More on IBIS Modeling for Load-Dependent Current-Mode Differential Drivers

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Outlines

- Motivation

- Load-Dependent Current-Mode Differential Driver

- IBIS Extraction Method
  - Legacy method
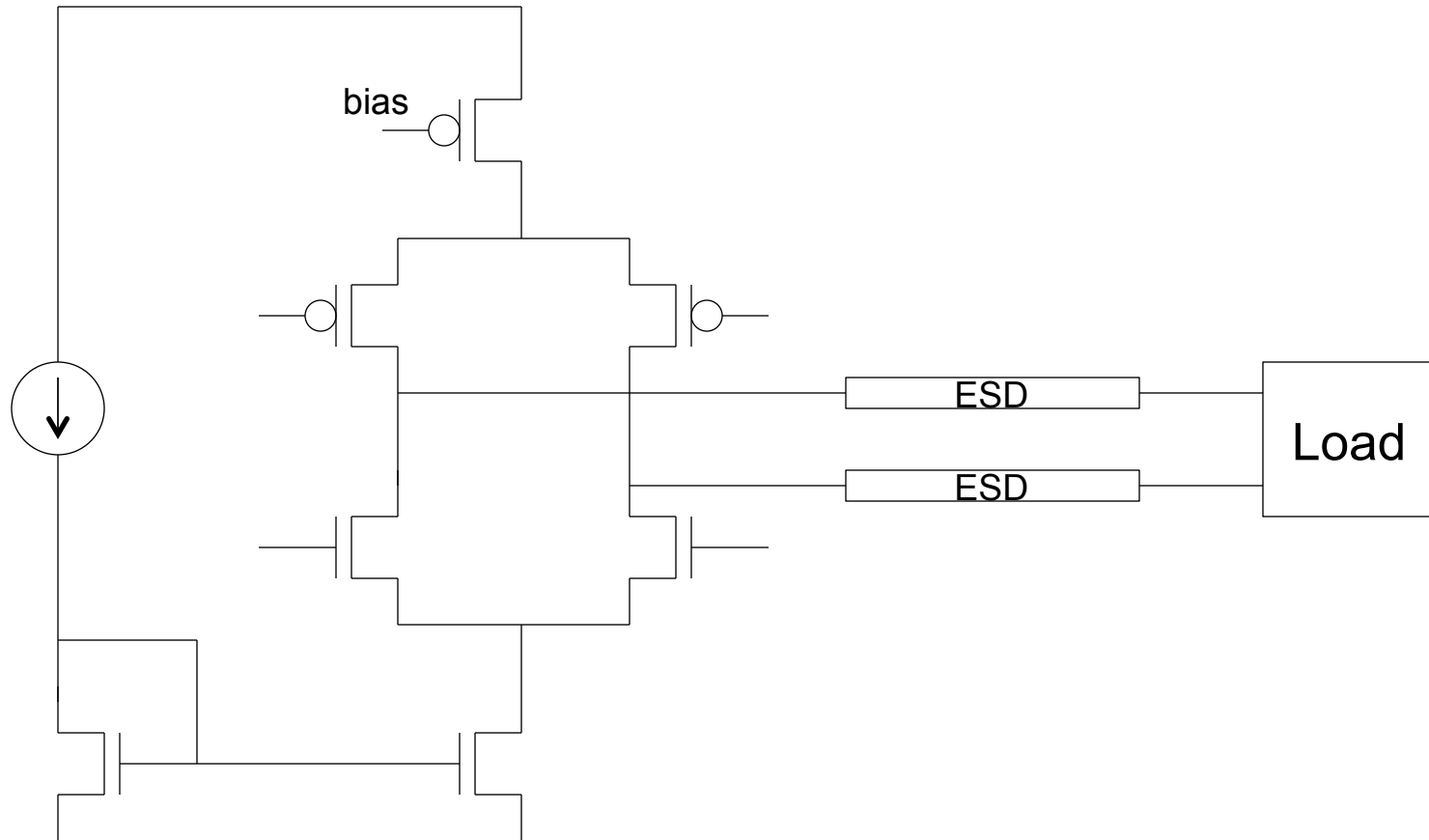 - Enhanced extraction method

