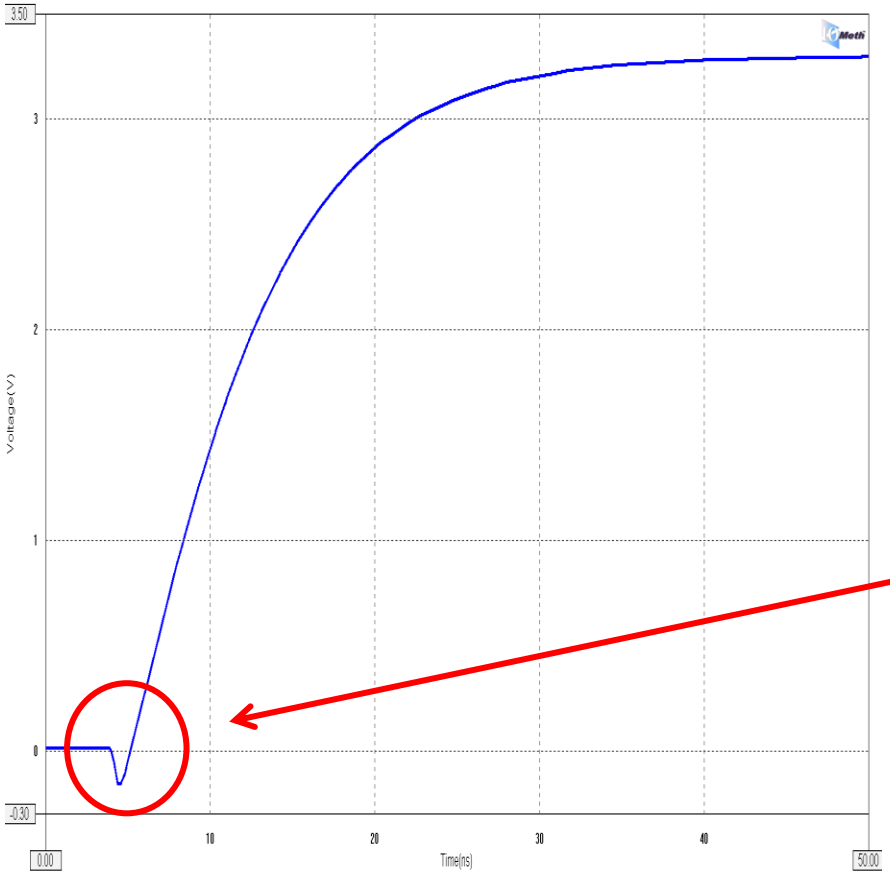
The case study

- 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

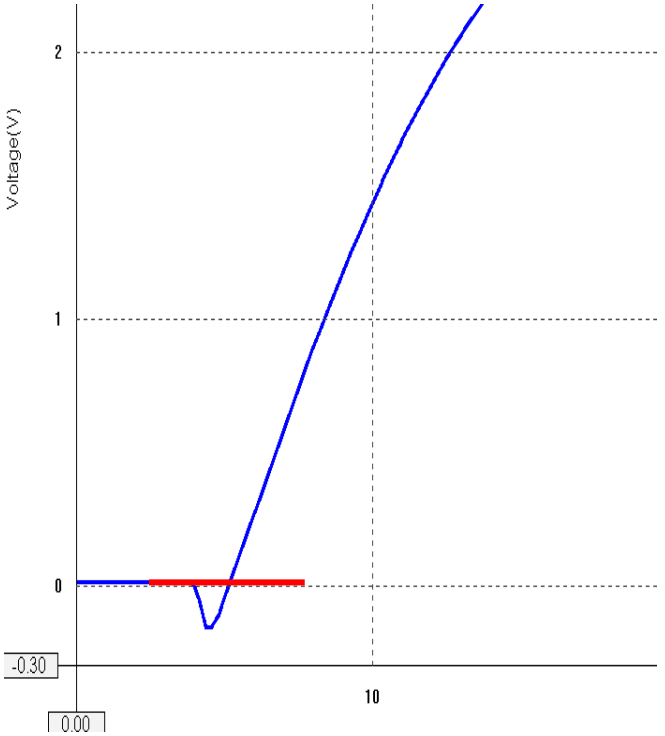
The case study



- 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?

