C_comp and Buffer Scaling Observations

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Agenda

• Enhanced IBIS Version 2.1 model subset
• 2-tap pre-emphasis example and impedance interaction
  – Driver Schedule
  – Combining Buffers
• Ideal buffer test case
  – Problems
  – C_fixture solution for peaking
• Conclusions/recommendations
Full IBIS Version 2.1 Buffer
(C_comp is part of buffer)
Typical Industrial Subset of IBIS Version 2.1

R Fixture, V Fixture and C Comp

Used for K-table extraction algorithm to develop internal driver model
Proposed Enhanced Subset of IBIS Version 2.1

\[ C_{\text{comp}*} = C_{\text{comp}} + C_{\text{dut}} + C_{\text{fixture}} \]

K-table Extraction algorithm UNCHANGED
2 – Tap Pre-emphasis, Differential Control and [Driver Schedule]

IN+ Input bit pattern + TX+

IN- - MAIN - TX-

Inverse 1-bit delays

[Driver Schedule]

<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>
</thead>
<tbody>
<tr>
<td>MAIN</td>
<td>0</td>
<td>NA</td>
<td>0</td>
<td>NA</td>
</tr>
<tr>
<td>BOOST</td>
<td>NA</td>
<td>0.47059ns</td>
<td>NA</td>
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Output Impedance and C_comp Interaction??

[Driver Schedule]

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IBIS Solution - \( C_{\text{comp}} \) as Load with [Driver Schedule]

\[ C_{\text{comp}} (M,B) = 0.0 \]
Macro Model – Buffer Scaling Solution

\[ C_{\text{comp}} (M,B) \]
\[ C_{\text{comp}} = C(M+B) \]
Both Approaches Have Limits - Shown by Ideal Buffer Test Case

- Summation
  - 100 ps ideal ramp
  - 25 Ω ideal buffer (in connected mode)
  - $C_{\text{comp}} = 3.0 \, \text{pF}$
  - $V_{\text{dd}} = 1.5 \, \text{V}$

- Each one-half scaled
  - 100 ps ideal ramp
  - 50 Ω ideal buffer

- 50 Ω $R_{\text{fixture}}$
- 50 Ω load
IBIS [Driver Schedule] Setup with/without C_comp = 3 pF
Connected One-half Scaled Buffers

0 pF

1.5 pF
C\_fixture Peaking Works in All Cases with Original Scaled Waveforms

Desired (Measured) Response

1.5 pF and C\_fixture = 0.5 pF

or 0 pF and C\_fixture = 2.0 pF for [Driver Schedule] setup
Conclusions/Recommendations

• Implement “enhanced” IBIS Version 2.1 subset with C_fixture and C_dut processing
  – No algorithm change
• Use a C_fixture tweak for 2-tap pre-emphasis simulation ([Driver Schedule], language, macro-model, etc.) with “scaled” buffers
  – Independent tweaks for rising, falling edges possible
  – Experimentally adjust C_fixture with real non-linear, non-ideal buffers
• Watch out for impedance interactions!!