- Summary

Note: The partial materials in this presentation have been presented in 2013 European IBIS Summit in Paris
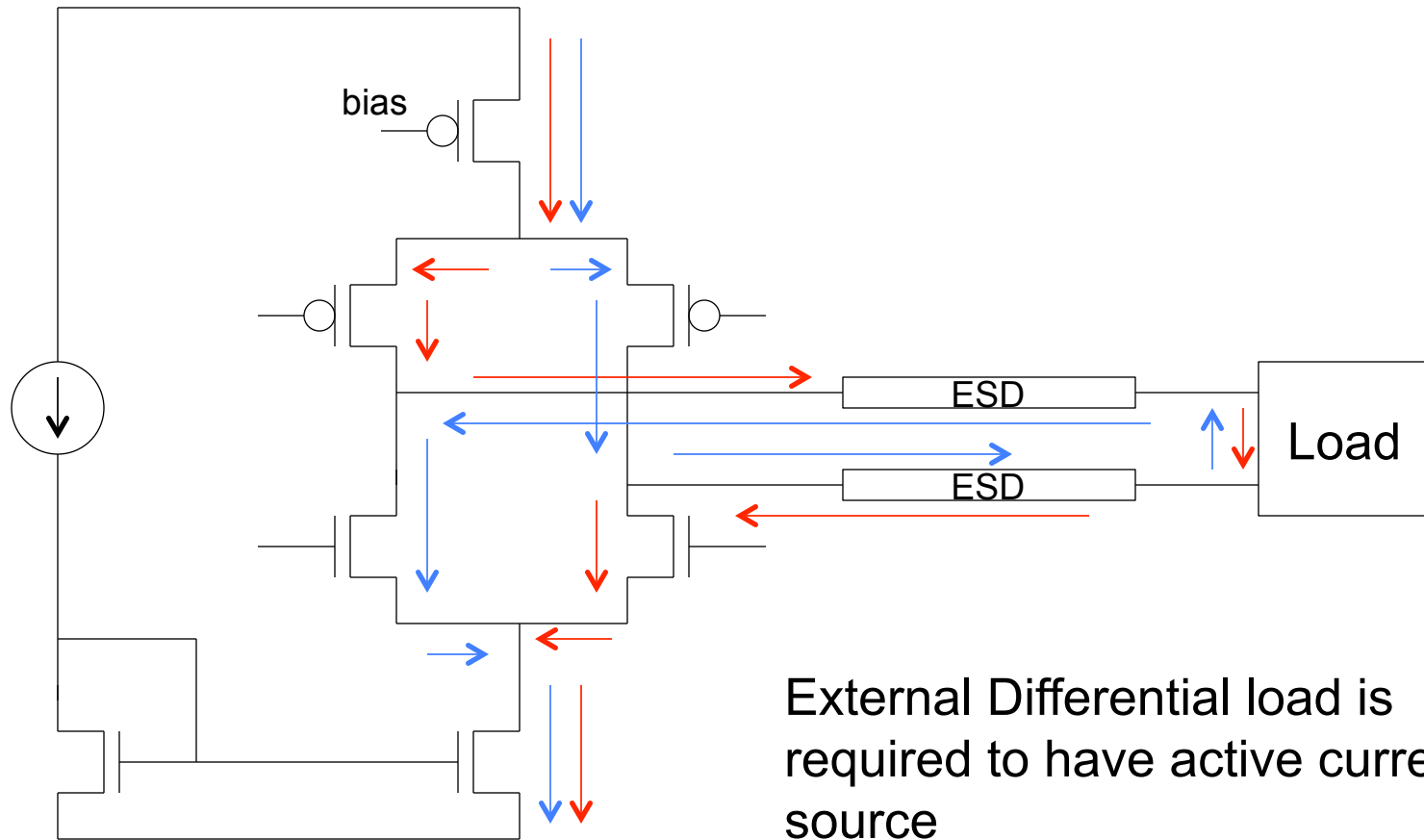
Motivation

- Load-dependent current-mode differential pair buffers are found increasingly often in GHz serial link designs
  - Easy to control the output current and common-mode voltage
  - Often used in pre-emphasis buffers
- Using traditional IBIS buffer extraction method is not accurate enough

Is it possible to use the current IBIS spec for this kind of differential buffer?