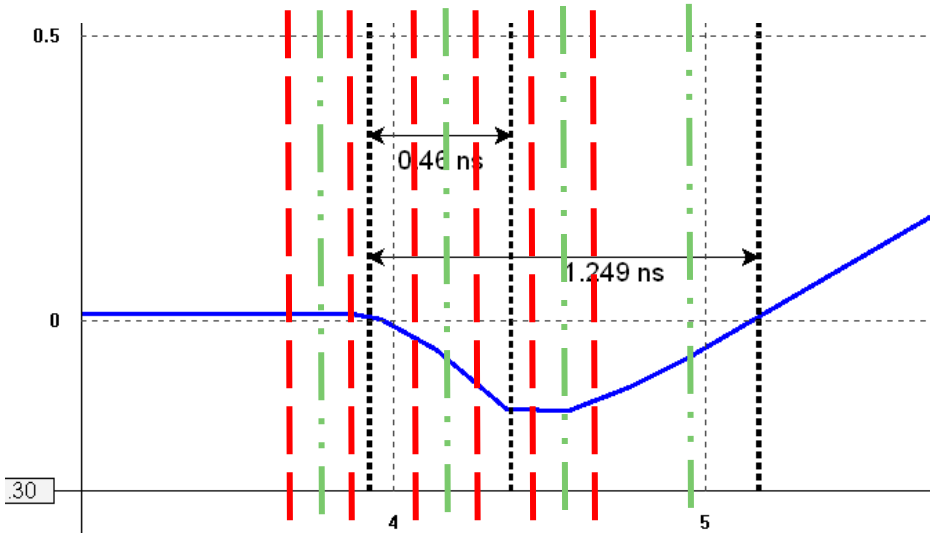


The root cause

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.

