Pad Capacitance Extraction *SPICE Simulations*

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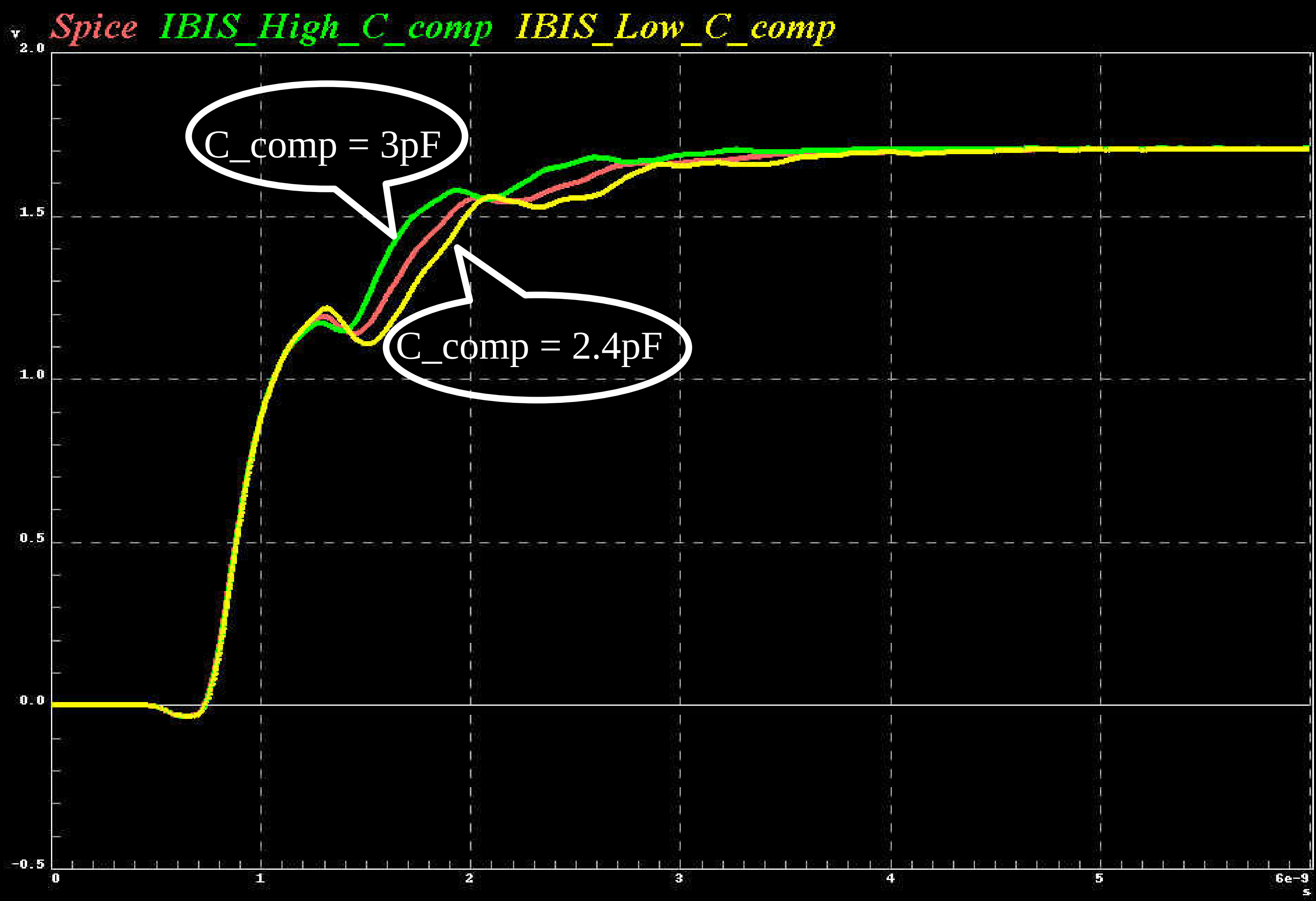
Agenda

