

## BUFFER ISSUE RESOLUTION DOCUMENT (BIRD)

**BIRD NUMBER:** (for administrative use)  
**ISSUE TITLE:** [Pin Reference]  
**REQUESTOR:** Walter Katz, Signal Integrity Software, Inc.

**DATE SUBMITTED:** (Draft 5, June 28, 2016)  
**DATE REVISED:** (for administrative use)  
**DATE ACCEPTED:** (for administrative use)

### DEFINITION OF THE ISSUE:

All voltage measurements (“IBIS Data”) that are used to generate voltage values for IBIS subparameters within the [Model], [Model Spec], [Submodel Spec], and [Receiver Thresholds] keywords are relative to a test fixture reference node or a simulator reference node.

IBIS defines the derivation of “IBIS Data” consisting of I-V, V-T, ISSO and voltage thresholds for a device under test. For I-V, voltages are defined as measured across the associated [Pullup], [Pulldown], [POWER Clamp], and [GND Clamp] elements. For V-T, ISSO and voltage thresholds, IBIS defines the reference node used to measure these voltages. IBIS contemplates the use of these models with the buffer supplied by specific rail voltages prescribed by the [Voltage Range], [Pullup Reference], [Pulldown Reference], [POWER Clamp Reference], [GND Clamp Reference], and [External Reference] (“[\*Reference]”) keywords. These voltages are measured relative to the test fixture reference.

During a simulation that uses IBIS Models, the IBIS specification is not clear what node should be used as the reference node for the voltage at the buffer I/O. This is not an issue when the simulator supplies rail voltages Pullup\_ref, Pulldown\_ref, Power\_clamp\_ref, Gnd\_clamp\_ref and Ext\_ref (“\*\_ref”) to a model relative to the simulator reference node (e.g. Node 0) that are same as the reference voltages (“[\*Reference]”) supplied to the buffer when generating the IBIS Data (Device Under Test or DUT).

If the voltages at the rails (\*\_ref) relative to the simulator reference are not the same as the reference voltages (“[\* Reference]”) supplied to the buffer when generating the IBIS Data the Device is In Action (DIA). The specification does not say how to measure the voltages at the DIA buffer I/O terminal and compare them to the thresholds that were generated relative to the test fixture reference. This BIRD clarifies this by stating that the EDA tool should use the same model terminal as the reference terminal during DIA that was used as the reference node during DUT measurement/simulation.

If any one of the [\* Reference] values is 0.0V, then the corresponding \*\_ref terminal is the reference terminal during DUT, and should be used as the reference terminal during DIA.

In some I/O buffers the test fixture reference node is connected to a pin that is not connected to one of the I/O buffer terminals, and specifically, none of the [\* Reference] values are 0.0V. This BIRD

enhances the IBIS specification to define the POWER or GND signal name that the EDA tool should use as the reference node for all I/O buffer terminal measurements.

If two [\* Reference] have the same value then the two terminals are connected.

Given this clear definition of what a simulator should use as the reference node during DIA simulations, it is now possible to clarify how C\_comp should be connected during DIA simulations.

IBIS states on page 72:

The absolute GND is the reference for the V\_fixture voltage and the package model equivalent network. It can also serve as a reference for C\_comp, unless C\_comp is optionally split into ~~component attached to~~ the other reference voltages.

This “absolute GND” is the reference node for all measurements at the buffer when making DUT voltage measurements. During DIA simulations C\_comp should be connected between the I/O terminal and the same location in the component that was used as the DUT reference node.

This BIRD relies on three editorial changes that can either be added to this BIRD, or included in the editorial changes currently being considered elsewhere:

- Add to Guideline #2 on page 9:  
Note that these reserved name rules do not apply to pin names and signal names in the [Pin] section and node names in figures showing the interconnections between Devices Under Test (DUT) and the Test Fixture.
- Add new Guideline 15 on page 10:  
15. There are a number of places in this document where a node in a figure is called “GND” or is an “Earth Ground Symbol”. This is meant to represent the Test Fixture reference node for all Device Under Test voltage measurements. The model terminal (or a pin) on this Test Fixture reference node is to be used by EDA tools as the reference node of all voltage measurements made at the other IBIS model terminals (or pins) in simulations.(Unless otherwise stated)
- Add the following new rule to the [Pin] section on page 21:
  - If two pins have the same signal\_name, they must have the same model\_name.

