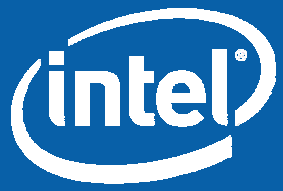

New Table-based Keywords in IBIS 5.0

A Cookbook-style Guide

Michael Mirmak
Intel Corporation
Chair, IBIS Open Forum
michael.mirmak@intel.com

マイケルマーマク
インテルコーポレーション
会長，アイビス

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IBIS Development

ANSI standard

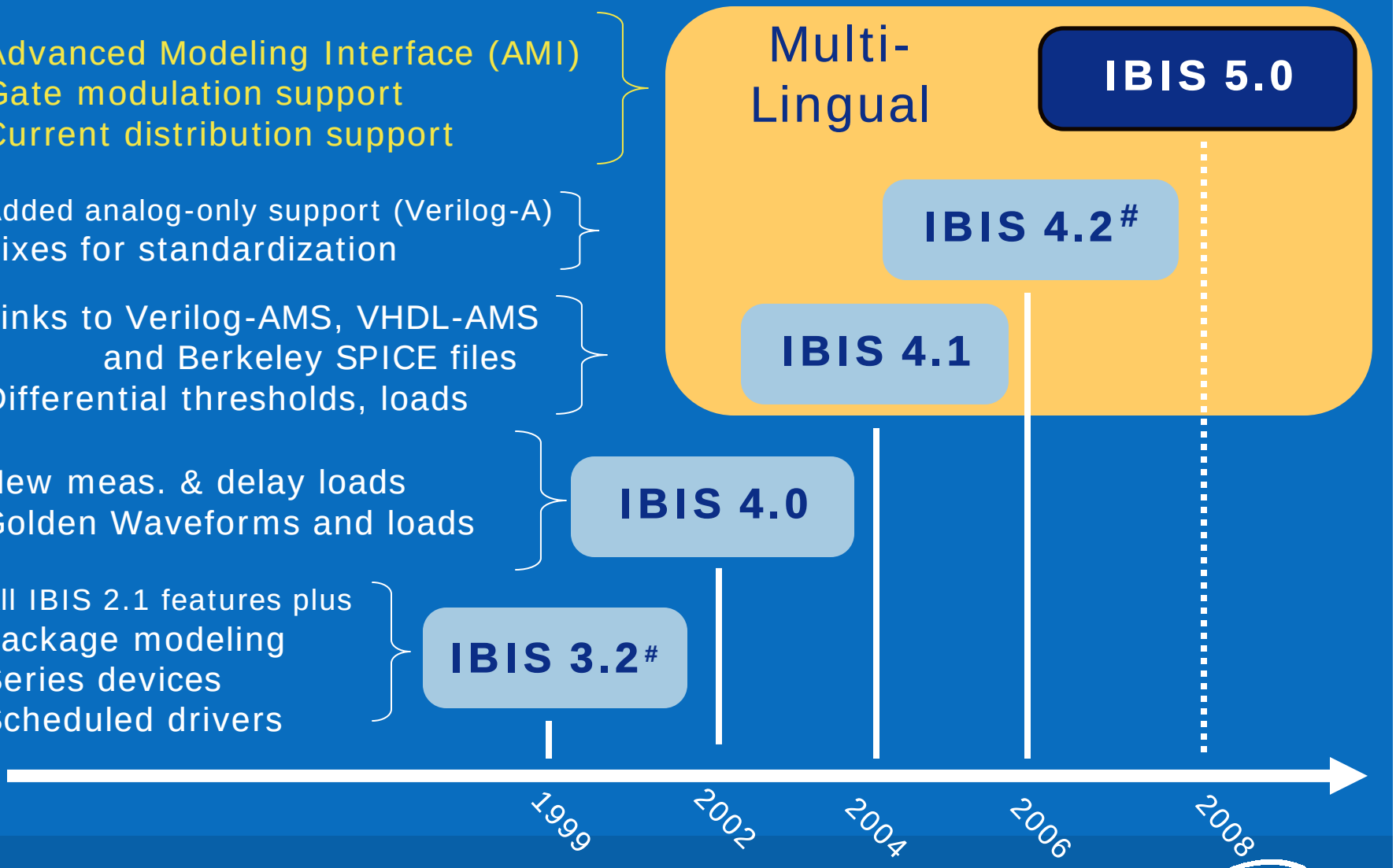
- Advanced Modeling Interface (AMI)
- Gate modulation support
- Current distribution support