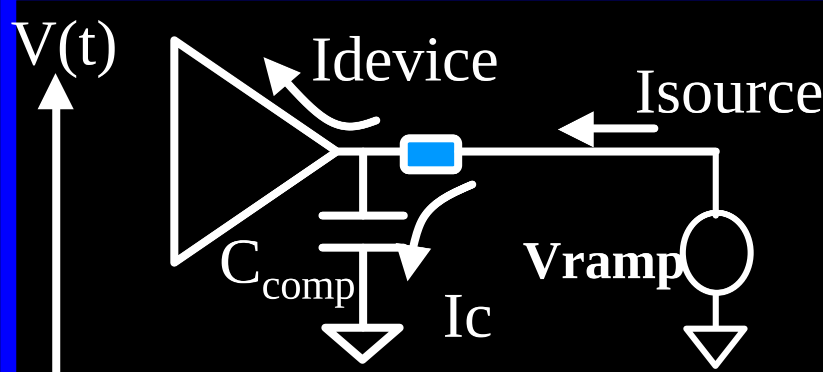
- Why it's so important !!!
- Time domain methods
- Frequency domain technique
  - Sweeping the whole domain
  - Tank construction
  - Enhancement

Why It's So Important !!!

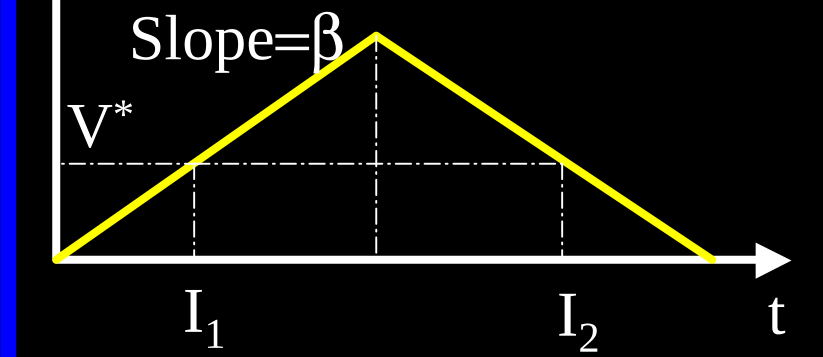


Time Domain Methods

- **Apply ramp voltage source (b*t) & measure the current.**
- **Subtract DC current in pull up/down device.**
- **C(t) = (I1 – I2)/2b = $(I(t)_{Source} - I(t)_{Device})/b$.**
- **Ccomp varies with b !!!!**