**SOLUTION REQUIREMENTS:**

The IBIS specification must meet these requirements:

**Table 1: Solution Requirements**

Requirement	Notes
1. Allow an EDA tool to use IBIS model thresholds in simulations where the voltages applied to a model rail terminals are not the same as the voltages applied to	

the rail terminals of the model when the “IBIS Data” is generated.	
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### SUMMARY OF PROPOSED CHANGES:

This BIRD address this confusion by specifying supply node that the EDA tool should use as a reference node for measurements at the I/O pad when DIA.

For review purposes, the proposed changes are summarized as follows:

**Table 2: IBIS Keywords, Subparameters, AMI Reserved\_Parameters, and AMI functions Affected**

Specification Item	New/Modified/Other	Notes
New [Component] section [Pin Reference]	New	It is not required that there is a [Pin Mapping] section in the [Component]

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### PROPOSED CHANGES:

#### Add to section 5 after [Pin Mapping]:

*Keyword:* [Pin Reference]

*Required:* No

*Description:* This keyword defines for any pin in the [Pin] section of the [Component] section the signal\_name that has been used as the reference node for voltage measurements at the terminals of the model connected to the pin.

*Sub-Params:* pin\_name, signal\_name

*Usage Rules:* For each pin listed, a simulation node of the signal\_name connection shall be used as the reference node of measurements at the pin\_name node when comparing simulation results with model thresholds.

Pin\_name must exist in the [Component] [Pin] section, and its pin must have a Model\_name that is not POWER, GND or NC.

Signal\_name must exist in the [Component] [Pin] section on at least one pin\_name that has a model\_name POWER or GND.

*Other Notes:* If a pin\_name in the component section does not have an entry in the [Pin Reference] section, and there is a model\_name on that pin that is not NC, POWER or GND, then the EDA tool should use as the reference node the rail terminal that has its DUT reference voltage ([Pullup Reference], [Pulldown Reference], [POWER Clamp Reference], [GND Clamp Reference], [Pullup Reference], and [External Reference]) defined as 0.0V in the model. If more than on [\* Reference] values are 0.0 then (are they colapsed together, what to do if Pulldown\_ref goes to one signal and Gnd\_clamp\_ref goes to a different signal\_name).

During simulations, unless C\_comp is optionally split into the other reference voltages, C\_comp shall be connected between the buffer I/O terminal and the reference node.

*Example:*

```

[Component] MECL
[Package]
R_pkg  1.0E-02  1.0E-02  1.0E-02
L_pkg  1.7E-09  1.7E-09  1.7E-09
C_pkg  4.2E-13  4.2E-13  4.2E-13
|
[Pin] signal_name  model_name  R_pin    L_pin    C_pin
1     IN           in         1.0E-02  1.7E-09  4.2E-13
2     VCC          POWER     1.0E-02  1.7E-09  4.2E-13
3     VEE          POWER     1.0E-02  1.7E-09  4.2E-13
4     VSS          GND       1.0E-02  1.7E-09  4.2E-13
[Pin Mapping]  pulldown_ref  pullup_ref  gnd_clamp_ref  power_clamp_ref
1              VEE          VEE          VCC             VEE
[Pin Reference] signal_name
1              VSS
[Model] in
Model_type ECL_Input
Vinl = 0.35V
Vinh = 0.55V
C_comp          1.0pF  1.0pF  1.0pF
[POWER Clamp Reference]  2.0V  2.0V  2.0V
[GND Clamp Reference]   -0.5V -0.5V -0.5V
[Temperature Range]     25.0  85.0 -40.0

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**BACKGROUND INFORMATION/HISTORY:**

Walter Katz gave a presentation “IO\_Buffer\_Reference\_Terminal” in the June 7, 2016 IBIS-ATM meeting, describing this issue.