- 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



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*

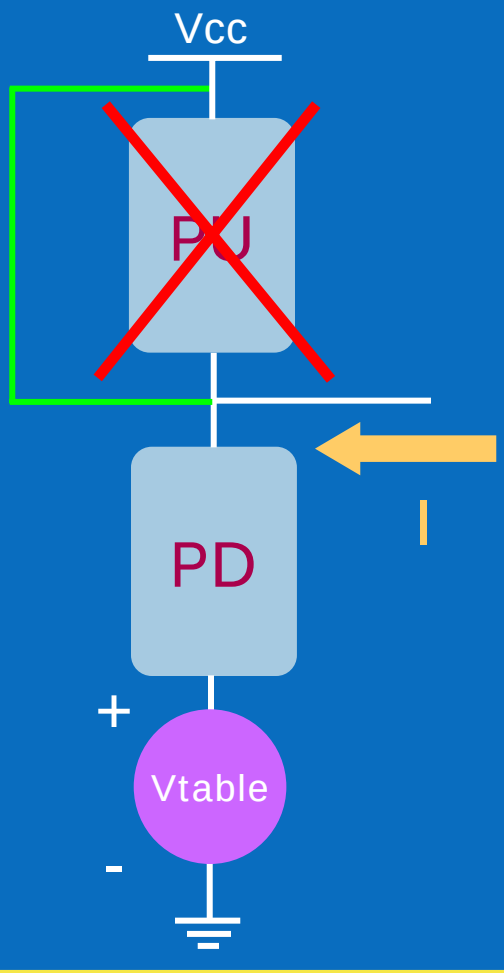
- [Composite Current]
  - *Originally called BIRD95*
  - *Characterizes currents from the supply rail through the buffer, as the buffer switches into a known load*
  - *A table of current vs. time (I-t) data, per corner*
  - *Resolves ambiguous rail current distribution from known pad current*
    -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

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

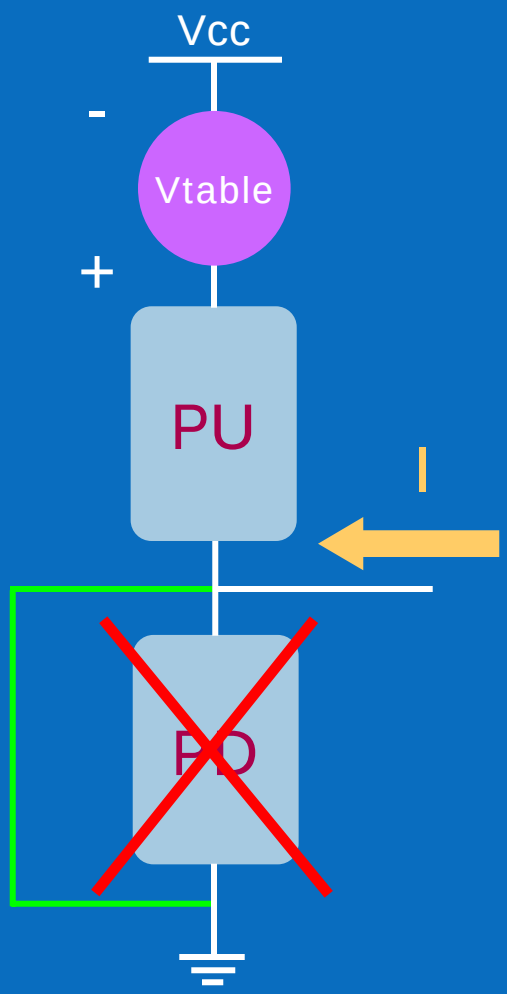
<u>Results</u>

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

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!)

