IBIS, current status (4.1) and some notes on IBIS4.0 parameters

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Overview

IBIS, current status (4.1) and some notes on IBIS 4.0 parameters

- questions
- statements
- parameters
- new tools
- current status
Current status

IBIS 4.1

Includes now external models:

VHDL AMS

Verilog AMS

SPICE (3F5)
New Keywords

Keywords

[External Model]
[End External Model]

Uses connectivity and IBIS-Parameters like VinH, VinL from [Model] Keyword

[External Circuit]
[End External Circuit]
[Node Declarations]
[End Node Declarations]
[Circuit Call]
[End Circuit Call]

Connectivity and measurement parameters are defined inside 'external circuit' (e.g. Inputs with 4 Thresholds)
New model types

4 new model types
  I/O_diff
  Output_diff
  3-state_diff
  Input_diff

2 new sub parameters
  Rref_diff
  Cref_diff

clarifications of many keyword descriptions
A living standard

Current status

Keywords
- IBIS1.1 (Apr. 1993)
- IBIS2.1 (Dec. 1995)
- IBIS3.2 (Aug. 1999)
- IBIS4.0 (Jul. 2002)

Subparams
- IBIS1.1
- IBIS2.1
- IBIS3.2
- IBIS4.0
- IBIS4.1

Selections
- IBIS1.1
- IBIS2.1
- IBIS3.2
- IBIS4.0
- IBIS4.1
ICM v1.0  IBIS InterConnect Modeling Specification

Coupling per section possible

Conductance added as a parameter

S-Parameters

Touchstone Format

Not frequency dependent,  -> next version
New free tools on the IBIS homepage

**s2ibis3**

- Java
- series MOSFETs
- better convergence with HSPICE

**Ibischeck 4.0**

- Check the file depending on the version in the keyword
  [IBIS Ver]   4.0
- Monotonicity of V-I-tables
  ver 4.0 : with summation of V-I-tables
  ver 3.2 : without summation (each table alone )
Keyword: [Receiver Thresholds]

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

Receiver thresholds single ended

Receiver thresholds differential

Vth, Vth-min, Vth-max
New Receiver thresholds

- \(\text{VinL}\text{\_ac, VinL}\text{\_dc}\) is offset to \(\text{Vth}\), no min max values
- \(\text{VinH}\text{\_ac, VinH}\text{\_dc}\) is offset to \(\text{Vth}\), no min max values
- \(\text{Vth}\) has got reference supply, with min max values
- \(\text{Reference}\_\text{supply for Vth}\)
- \(\text{Threshold}\_\text{sensitivity dependent on reference supply}\)
- \(\text{Vcross}\_\text{low, vcross}\_\text{high}\) is referenced to \(\text{gnd}\), no min max values
- \(\text{Vdiff}\_\text{ac, Vdiff}\_\text{dc}\), no min max values
Single ended parameters

VinH_ac : during a transition from L -> H, input will state change, when crossing Vinh_ac

VinH_dc : after a transition from L -> H, input will not change the new state, if above Vinh_dc
differential parameters

Differential signal:

- **Vdiff**
  - **Vdiff_dc**
  - **Vdiff_ac**

- **Vcross**
  - **Vcross_low**
  - **Vcross_high**

- Parameters:
  - $V_{ddq/2}$
  - $V_{ddq/2} - 0.175V$
  - $V_{ddq/2} + 0.175V$

- Voltages:
  - $0V$
  - $0.25V$
  - $0.5V$
Threshold voltage $V_{th}$

- $V_{th}$ is for typical values only.
- $V_{th\_min}$, $V_{th\_max}$ are values for typical conditions.
- No explicit values for min-max-condition Models.
- These will be calculated using the equation:
  
  $V_{th\text{(min/max)}} = V_{th} + (\text{Threshold sensitivity} \times \text{change in supply voltage})$
Threshold example part 1

Threshold sense = \frac{(V_{th\text{MAX}}-V_{th\text{MIN}})}{(V_{\text{supply}\text{MAX}}-V_{\text{supply}\text{MIN}})}

= \frac{(1.8V - 1.5V)}{(3.6V - 3.0V)} = \frac{0.3V}{0.6V} = 0.5

V_{th} and threshold sense must come from the IC-Manufacturer
### Threshold example part 2

<table>
<thead>
<tr>
<th>Typ</th>
<th>Min</th>
<th>Max</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vth</td>
<td>1.5v</td>
<td>xxx</td>
</tr>
<tr>
<td></td>
<td>VthMIN</td>
<td>VthMAX</td>
</tr>
<tr>
<td></td>
<td>xxx</td>
<td>yyy</td>
</tr>
<tr>
<td>Vthmin</td>
<td>1.45v</td>
<td>xx</td>
</tr>
<tr>
<td></td>
<td>VthMINmin</td>
<td>VthMAXmin</td>
</tr>
<tr>
<td></td>
<td>xx</td>
<td>yy</td>
</tr>
<tr>
<td>Vthmax</td>
<td>1.53v</td>
<td>x</td>
</tr>
<tr>
<td></td>
<td>VthMINmax</td>
<td>VthMAXmax</td>
</tr>
<tr>
<td></td>
<td>x</td>
<td>y</td>
</tr>
</tbody>
</table>