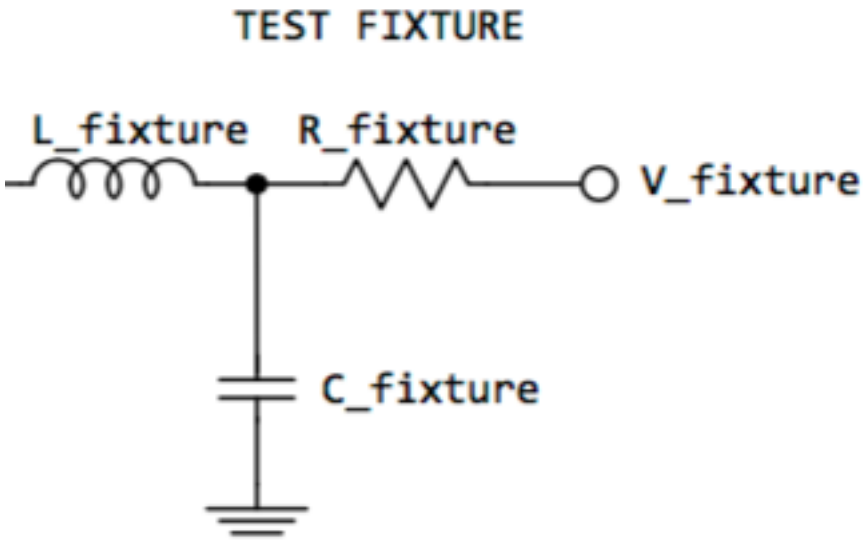


Solutions

- 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

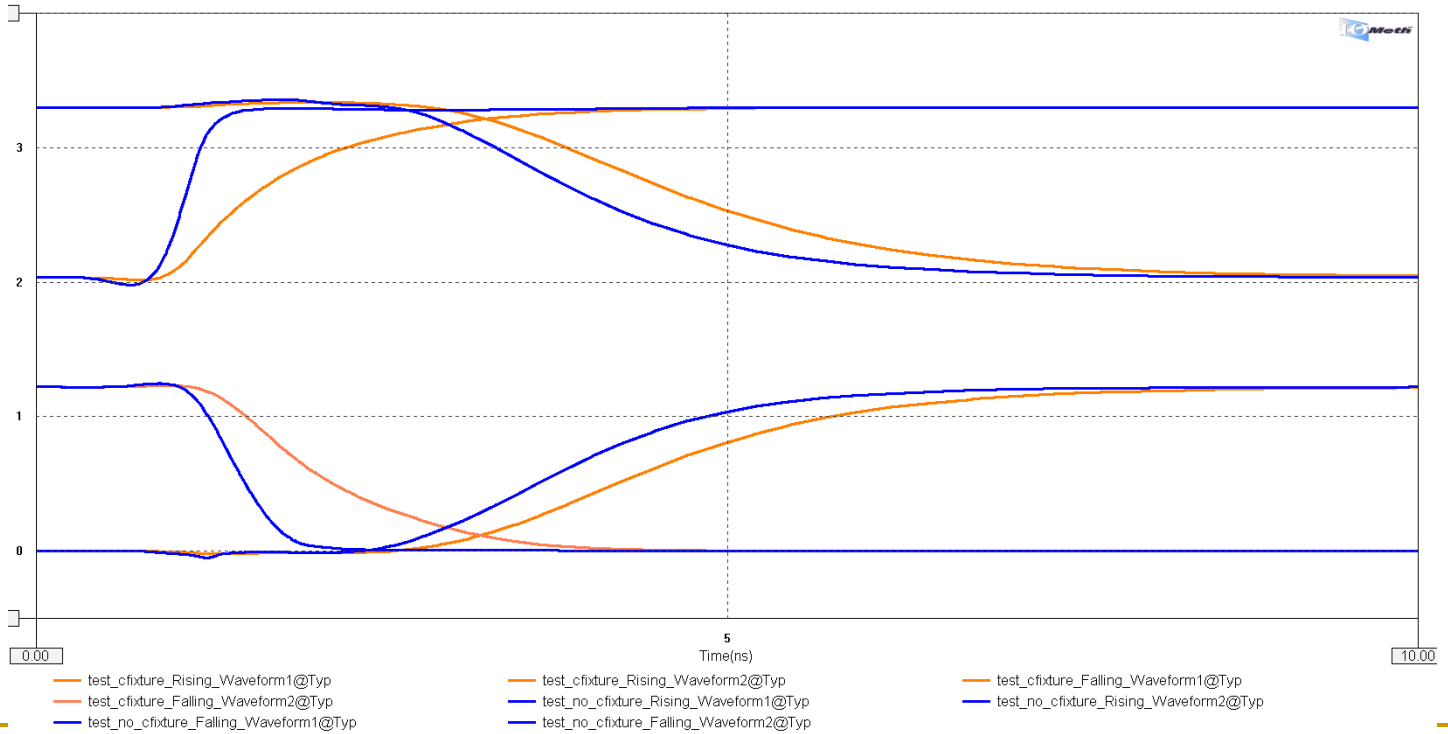
C_fixture setting in IBIS V-T section

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



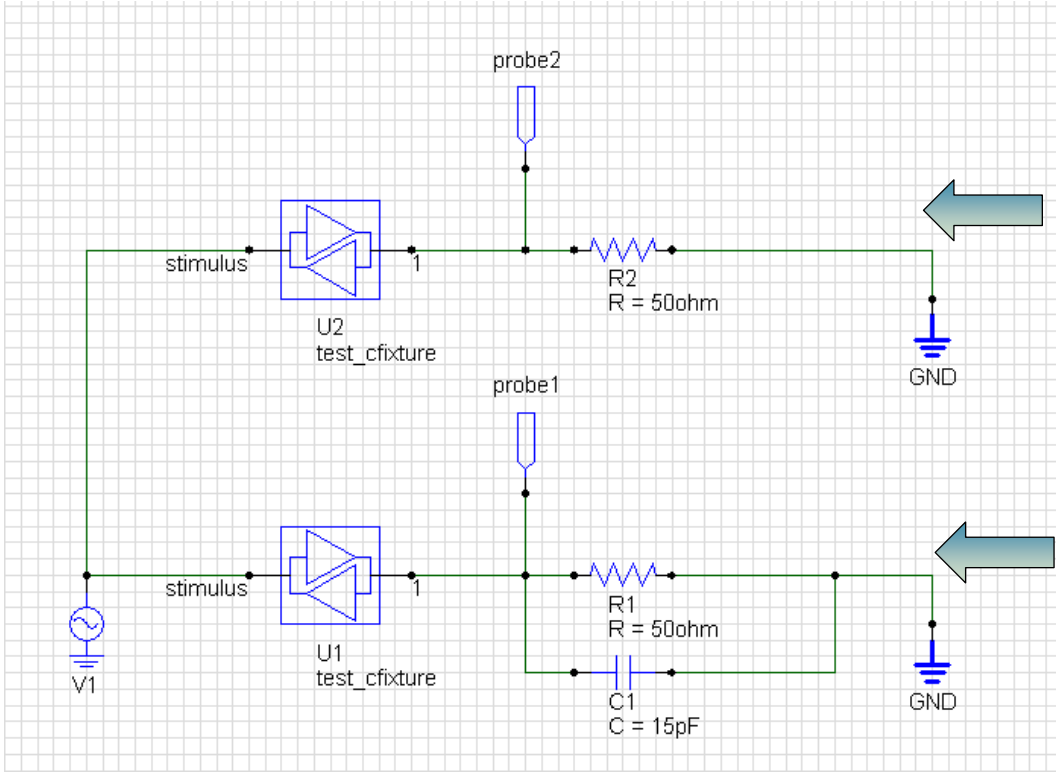
C_fixture test case

- 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

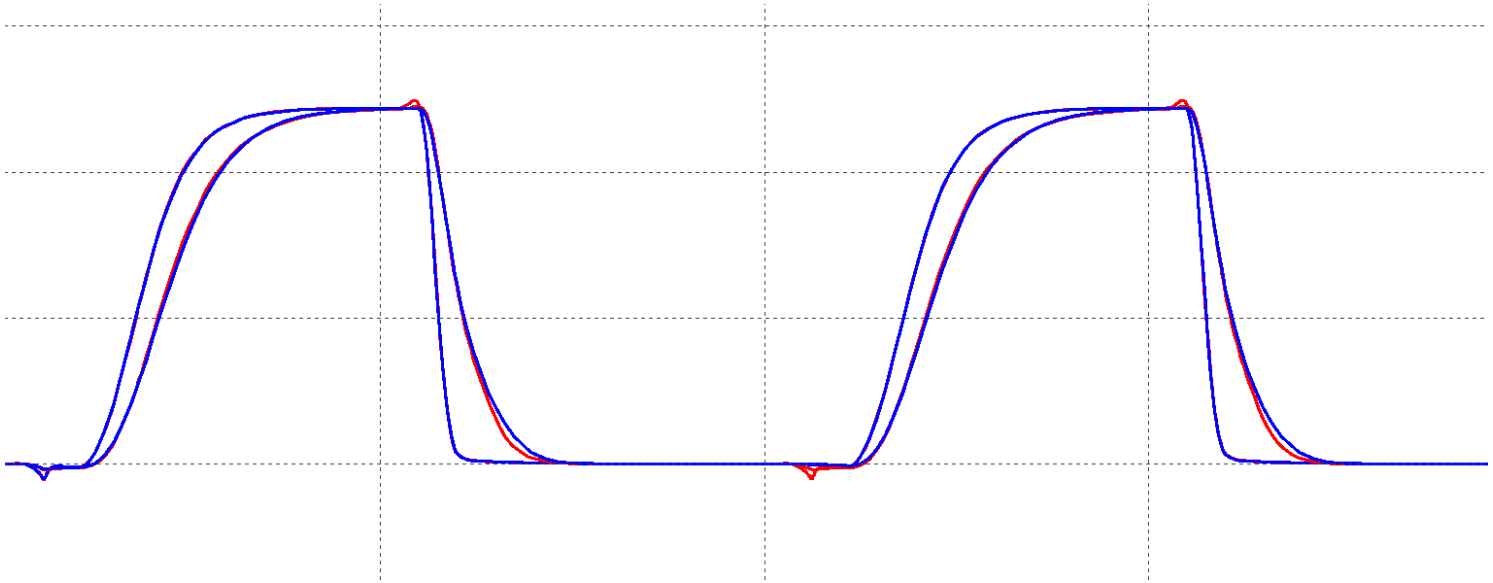