Load-Dependent Current-Mode Differential Driver

bias

ESD

ESD

Load

Load-Dependent Current-Mode Differential Driver (Current Flow)

bias

ESD

ESD

Load

External Differential load is required to have active current source

IBIS Extraction Method (Modeling as 2 individual pins)

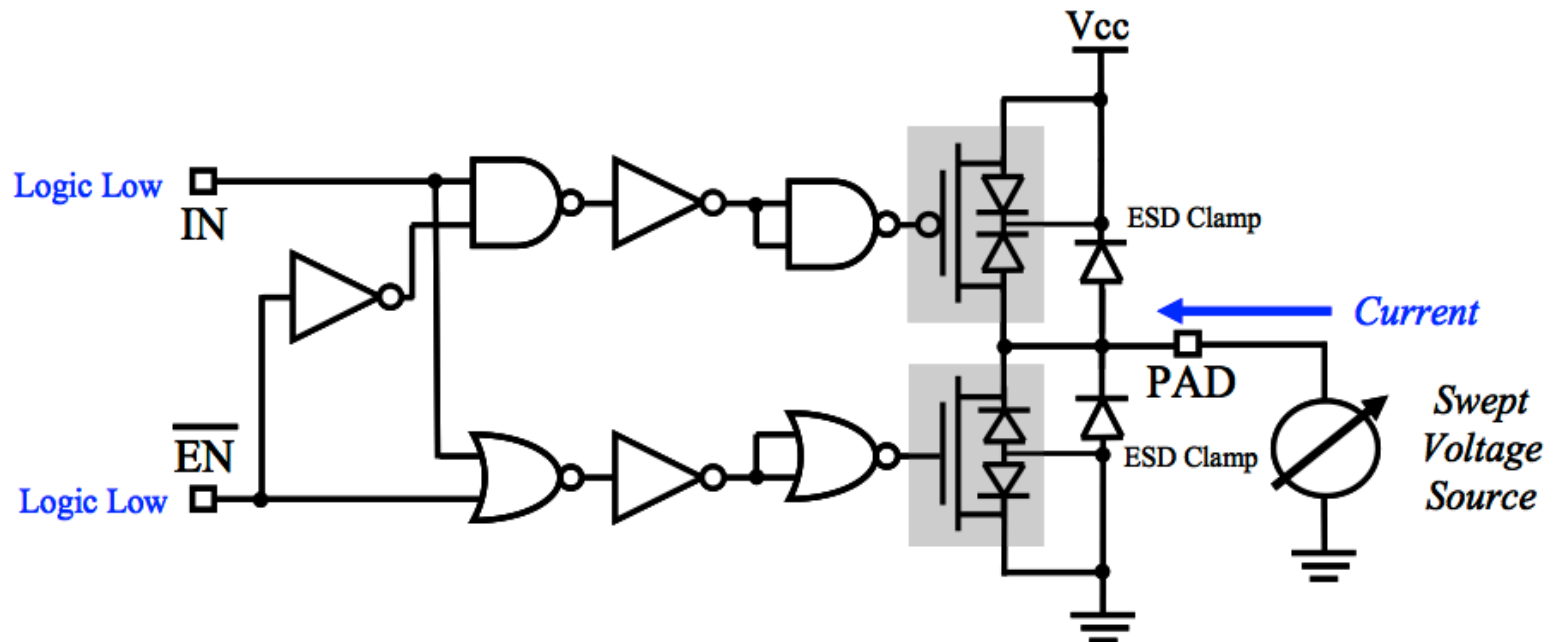No load to be used for I-V curve extraction

Figure 3.1 – Standard 3-state Buffer (Pulldown I-V Table Extraction Shown)

Pictures from IBIS cookbook

IBIS Extraction Method (Modeling as 2 individual pins)