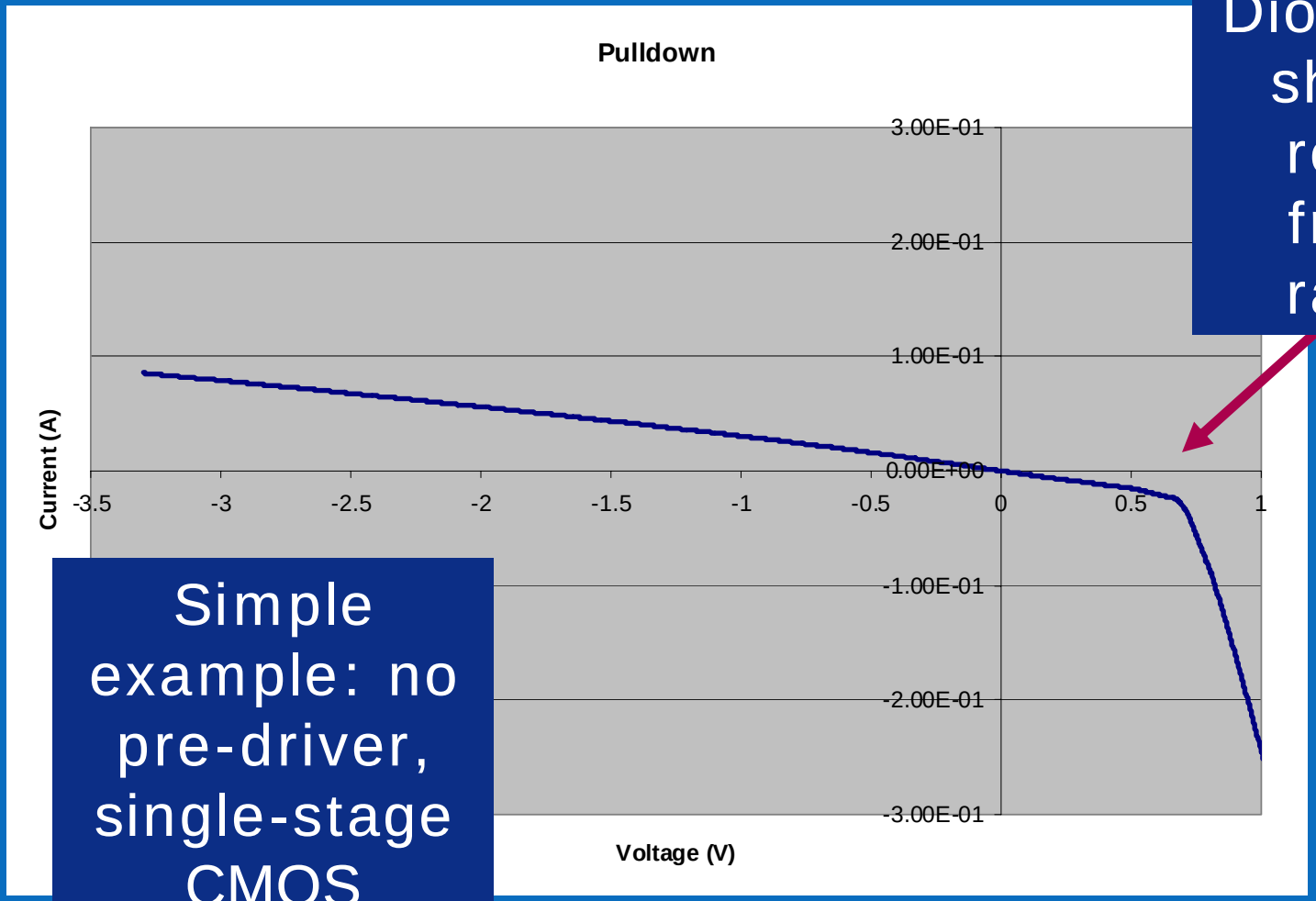
Results

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

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

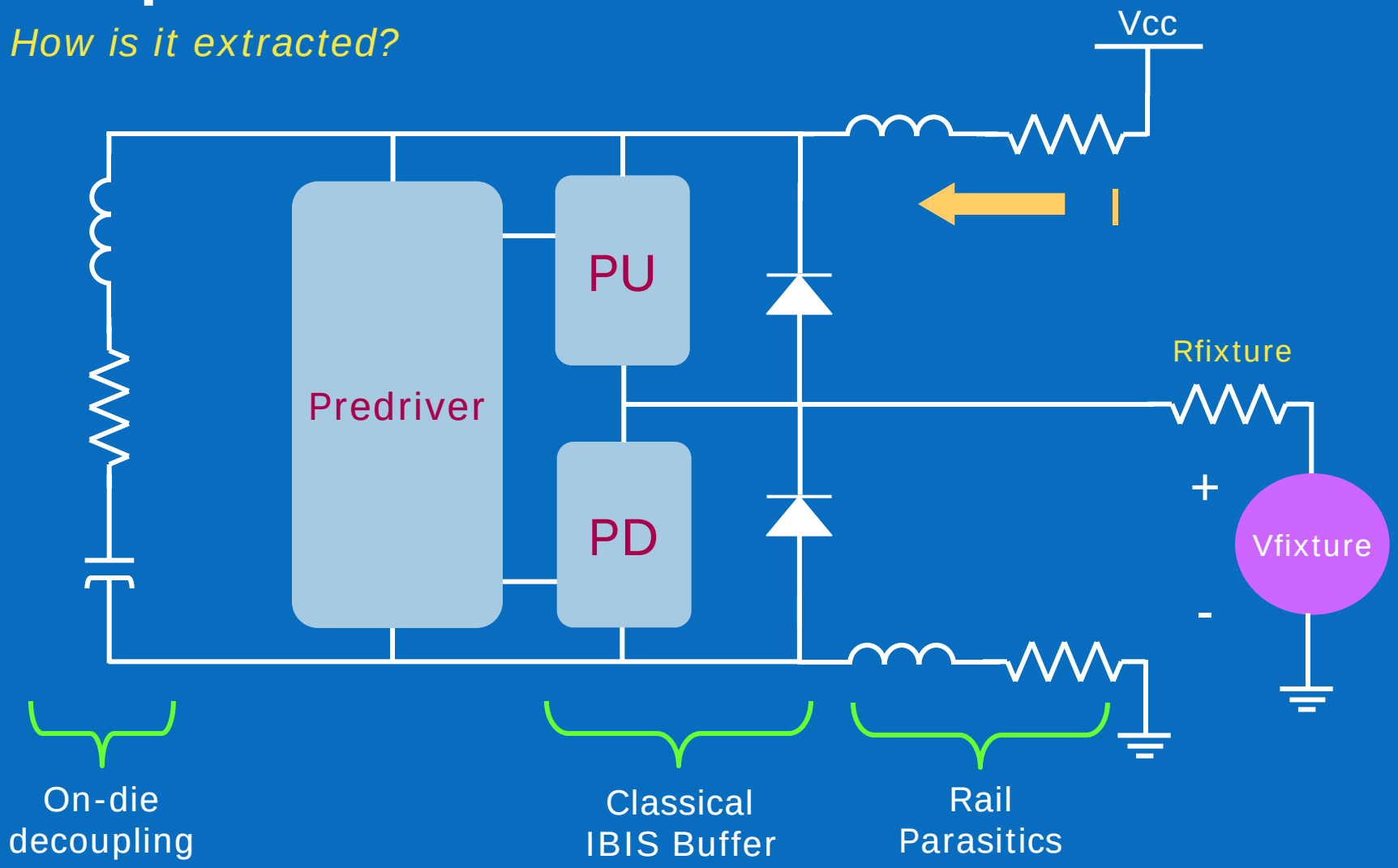
ISSO_PD, ISSO_PU - Recommendations

- 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

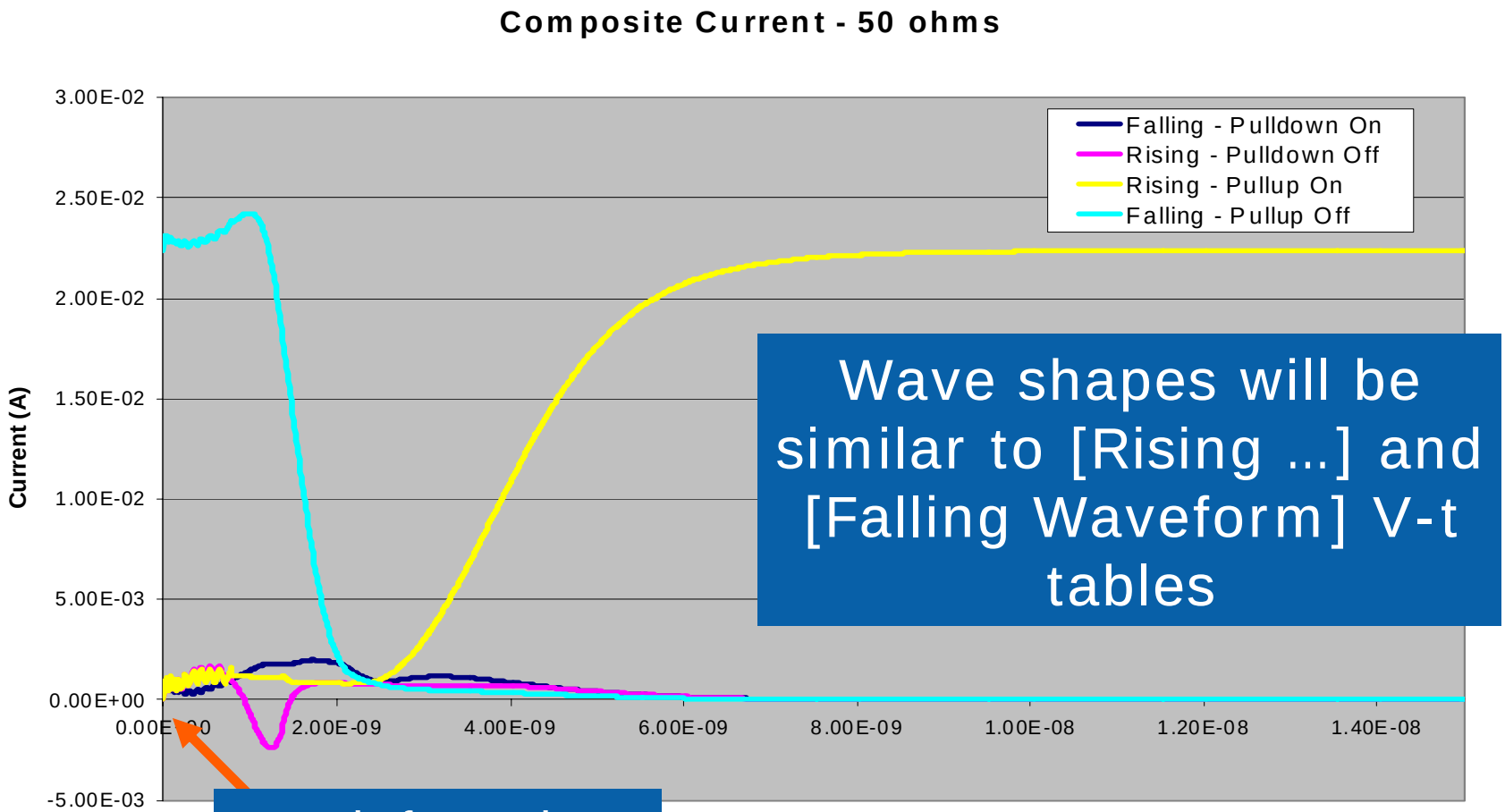
Composite Current

- *How is it extracted?*



Composite Current

- *What does the resulting waveform look like?*



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 similar rules as used for V-t tables
  - *Provide sufficient time-points for smooth transitions*
  - *Use resistive-only loads*

Very similar to traditional V-t tables
except using currents

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

- [ISSO_PD], [ISSO_PU]
  - *Characterize buffer supply voltage modulation*
  - *Resembles traditional I-V tables like [Pulldown]*
  - *Can capture gate variation, bounce and droop effects*

- [Composite Current]
  - *Characterizes buffer current distribution*
  - *Resembles traditional V-t tables but using currents*
  - *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/
- IBIS Specification 5.0
  - http://www.eda.org/ibis/ver5.0/
- IBIS Summit presentations
  - 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.vhdl.org/pub/ibis/futures/
  - http://www.eda.org/ibis/docs/
- The IBIS 4.0 Cookbook – recommended for model creation!
  - http://www.eda-stds.org/ibis/cookbook/
- Join the IBIS and IBIS-Users e-mail reflectors!