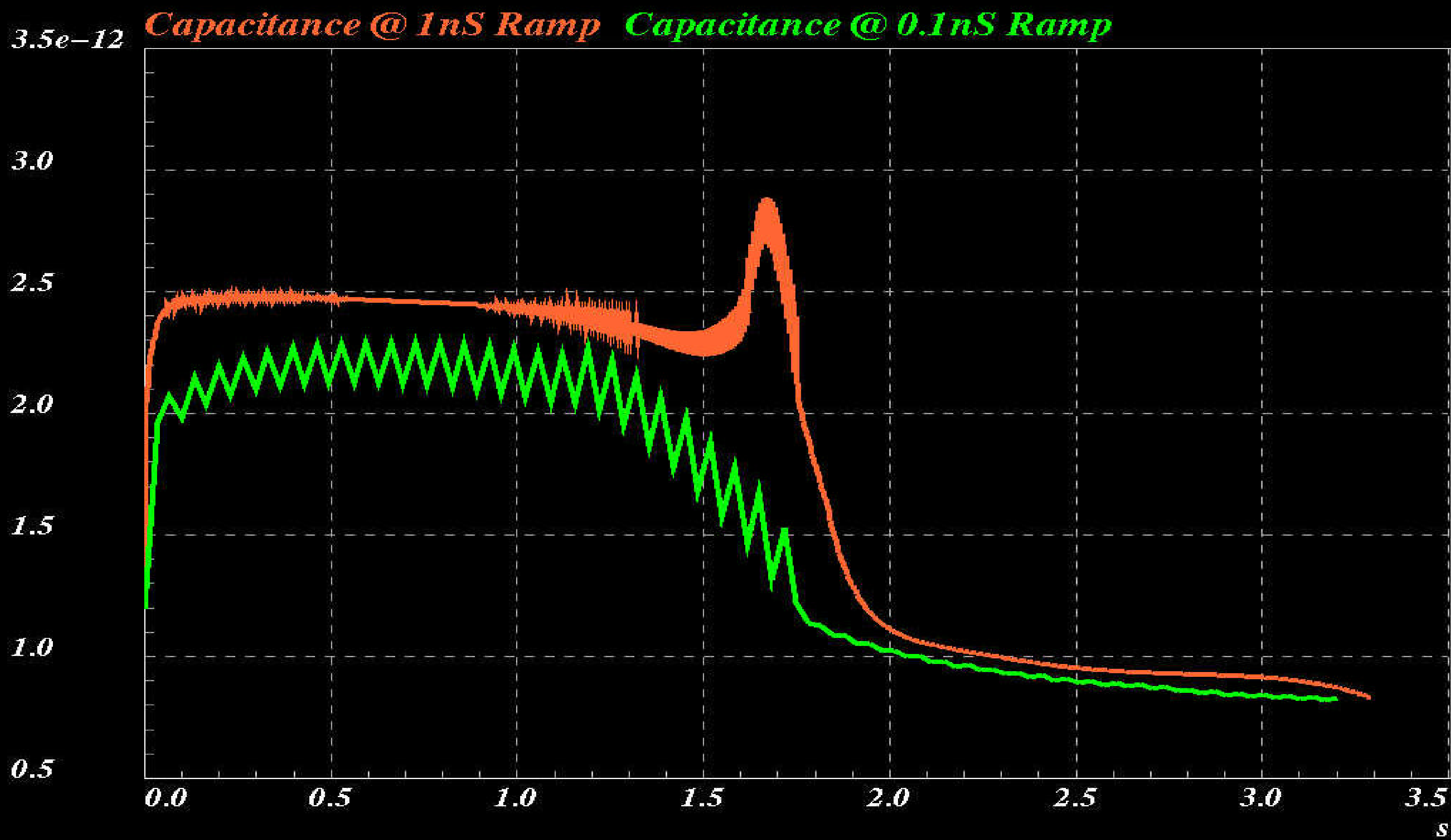


$$C_{\_comp} = [(I_1 - I_2)/2]*(dt/dv)$$



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

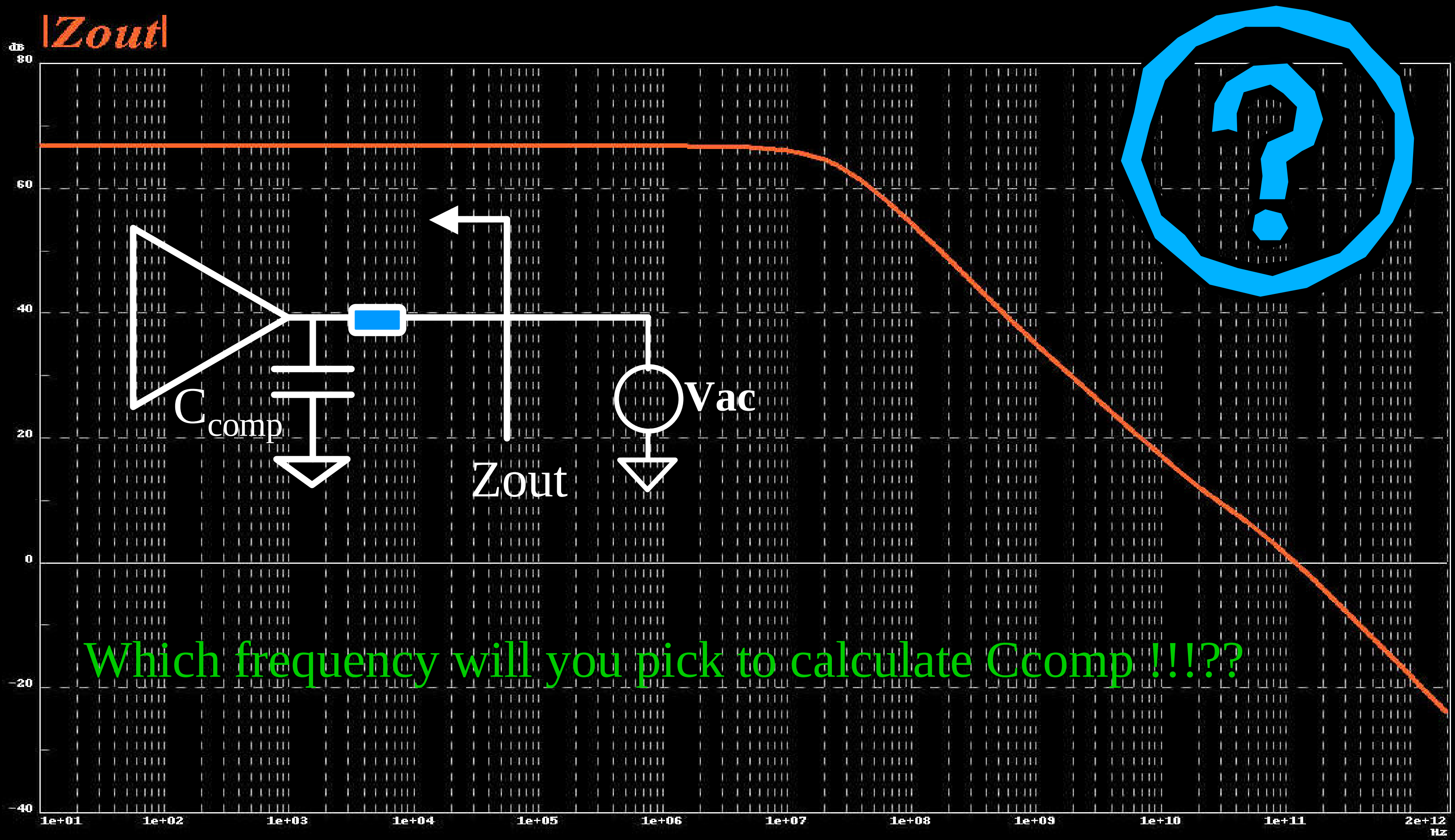
Time Domain Capacitance



Frequency Domain Technique

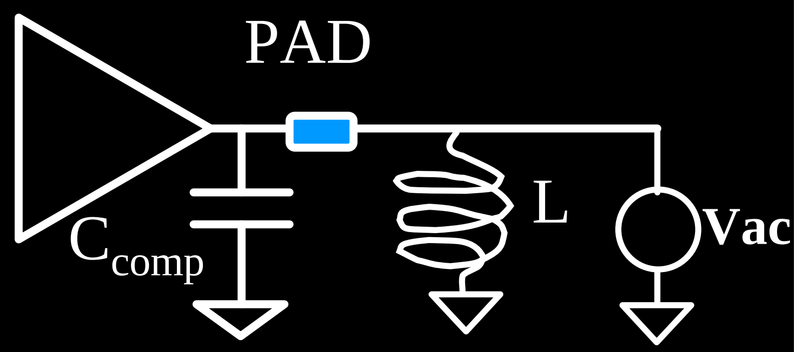
- **Time domain methods fails to give one simple result.**
- **Frequency domain analysis might be the alternative !!**
- **Spice AC analysis is a <u>small signal</u> time averaging per unit cycle.**
- **Enhancements to emulate large signal response.**

