References in IBIS

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Goals and Contents

- Overview of existing IBIS handling of voltages
- Local reference node of "ground" is implicitly assumed throughout IBIS
  - Evolution of IBIS leads to this interpretation
  - A few exceptions exist
- Clarifying references is IBIS Version 6.1 is a current task
- Simple definition: a voltage (or potential difference) is measured between TWO points (sometimes called nodes) in a system
- A single-valued node voltage entry usually assumes that the other node is "ground"

History

- IBIS 1.0, 1.1 had only [Voltage Range]
  - Focused only on CMOS and bipolar (e.g., TTL) technologies with the negative node connected to "ground"
- [Voltage Range] meant to be a voltage span
  - Later clarified as a fixed voltage with respect to "ground"
  - Necessary interpretation for simulation model extraction
- Other specific references added in Version 2.0
  - [Pulldown Reference], [Pullup Reference], [GND Clamp Reference], [Power Clamp Reference]
  - Covers general configurations (e.g., RS-232) and other technologies, i.e., ECL and PECL
  - Could override [Voltage Range], regardless of its entry

[Model] Voltages and Voltage References

- **Keywords give single-valued voltage entries relative to a "ground" node, NOT with respect to any other reference**
  - **[Voltage Range] 3.3 3.0 3.6**
  - **[Pullup Reference] 3.3 3.0 3.6**
- **Determines actual voltages for the 0.0 V position in the corresponding I-V tables**
  - **[Pullup], [Pulldown], [POWER Clamp], [GND Clamp]**

Under [GND Clamp Reference]

Other Notes: Power Supplies: It is intended that standard TTL and CMOS models be specified using only the [Voltage Range] keyword. However, in cases where the output characteristics of a model depend on more than a single supply and ground, or a [Pullup], [Pulldown], [POWER Clamp], or [GND Clamp] table is referenced to something other than the default supplies, use the additional "reference" keywords.

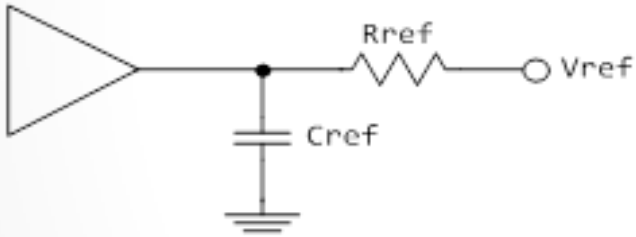
Terminal Names

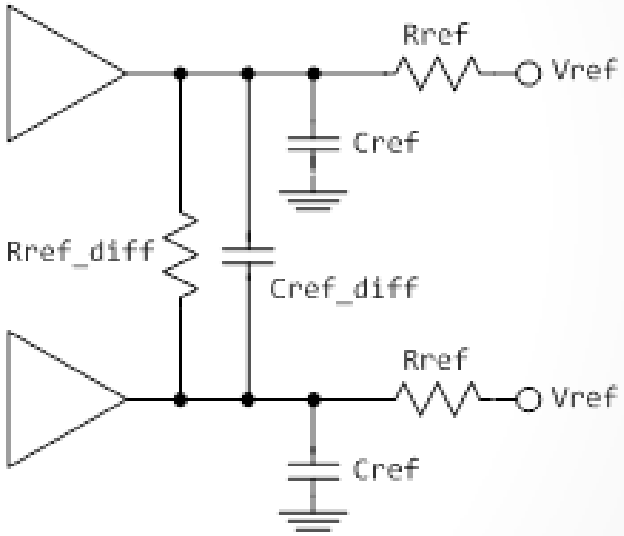
- [Component]/[Pin Mapping]
  - Terminals associated with [Model] reference voltages
  - pulldown_ref for [Pulldown Reference], pullup_ref for [Pullup Reference], etc.
  - ext_ref for buffer terminal, if it exists
- [External Model] (also [External Circuit])
  - A_puref, A_pdref, A_extref, etc.
  - Also, A_gnd was added to allow connecting to SPICE node 0 in a subcircuit
- [External Reference] special application
  - Externally set or internally derived (such as from a voltage divider)
  - Another threshold voltage