Without capacitance load

With capacitance load

C_fixture test case

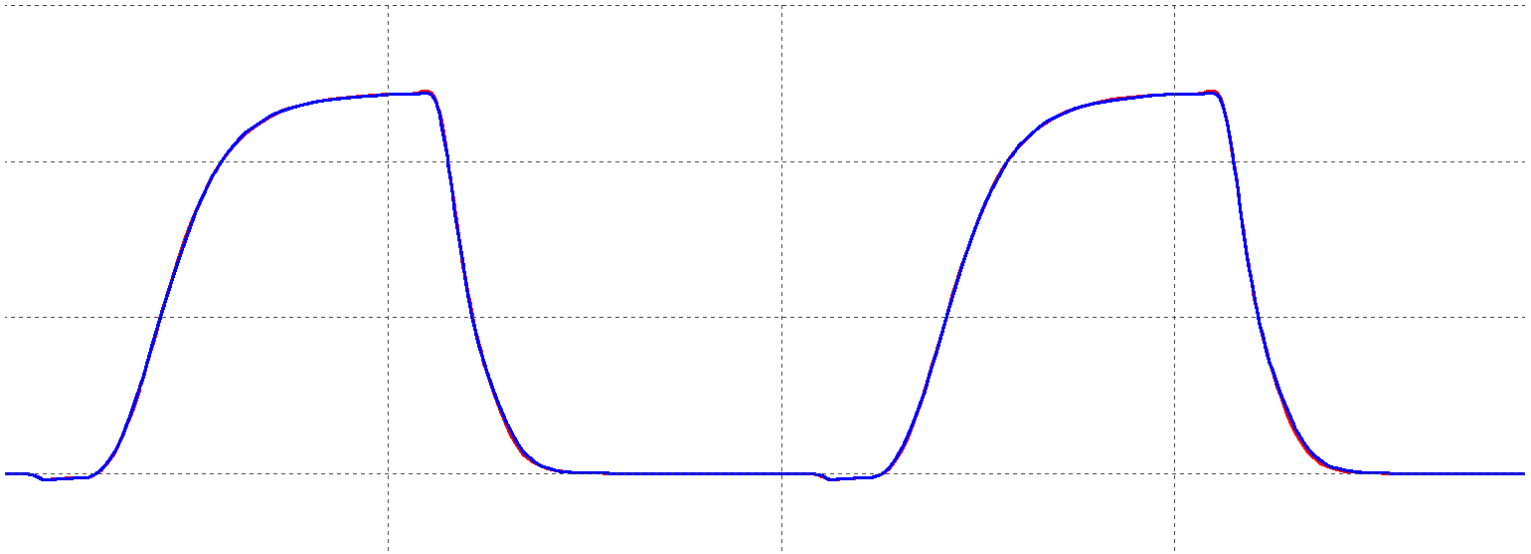
- Both cases correlate well with Spice simulations for C_fixture=0 IBIS Model



Red – Spice Blue – IBIS

C_fixture test case

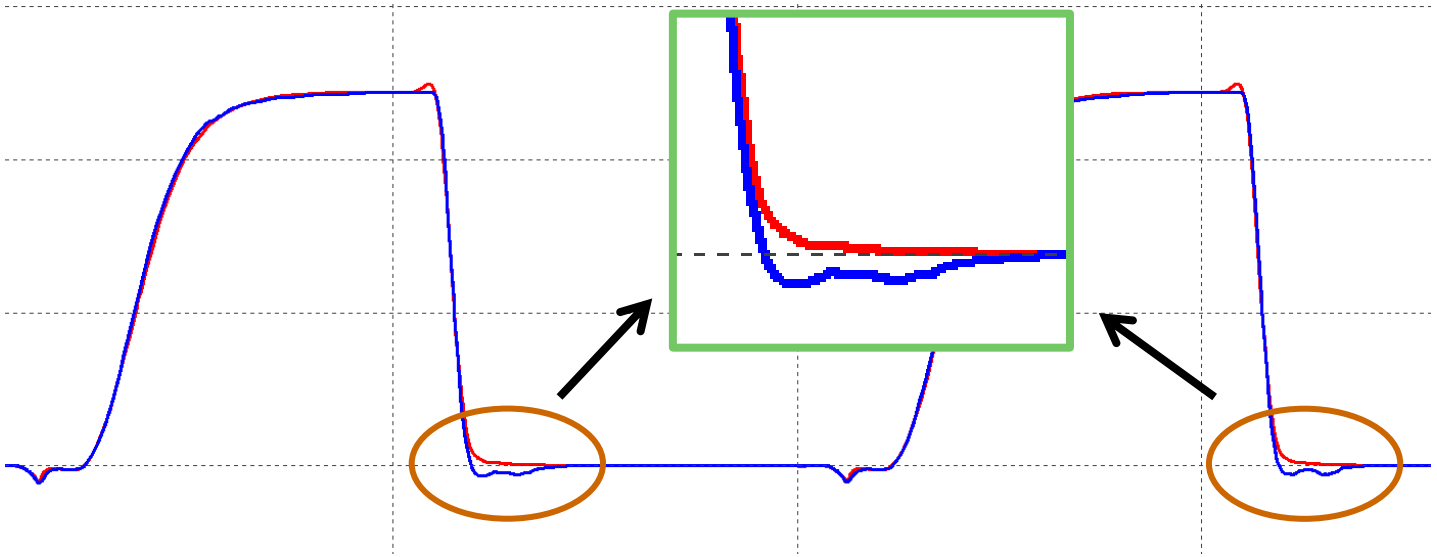
- The result from the load with capacitance correlates well with Spice simulations for C_fixture=15pF IBIS Model



Red – Spice Blue – IBIS

C_fixture test case

- The slight difference in results from the load without capacitance for C_fixture=15pF 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!

Summary

- 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 results
  - Some simulators do not support C_fixture in IBIS model
  - Recommend using linear load for V-T curves in IBIS model.

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