Threshold sensitivity 0.45

Ref. Supply | Power clamp reference
---|---
Powerclamp | 3.3V | 3.15V | 3.45V
Threshold example part 3 calculation

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Typ</th>
<th>Min</th>
<th>Max</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vth</td>
<td>1.5</td>
<td>1.35</td>
<td>1.65</td>
</tr>
<tr>
<td>VthMIN</td>
<td>1.4325</td>
<td>1.3825</td>
<td>1.5175</td>
</tr>
<tr>
<td>VthMAX</td>
<td>1.5675</td>
<td>1.5175</td>
<td>1.5975</td>
</tr>
<tr>
<td>Vthmin</td>
<td>1.45</td>
<td>1.35</td>
<td>1.60</td>
</tr>
<tr>
<td>VthMINmin</td>
<td>1.3825</td>
<td>1.35</td>
<td>1.5175</td>
</tr>
<tr>
<td>VthMAXmin</td>
<td>1.5175</td>
<td>1.3825</td>
<td>1.5975</td>
</tr>
<tr>
<td>Vthmax</td>
<td>1.53</td>
<td>1.38</td>
<td>1.68</td>
</tr>
<tr>
<td>VthMAXmax</td>
<td>1.5975</td>
<td>1.5175</td>
<td>1.68</td>
</tr>
</tbody>
</table>

Threshold sense

Ref. Supply Power clamp reference

<table>
<thead>
<tr>
<th>Powerclamp</th>
<th>3.3</th>
<th>3.15</th>
<th>3.45</th>
</tr>
</thead>
<tbody>
<tr>
<td>VthMINtyp</td>
<td>1.4325V</td>
<td>(3.15V - 3.3V) * 0.45</td>
<td></td>
</tr>
<tr>
<td>VthMAXtyp</td>
<td>1.5675V</td>
<td>(3.45V - 3.3V) * 0.45</td>
<td></td>
</tr>
<tr>
<td>VthMINmin</td>
<td>1.3925V</td>
<td>(3.15V - 3.3V) * 0.45</td>
<td></td>
</tr>
<tr>
<td>VthMAXmin</td>
<td>1.4625V</td>
<td>(3.45V - 3.3V) * 0.45</td>
<td></td>
</tr>
<tr>
<td>VthMINmax</td>
<td>1.5175V</td>
<td>(3.15V - 3.3V) * 0.45</td>
<td></td>
</tr>
<tr>
<td>VthMAXmax</td>
<td>1.5975V</td>
<td>(3.45V - 3.3V) * 0.45</td>
<td></td>
</tr>
</tbody>
</table>
Threshold sensitivity

VthMAXmax
VthMAXtyp
VthMAXmin

VthMINmax
VthMINtyp
VthMINmin

VthTYPmax
VthTYPtyp
VthTYPmin
Questions and statements

- Few new members in IBIS
- Gurus and beginners
- IBIS 4.1 contains now 140 pages
- ICM contains 50 pages

E-roadshows for training & interactions
Increasing issues

- Number of IO-models per file
- Number of parameters
- Gap between current version of IBIS and models you get
- Information needed, which tool uses which parameters
IBIS is a standard  ANSI/EIA 656-A

Past  Today  Future

Model availability

Model quality

Good accuracy with short simulation time

Tool independent
<table>
<thead>
<tr>
<th>Model class</th>
<th>δVcc</th>
<th>Tj</th>
<th>Process</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>± 5%</td>
<td>0 – 110</td>
<td>± 2σ</td>
</tr>
<tr>
<td>2</td>
<td>± 5%</td>
<td>0 – 110</td>
<td>± 3σ</td>
</tr>
<tr>
<td>3</td>
<td>± 5%</td>
<td>m40 – 125</td>
<td>± 2σ</td>
</tr>
<tr>
<td>4</td>
<td>± 5%</td>
<td>m40 – 125</td>
<td>± 3σ</td>
</tr>
<tr>
<td>5</td>
<td>± 10%</td>
<td>0 – 110</td>
<td>± 2σ</td>
</tr>
<tr>
<td>6</td>
<td>± 10%</td>
<td>0 – 110</td>
<td>± 3σ</td>
</tr>
<tr>
<td>7</td>
<td>± 10%</td>
<td>m40 – 125</td>
<td>± 2σ</td>
</tr>
<tr>
<td>8</td>
<td>± 10%</td>
<td>m40 – 125</td>
<td>± 3σ</td>
</tr>
</tbody>
</table>

± 2σ means 95.5% of all shipped parts fulfill these limits
± 3σ means 99.7% of all shipped parts fulfill these limits
δVcc ± 5% means e.g. 3P3V -- 3P15V -- 3P45V
δVcc ± 10% means e.g. 3P3V -- 3P00V -- 3P60V
Questions to IBIS4.1

VHDL-AMS model support

How to check?
- visual
- syntax
- ???

SPICE 3F5

- How to translate to other SPICE-tools?
- encrypted SPICE?
Acceptance of new IBIS-versions must be higher

More graphical explanations of parameters

IC vendors must support new parameters faster

Tool vendors must support new parameters faster

E-roadshows sounds good