Specification Voltages and Capacitances

- Also relative to a "ground" node
  - Voltage values may shift with the [* Reference] voltages
- Single values, relative to "ground", e.g.,
  - Vinh = 3.5 V
  - Vinl = 1.5 V
- [Model Spec] single-valued typ/min/max voltage entries usually relative to "ground"
- [Model Spec] Cref*, Vref* connected to an external "ground"
- Two node exceptions: e.g., vdiff, Cref_diff

Timing Test Load
External "ground" Example





Specification Voltage Example

- **Values can shift with [* Reference] supplies**
- **Entries with respect to "ground" even though thresholds relative to Vcc**

```
[Model Spec]                                  | 10% supply variations
|          typ        min        max
| ECL (Vcc = 0.0 V, Vee = -5.2 V
Vinh      -1.165     -1.165     -1.165   | referenced to Vcc
Vinl      -1.365     -1.365     -1.365
| PECL (Vcc = 5.0 V, Vee = 0.0 V
Vinh       3.835      3.335      4.335
Vinl       3.525      3.025      4.025
| PECL (Vcc 2.0 V, Vee = -3.2 V)
Vinh       0.835      0.635      1.035
Vinl       0.525      0.325      0.725   | no internal "ground" node
```

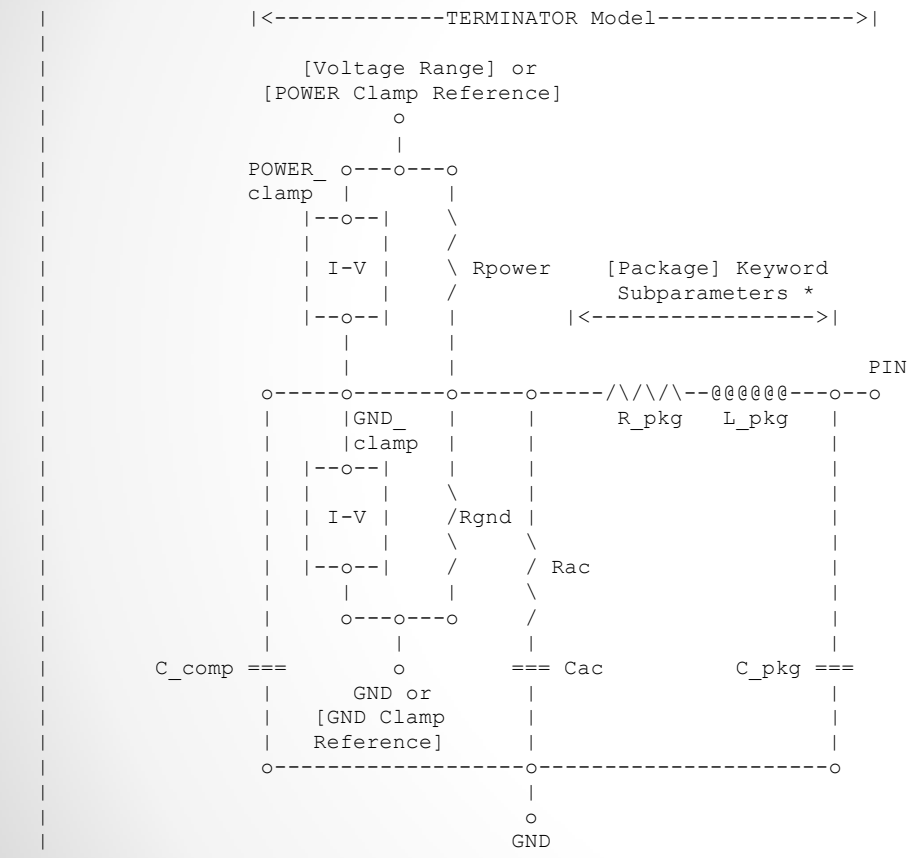
Package References

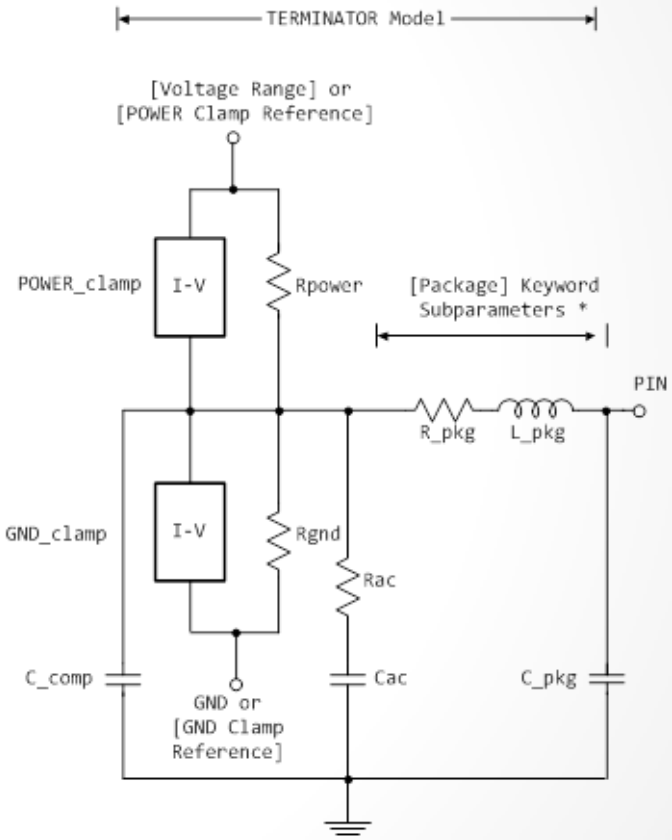
- Also relative to “ground”
- [Package] C_pkg
- [Pin] C_pin
- [Define Package Model]
  - [Capacitance Matrix]
  - C
- EBD
  - C

C_comp

- Historically assumed a “ground” node reference
- For simulation model extraction, any fixed node reference produces the same simulation model
- Power-aware simulation
  - C_comp node connections critical
  - Global or local “ground” reference is not accurate
  - However, using C_comp* subparameters allow connecting C_comp to *_ref terminals to increase simulation accuracy
- C_comp improvements to be resolved

Terminator Model "ground" in IBIS 5.0 and 6.1





* Note: More advanced package parameters are available within this standard, including more detailed power and ground net descriptions.