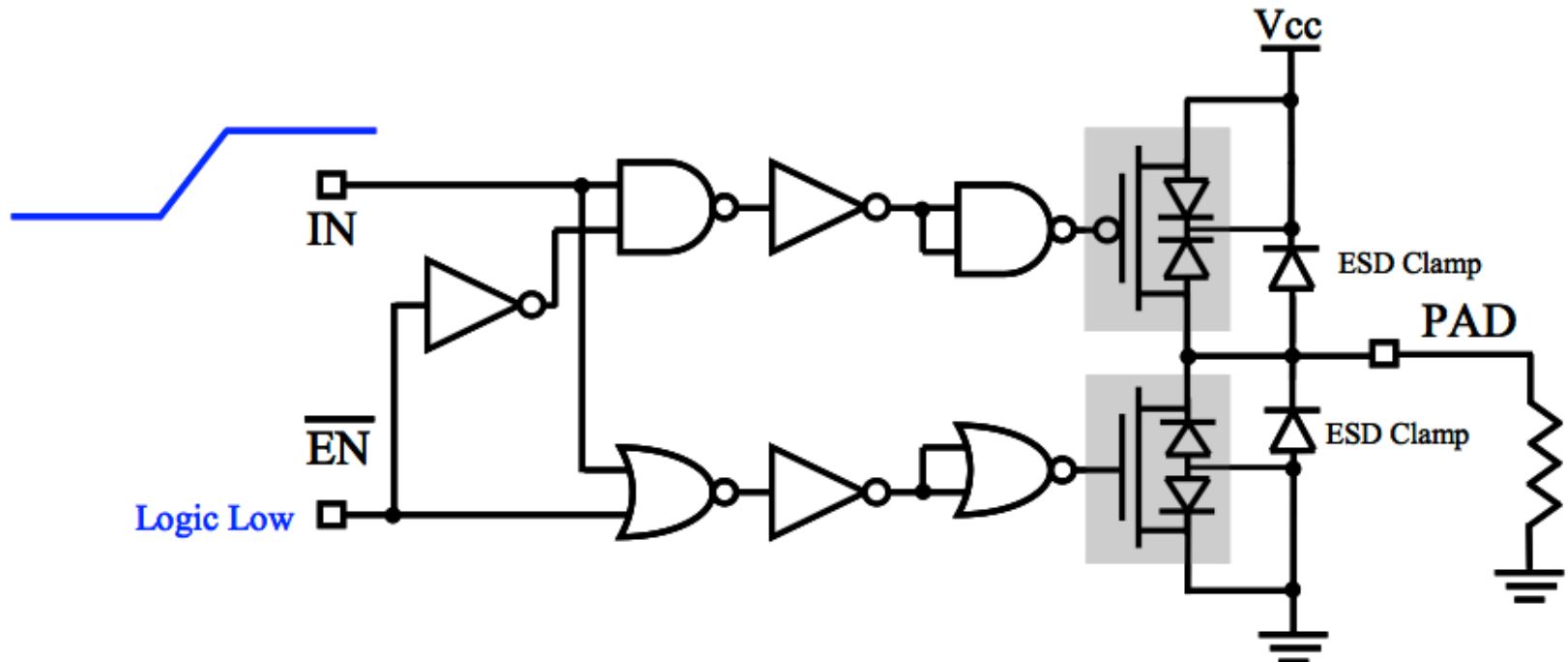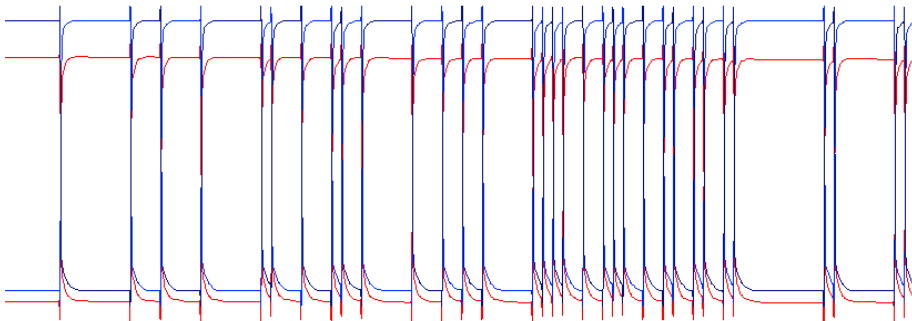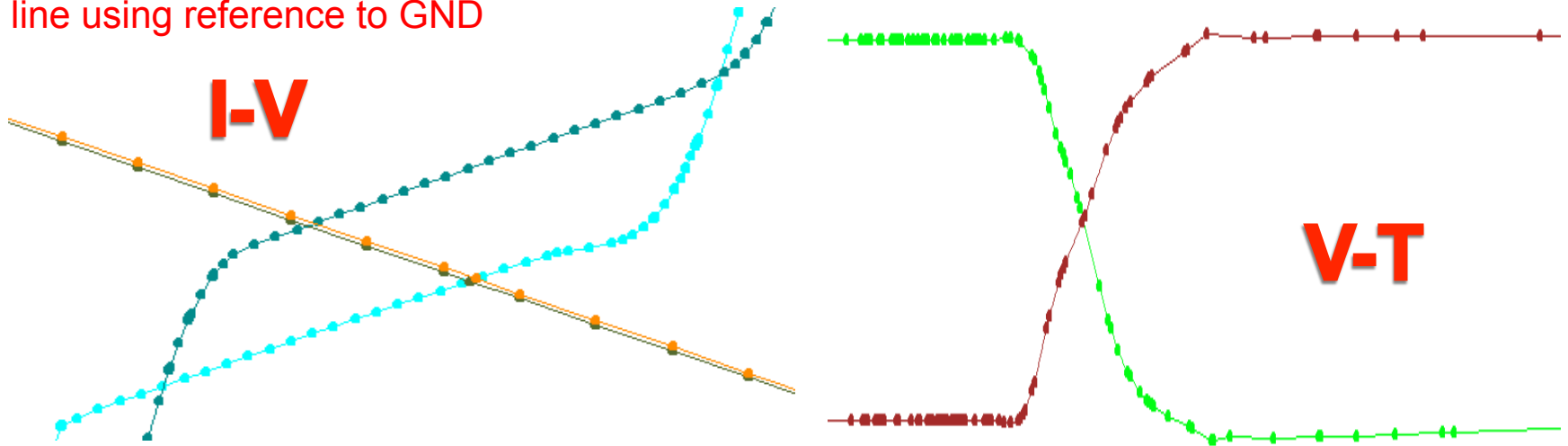Load connected to GND or VCC to be used for V-T curve extraction