Sweeping the Whole Domain



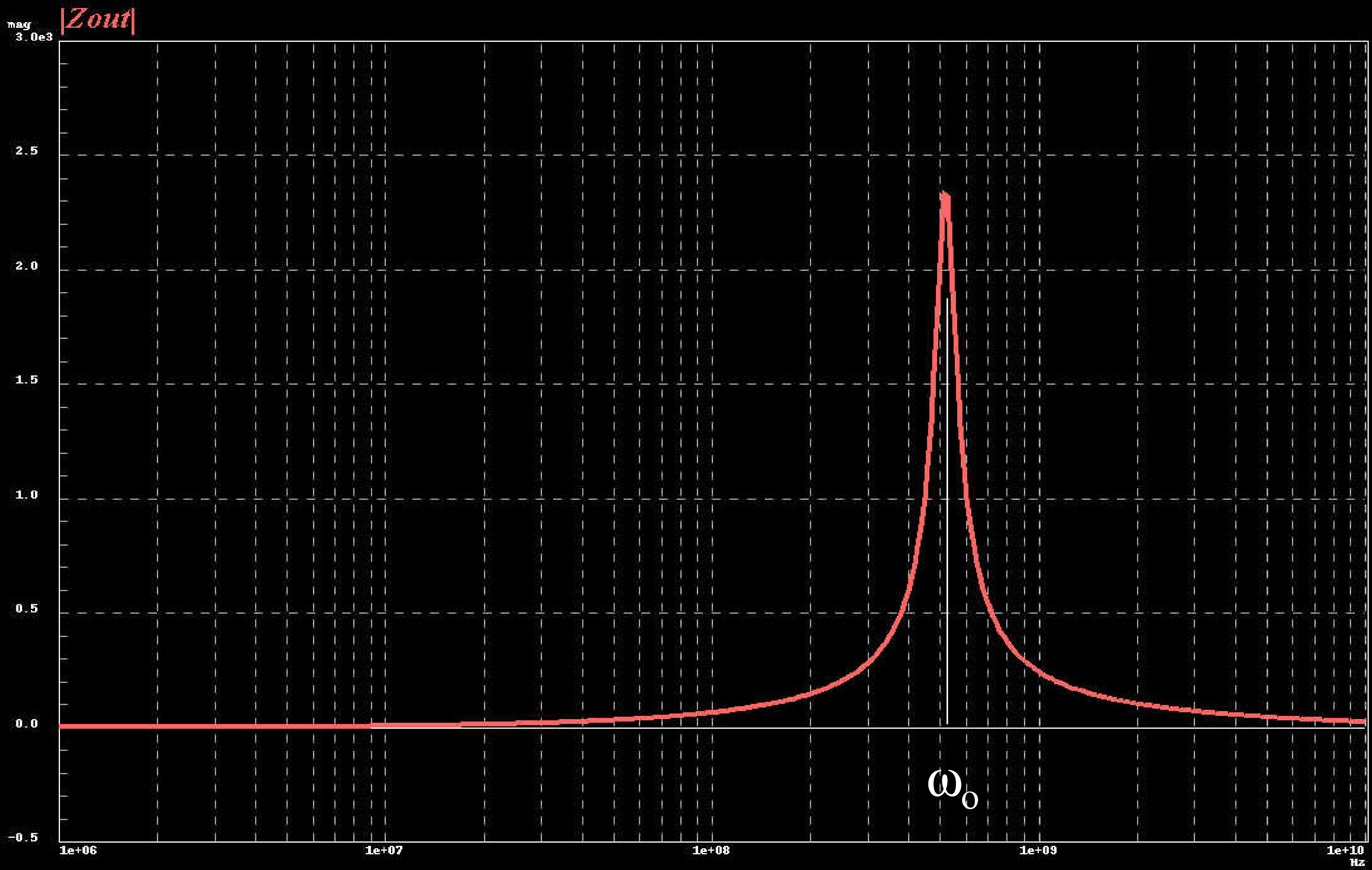
Tank Construction

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



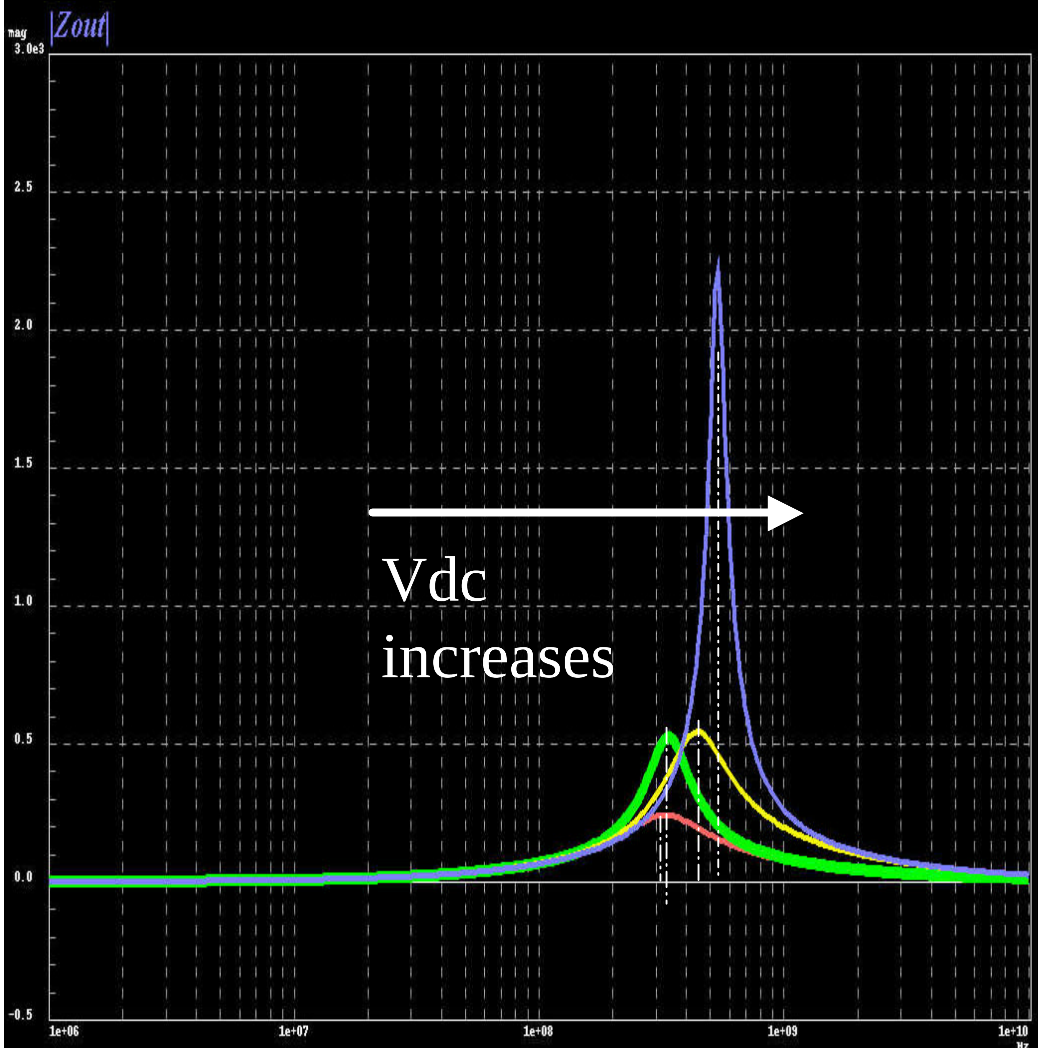
