ODT, Pre-Emphasis, and Speed

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On-Die Terminations (ODT)

- Model the device structure
- More details on “DEC” (Deviate, Extrapolate, Calculate) process:
  - http://www.eda.org/pub/ibis/summits/sep05/ross2.pdf
Four ODTs With Same Total I-V

1. [Gnd Clamp] (1.2 V, 50 Ω)
2. [Power Clamp] (0.6 V, 50 Ω)
3. “Clip and Extend” (both clamps clipped)
4. “DEC” (75 Ω, 150 Ω)
Real “50 Ω” ODT Choices

1. I-V in [Gnd Clamp]
2. I-V in [Power Clamp]
3. “Clip and Extend” 52.8 Ω
4. “DEC” 94.2 Ω, 120 Ω
Pre-emphasis

• Add [Driver Schedule] to match the device structure

• Examples:
  – 2-tap current mode logic (CML) 1-bit delay (de-emphasis) structure
  – Kickers for internal logic controlled boosts (and adjusted waveform delays)
CML Structure using IBIS Open_drain Models and Connected by [Diff Pin]

- Top-level
  - ODT [Power Clamp]
  - MAIN [Pulldown]
    - Extracted waveforms with ODT & 50 Ω
      - Pre-emphasis = 0
  - [Driver Schedule]
- MAIN [Pulldown]
- BOOST [Pulldown]
  - Scaled waveforms
  - Scaled waveforms
Actual SPICE Configuration with Differential Control

<table>
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<tr>
<th>Model_name</th>
<th>Rise_on_dly</th>
<th>Rise_off_dly</th>
<th>Fall_on_dly</th>
<th>Fall_off_dly</th>
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</thead>
<tbody>
<tr>
<td>MAIN</td>
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<td>NA</td>
<td>0</td>
<td>NA</td>
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<tr>
<td>BOOST</td>
<td>NA</td>
<td>0.47059ns</td>
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<td>0.47059ns</td>
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Different Typ-Min-Max Kicker Times (Internal Logic Control Kickers)

<table>
<thead>
<tr>
<th>Model_name</th>
<th>Rise_on_dly</th>
<th>Rise_off_dly</th>
<th>Fall_on_dly</th>
<th>Fall_off_dly</th>
</tr>
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<tbody>
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<td>MAIN_TOTEM</td>
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<tr>
<td>NMOS_OD</td>
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<td>NA</td>
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</tr>
</tbody>
</table>

Diagram showing PMOS_OS, MAIN_TOTEM, and NMOS_OD connections.

Graph showing waveforms over time.
Speed – How Fast Is IBIS?

• World’s fastest published IBIS model:

```
[IBIS Ver] 1.1
[File Name] fastest.ibs
[File Rev] 0
[Date] October 27, 2006
[Component] Worlds_Fastest_Model
[Manufacturer] Teraspeed Consulting Group

R_pkg 0 NA NA
L_pkg 0 NA NA
C_pkg 0 NA NA
[Pin] signal_name model_name
  1 Open_Drain FAST_OD
[Model] FAST_OD
Model_type Open_drain
C_comp 0 NA NA
[Voltage Range] 1E-100 NA NA
[Pulldown] -1e-100 -20E-103 NA NA
  2e-100 40E-103 NA NA
[Ramp] dV/dt_r 0.3e-100/0.6E-109 NA NA
dV/dt_f 0.3e-100/0.6E-109 NA NA
[End]
```

1.0E-100 V, 50 Ω driver
1.0E-109 s ramps
Conclusion

• How fast is IBIS?
  – “As fast as you are smart”

• How accurate is IBIS?
  – Configure IBIS to match device structure for best accuracy
  – IBIS is as accurate as you are smart