Figure 3.2 – Simulation Setup for Extracting Ramp Rate Information (Rising Edge Shown)
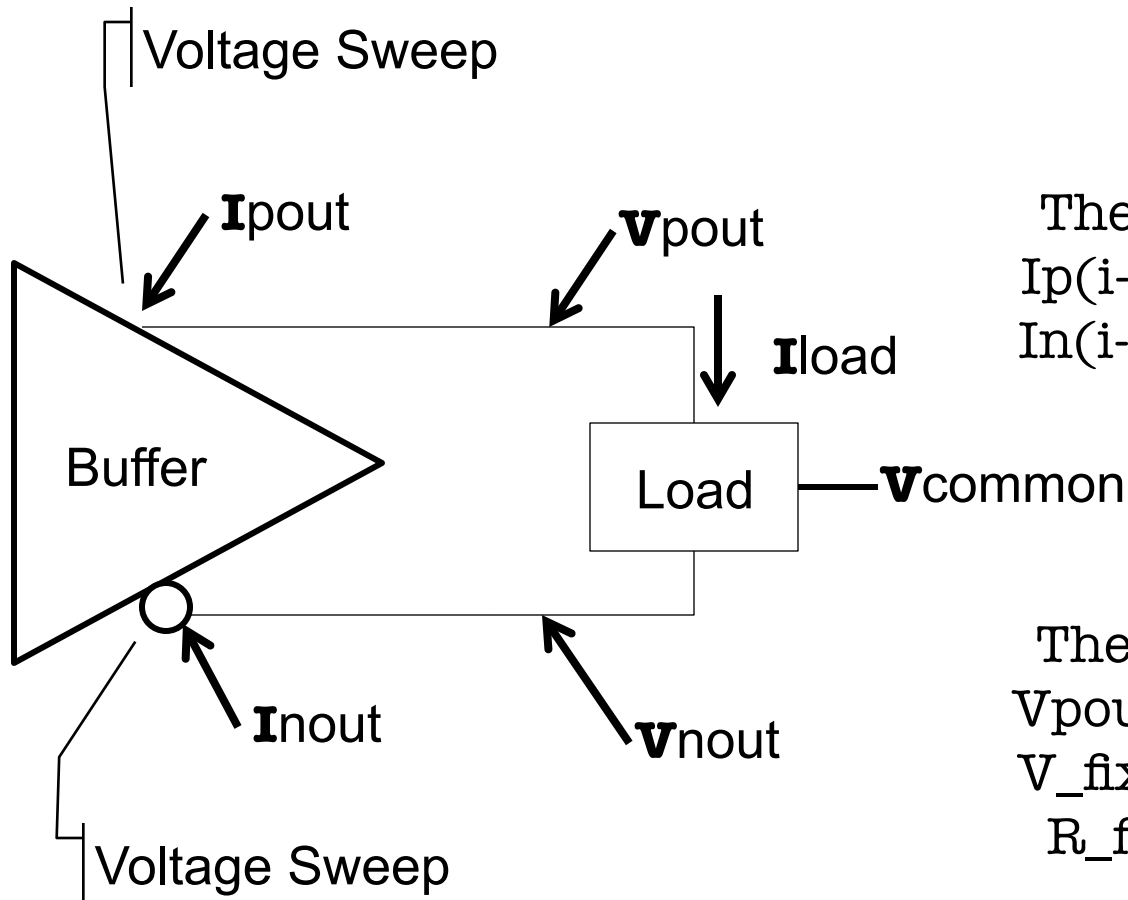
Pictures from IBIS cookbook