$$\omega_o = 1/Sqrt(LC_{comp})$$

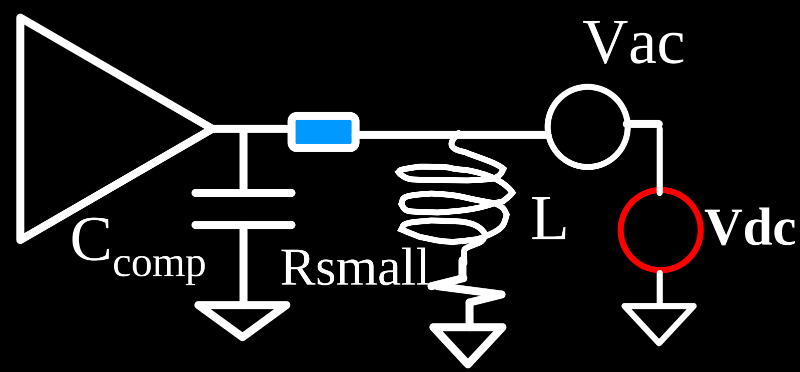
Results



|Zout|
mag
3.0e3
2.5
2.0
1.5
1.0
0.5
0.0
-0.5
1e+06
1e+07
1e+08
1e+09
1e+10
Hz
ω_0