Notes on Data Derivation Method

- Ranges listed ambiguously in terms of model names GND and POWER as voltages
- E.g., For [Pulldown] table
  - GND-POWER to POWER+POWER (using typ value only)
- Rule incorrectly uses model names POWER and GND as voltages
- Must INFER the intended rule if the reference voltages are shifted
- Better rule statement needs to be developed

[Test Load], EMI Section

- **[Test Load]**
  - **Capacitances relative to external "ground" node**
  - **Td, Zo – ideal transmission line relative to external "ground"**
- **EMI also has several capacitor subparameters**
  - **C_Heatsink_float – no reference**
  - **C_Heatsink_gnd – "ground" reference**
  - **Cpd – power dissipation capacitance used in a formula per a device specification, and is not connected**

[Receiver Thresholds] Specification Exception

- **[Receiver Thresholds]**
- **Reference_supply subparameter uses reserved arguments to name which reference voltage to use:**

Sub-Params: Vth, Vth_min, Vth_max, Vinh_ac, Vinh_dc, Vinl_ac, Vinl_dc, Threshold_sensitivity, Reference_supply, Vcross_low, Vcross_high, Vdiff_ac, Vdiff_dc, Tslew_ac, Tdiffslew_ac

Reference_supply indicates which supply voltage Vth tracks; i.e., it indicates which supply voltage change causes a change in input threshold. The legal arguments to this subparameter are as follows:

Power_clamp_ref The supply voltage defined by the [POWER Clamp Reference] keyword

Gnd_clamp_ref The supply voltage defined by the [GND Clamp Reference] keyword

Pullup_ref The supply voltage defined by the [Pullup reference] keyword

Pulldown_ref The supply voltage defined by the [Pulldown reference] keyword

Ext_ref The supply voltage defined by the [External Reference] keyword

Advice to Fix

- **Understand and apply to all areas of IBIS**
- **Note, that references are stated in many ways or are just assumed to be "ground" or external "ground"**
- **So page-by-page scrub is needed based on understanding**