Using normal extraction methods for I-V and V-T curves

* I-V curves shown are combined curves and load line using reference to GND

I-V

V-T

Correlation shows they are way off from the Spice result
RED – Spice, BLUE - IBIS

Enhanced I-V Extraction Method

Voltage Sweep

Ipout

Vpout

Iload

Buffer

Load ——— **V**common

Inout

Vnout

Voltage Sweep
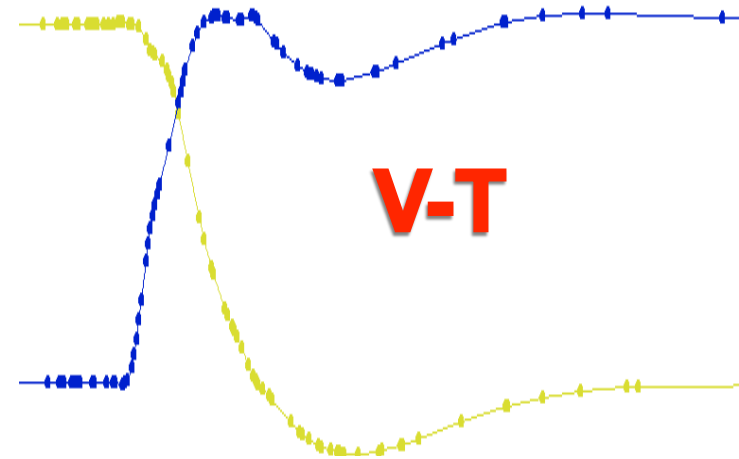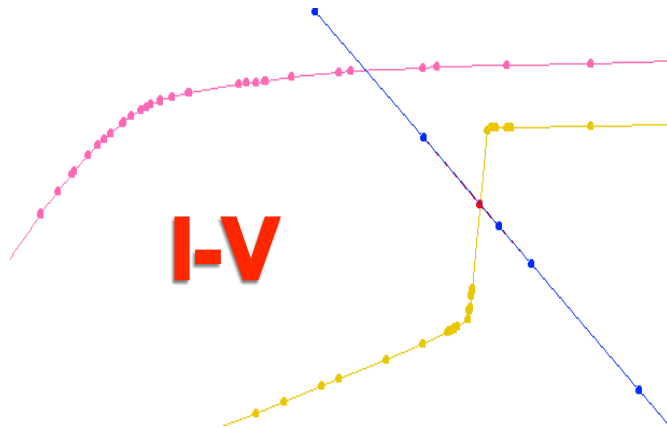
The IBIS I-V will be:
Ip(i-v) = Ipout − Iload
In(i-v) = Inout + Iload

The IBIS V-T will be:
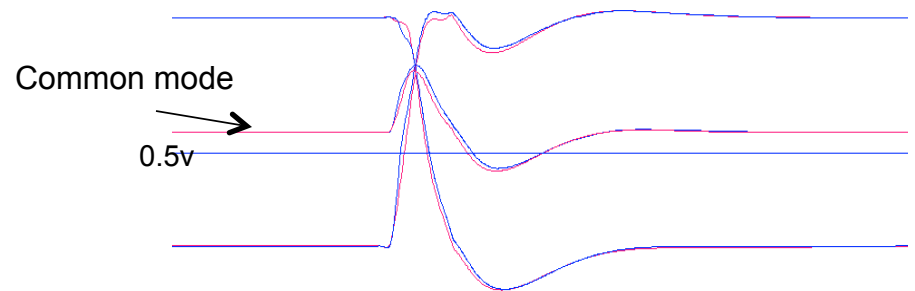Vpout and Vnout with
V_fixture = Vcommon
R_fixture = Rload/2

Using enhanced extraction method with differential load

* I-V curves shown are combined curves and load line using reference to GND

I-V

V-T

Correlation shows matched result with Spice
RED – SPICE, BLUE - IBIS

Common mode

0.5v

Summary

- Normal IBIS extraction method for load-dependent current-mode differential pair buffers produces inaccurate models

- Enhanced method considering differential load can solve this issue. It gives the matched results when correlating with Spice simulation results

- It would be better to have IBIS Spec accept "Rref_diff/Cref_diff" kind of differential loads for regular IBIS differential pair models
  - Rref_diff/Cref_diff is limited for External model use now

- IBIS Spec needs to be enhanced when modeling dynamic PLL current mode buffer
  - Various I-V tables for different diff_loads
  - Current dependent C-comp value table

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