New Table-based Keywords in IBIS 5.0
A Cookbook-style Guide

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IBIS Development

- Advanced Modeling Interface (AMI)
- Gate modulation support
- Current distribution support

- Added analog-only support (Verilog-A)
- Fixes for standardization

- Links to Verilog-AMS, VHDL-AMS and Berkeley SPICE files
- Differential thresholds, loads

- New meas. & delay loads
- Golden Waveforms and loads

- All IBIS 2.1 features plus
- Package modeling
- Series devices
- Scheduled drivers

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Two New IBIS 5.0 Table-Based Keywords

- **[ISSO_PD]**, **[ISSO PU]**
  - Originally called BIRD97/98
  - Characterizes buffer current modulation due to supply variation
    - For example, SSO, “droop” or “bounce” events
    - Tools today scale the [Pulldown]... I-V tables, which is inappropriate
  - Each one a table of current vs. voltage (I-V) data, per corner

- **[Composite Current]**
  - Originally called BIRD95
  - Characterizes currents from the supply rail through the buffer, as the buffer switches into a known load
  - A table of current vs. time (I-t) data, per corner
  - Resolves ambiguous rail current distribution from known pad current
    - For example, can capture crowbar and/or pre-driver currents
    - Tools today “guess” at buffer current distributions

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ISSO_PD

- **How is it extracted?**

  Short-circuit effectively removes the pullup section

  Pulldown section is “on” (buffer at logical 0)

Measure the current as voltage is swept from −Vcc to Vcc

**Results**

An I-V table that characterizes pulldown strength as its reference voltage varies...

Similar to but different than [Pulldown], which characterizes output strength with fixed reference

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**ISSO_PU**

- *How is it extracted?*

Pullup section is “on” (buffer at logical 1)

Short-circuit effectively removes the pulldown section

- Measure the current as voltage is swept from –Vcc to Vcc (relative to Vcc!)

**Results**

An I-V table that characterizes pullup strength as its reference voltage varies...

Similar to but different than [Pullup], which characterizes output strength with *fixed* reference

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ISSO_PD

- What does the resulting waveforms look like?

Diode effects should be removed from the raw data

Simple example: no pre-driver, single-stage CMOS

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**ISSO_PD, ISSO PU - Recommendations**

- Ensure that extraction polarities are correct
  - *Similar to sweep sources for [Pullup], [Pulldown]*

- Watch out for clamp currents
  - *Clamp currents should be excluded from ISSO tables*
  - *This includes on-die termination effects!*

- Watch out for reference voltages
  - *[Pullup Reference], [Pulldown Reference], etc. still apply*

- Beware of what isn’t included
  - *ISSO keywords describe the final driver stage, not the pre-driver*
  - *The keywords describe static, not dynamic, current modulation*

**Very similar to traditional I-V tables**
Composite Current

- How is it extracted?

On-die decoupling

Classical IBIS Buffer

Rail Parasitics

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Composite Current

- *What does the resulting waveform look like?*

*Watch for noise...*

Wave shapes will be similar to [Rising ...] and [Falling Waveform] V-t tables.

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Composite Current - Recommendations

- Supply sufficient data, ideally including...
  - *Tables using the same load as [Rising...] and [Falling Waveform]*
  - *Tables for no-load conditions (extremely high resistances)*
- Ensure the data is time-correlated to existing V-t tables
  - *Must start and end in states and with delays matching associated [Rising Waveform] and [Falling Waveform] tables*
- Make the power delivery structure is complete and includes...
  - *Buffer rail inductances and resistances*
  - *Pre-driver structures (if/when connected to the driver rails)*
  - *On-die decoupling structures, at buffer-level scale*
- Follow the same rules as for V-t tables
  - *Provide sufficient time-points for smooth transitions*
  - *Use resistive-only loads*

Very similar to traditional V-t tables but using currents

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Additional Notes

• Support
  • *IBISCHK5 parser should be available in the first half of 2009*
  • *No tools today support these keywords, or automatically extracting data for them*

• Today’s Options
  • *SPICE templates can be created to extract the data manually*
  • *Composite Current data can be used with existing models in a SPICE implementation (see References)*
  • *The IBIS 5.0 specification contains guidance on [ISSO_PD], [ISSO_PU] adjustments to how I-V and V-t data interact*
Summary

• \texttt{[ISSO\_PD], [ISSO\_PU]}
  • Characterize buffer supply voltage modulation
  • Resembles traditional I-V tables like \texttt{[Pulldown]}
  • Can capture gate variation, bounce and droop effects

• \texttt{[Composite Current]}
  • Characterizes buffer current distribution
  • Resembles traditional V-t tables like \texttt{[Rising Waveform]}
  • Can reveal and include crowbar current effects

Start collecting data now, and encourage your model and EDA tool providers to support these keywords!
**References**

- Official IBIS Website, including tools, articles, specifications
  - [http://www.eigroup.org/ibis/](http://www.eigroup.org/ibis/)

- IBIS Specification 5.0
  - [http://www.eda.org/ibis/ver5.0/](http://www.eda.org/ibis/ver5.0/)

- IBIS Summit presentations
  - [http://www.eda-stds.org/ibis/summits/index-bydate.htm](http://www.eda-stds.org/ibis/summits/index-bydate.htm)
  - Excellent presentations in 2005 and 2006 cover BIRD 95 and 97/98

- Test Code and Development Documents
  - [http://www.eda.org/ibis/docs/](http://www.eda.org/ibis/docs/)

- The IBIS 4.0 Cookbook – recommended for model creation!

- Join the IBIS and IBIS-Users e-mail reflectors!
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