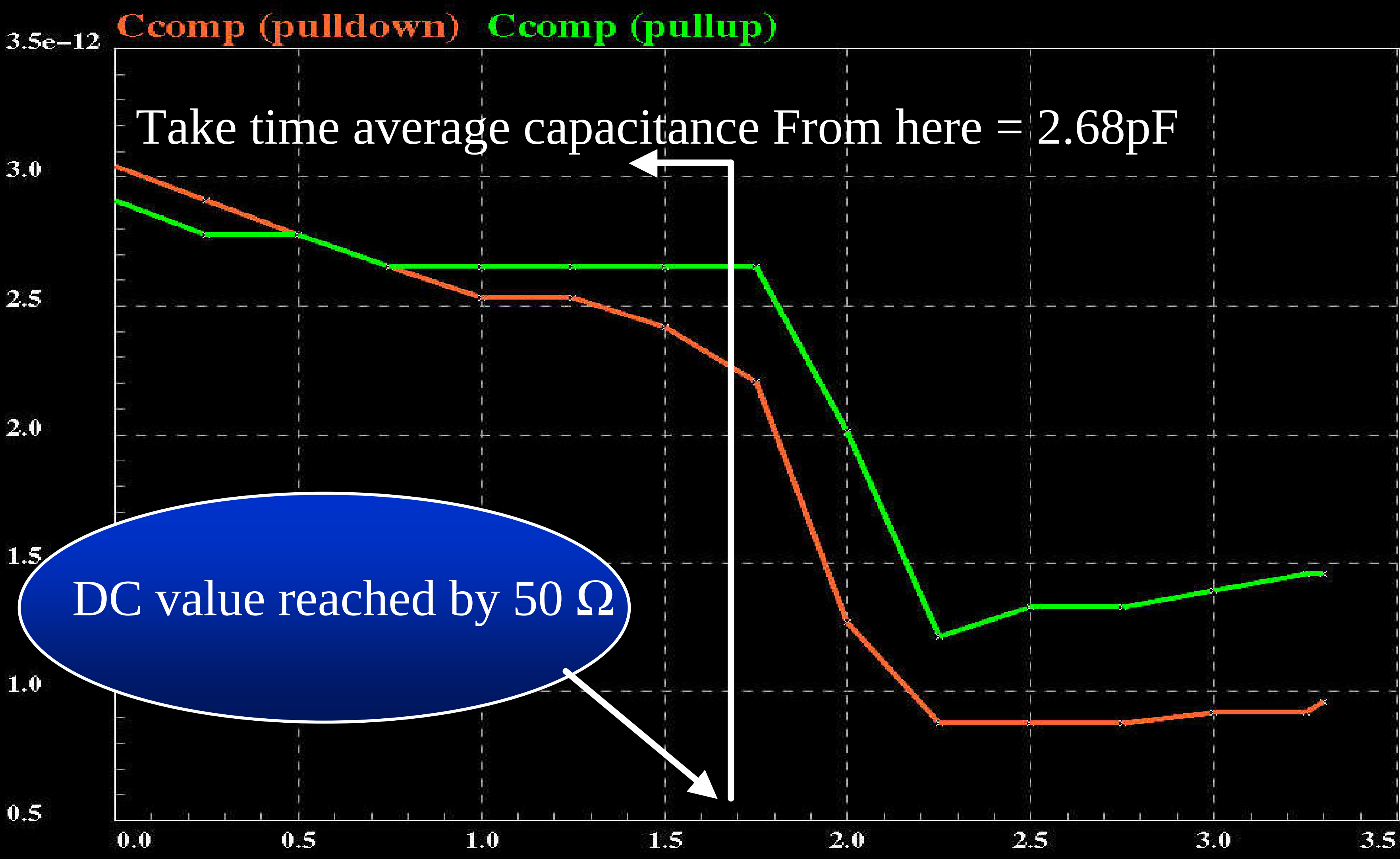
Voltage Dependence



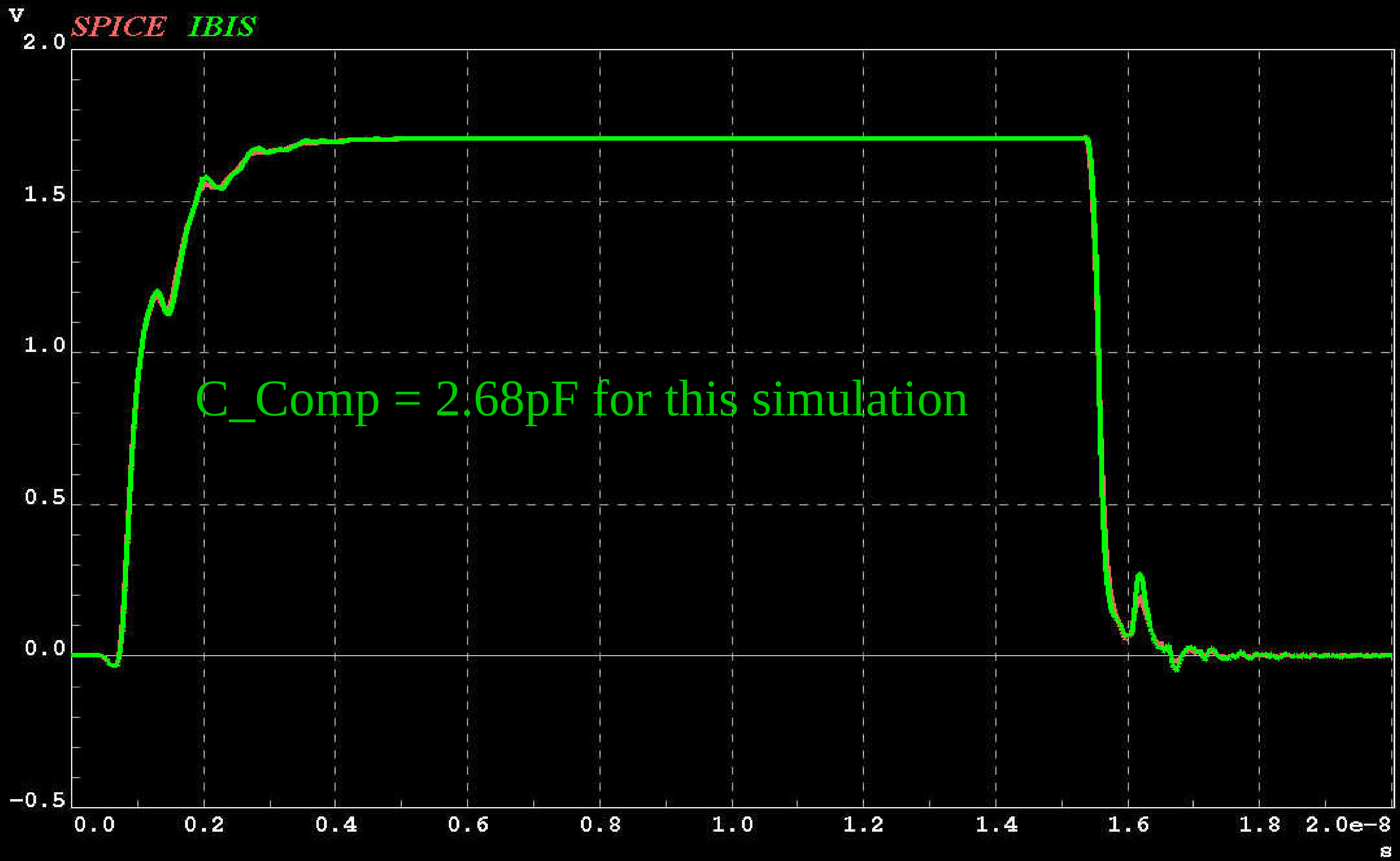


$$\omega_o = 1/\mathrm{Sqrt}(LC_{comp})$$

Voltage Dependence……..



Final Comparison



Closer Look

Summary

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

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