Pad Capacitance Extraction

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Agenda

- Why it’s so important !!
- Time domain methods
- Frequency domain technique
  - Sweeping the whole domain
  - Tank construction
  - Enhancement
Why It’s So Important !!!

$C_{\text{comp}} = 3 \text{pF}$

$C_{\text{comp}} = 2.4 \text{pF}$
Time Domain Methods

- Apply ramp voltage source ($\beta \cdot t$) & measure the current.
- Subtract DC current in pull up/down device.
- $C(t) = (I_1 - I_2)/2\beta = (I(t)_{\text{Source}} - I(t)_{\text{Device}})/\beta$.
- $C_{\text{comp}}$ varies with $\beta$ !!!!

- Time domain methods depends on $I_C = C^*(dV/dt)$
Frequency Domain Technique

- Time domain methods fails to give one simple result.
- Frequency domain analysis might be the alternative!!
- Spice AC analysis is a small signal time averaging per unit cycle.
- Enhancements to emulate large signal response.
Sweeping the Whole Domain

Which frequency will you pick to calculate C_{comp} !!!??
Tank Construction

- Capacitance physically exists.
- It only varies with voltage.
- Adding Shunt L for resonance.
- Ccomp frequency dependence is omitted.
- One single value for Ccomp.

\[ \omega_o = \frac{1}{\sqrt{LC_{comp}}} \]
Results

\[ Z_{\text{out}} \]

\[ \omega_0 \]
Voltage Dependence

\[ \omega_o = \frac{1}{\sqrt{LC_{\text{comp}}}} \]

- As \( V_{dc} \) increases
- \[ |Z_{out}| \] approaches 2.0
Voltage Dependence.......

Take time average capacitance From here = 2.68pF

DC value reached by 50 Ω
Final Comparison

\[ C_{\text{Comp}} = 2.68\text{pF for this simulation} \]
Closer Look

Spice  IBIS

[Graph showing a plot with axes and data points]

Mentor Graphics

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Summary

- Hard to get straight answer from time domain methods.
- Can’t calculate $C_{comp}$ from a simple sweep of frequency domain (Which frequency will you take?).
- Tank method gives accurate answer at each voltage value.
- Large variation of $C_{comp}$ is a limitation for tank method as well as IBIS standard.