Influence of stimuli on the rising falling waveform timing
Agenda

- Motivation
- Possible reasons for mismatch
- Investigation scenarios
- First results
- Operating frequency
- Summary
Single ended

motivation

E. Lenski / Com MN PG R H B 8      DATE  2006     IBIS summit   10th March  2006
Correct Crossing
For differential signal

Bad Crossing
For differential signal
Possible reasons for bad model

- Wrong threshold for core
- Wrong temperature range
- Wrong spice node description
- Wrong spice node connections
- Wrong extraction (wrong spice 2 ibis)
- Other
Cookbook definition

Internal driving waveform should be appropriate
to the normal use of the device
### Stimuli cases for core-input

<table>
<thead>
<tr>
<th>Case</th>
<th>Trise</th>
<th>Tfall</th>
<th>Vswing</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>1ps</td>
<td>1ps</td>
<td>1.8V</td>
</tr>
<tr>
<td>2</td>
<td>1ns</td>
<td>1ns</td>
<td>1.8V</td>
</tr>
<tr>
<td>3</td>
<td>1ps</td>
<td>1ps</td>
<td>2.5V</td>
</tr>
<tr>
<td>4</td>
<td>1ns</td>
<td>1ns</td>
<td>2.5V</td>
</tr>
</tbody>
</table>

Vcc-core 1P8V // Vcc-Out 2P5V
Stimuli comparison for internal 1.8V Vcc-core

1.8V symmetrical crossing of threshold

2.5V unsymmetrical crossing of threshold

35%  50%  50%  65%
Rising waveforms

[Diagram showing various stimuli waveforms with different parameters like voltage (V) and time (ns)].

- Stimuli: 1p8v-full-1ns-50gnd
- Notice the different waveforms under various conditions.
Falling waveforms

![Diagram showing falling waveforms with various stimuli and their respective voltages and times.]

- Stimuli
- 1p8v-full-1ps-50gnd
- 1p8v-full-1ps-50vcc
- 1p8v-full-1ns-50gnd
- 1p8v-full-1ns-50vcc
- 2p5v-full-1ps-50gnd
- 2p5v-full-1ps-50vcc
- 2p5v-full-1ns-50gnd
- 2p5v-full-1ns-50vcc
Comparison 1ps risetime and swing 1p8v—2p5v
Comparison 1ns risetime and swing 1p8v—2p5v
Closer Comparison 1ns risetime and swing 1p8v—2p5v

RISING:
Green curves are starting before the blue ones

FALLING:
Green curves are starting after the blue ones
Very Close Comparison 1ns risetime and swing $1p8v-2p5v$

Green curves are shifted because:

- $2p5V$-swing reaches Threshold first for rising
- $2p5V$-swing reaches Threshold second for falling
Influence on operating frequency rising edge

Stimuli 1ps  Stimuli 1ns

Frequency  trise/tfall
333MHz  1.5ns
200MHz  2.5ns

rising for model from
1ns-stimuli not finished
Influence on operating frequency falling edge

Stimuli 1ps  Stimuli 1ns

- Frequency
  - 333MHz: 1.5ns
  - 200MHz: 2.5ns

- trise/tfall
  - 1ns-stimuli not finished

- period

falling for model from

1ns-stimuli not finished
Rise Min  typ max waveforms comparison  1p8V swing only

Same shift because of different stimuli risetime

0 0,5 1,0 1,5 2,0 2,5
v

0 0,5 1,0 1,5 2,0 2,5
ns
Fall Min  typ max waveforms comparison 1p8v swing only

Same shift because of different stimuli falltime
Some rules of thumb

- $\text{Tr/tf stimuli} \ll \text{trisefall IO-buffer}$

- $\text{Tr/tf} \sim \left( \frac{\text{dt_ramp}}{100} \right)$

- $\text{Tr/tf} \sim \frac{\text{Tperiod}}{100}$
  \[\text{(333MHz} \Rightarrow \text{Tperiod} = 3\text{ns})\]

- Use correct voltage swing

- Use correct vcc-core / Vcc-IO combination
Summary

With 1ps stimuli risetime almost no difference in the created models

But 1ps is not always the correct time to use

For 10ns HCMOS even 1ns stimuli risetime is ok.
For a 250ps SSTL25/18 1ns is bad

Information about used stimuli is needed
(e.g. like in the IMIC-model from JEITA)

Cookbook should be more precise about the stimuli