Correlation of on-die termination to C_d value in COM model

Mau-Lin Wu, Ehung Chen, Tamer Ali
MediaTek
IEEE 802.3ck Task Force

Outline

- Background and Motivation

- Correlation

- Conclusions

Background & Motivation

- During 2019 Long Beach interim meeting,
  - Baseline package model was adopted [minutes_3ck_0119_unapproved.pdf, Straw poll #2]
    - However, 'C_d' is TBD
    - People is considering C_d = 110 fF & 130 fF
  - According to COM sensitivity analysis [wu_3ck_adhoc_01_022719.pdf]
    - COM is sensitive to C_d, if DFE tap (N_b) doesn't cover package double-reflection
    - COM difference is around 0.34 dB for C_d = 110 fF & 130 fF
  - Karthik created 't-coil based model' of typical design to correlate with 'simple lumped models' in COM [gopalakrishnan_3ck_adhoc_01_022719.pdf]
    - Proposed to adopt Cdtx ~ 110fF & Cdrx = 85fF
- Motivations
  - Provide on-die termination freq/time responses
  - Provide input to decide 'C_d' for RX
- Conclusions
  - The 'simple lumped model' can't match real response well
    - Q: Shall we consider some broadband model?
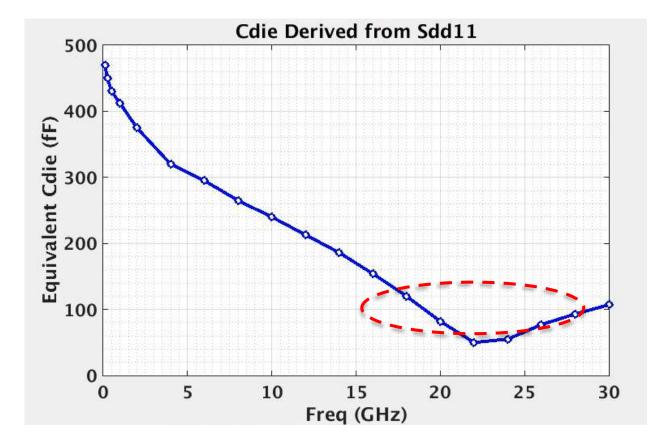 - Cdrx = 85fF is too small, larger value than 100fF shall be considered

Correlation of On-Die Termination to C_d

- In IEEE COM, the simple model of 50 Ohm on-die termination plus device capacitance (C_d) was included

  - However, the real input/output network at device's TX/RX is complicated

- We analyzed Sdd11 & time-domain step-response to correlate

  - 'Simple lumped model' used in COM
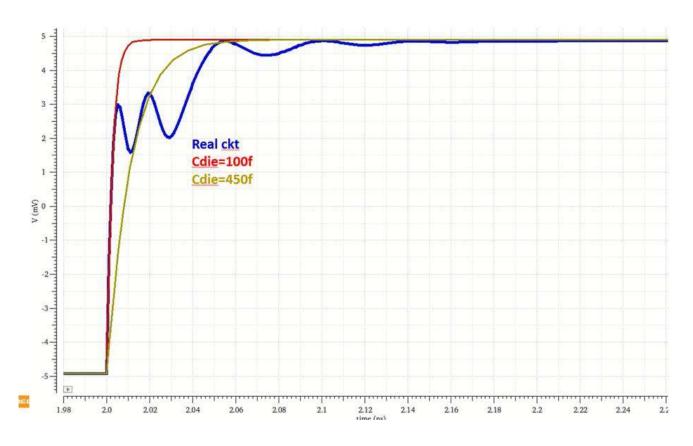 - 'Referenced design' of 100G SerDes

Frequency Domain Estimation of Rx C-Die

Cdie Derived from Sdd11

- C-die varies across freq due to the complexity of the input network
- We can say that C-die close to Nyquist and beyond is ~100fF
- However, settling behavior is decided by lower frequency C-die

Time Domain Estimation of Rx C-Die

Real ckt
Cdie=100f
Cdie=450f

- 100fF accurately models edge of pulse
- Settling is slower and could approach 450fF

Conclusions

- The real circuit is not the 'simple lumped RC' circuit
  - Q: shall we consider some kind of broadband model?

- If we adopted the 'simple lumped RC' model, the appropriate 'C_d' values shall be
  - Larger value than 100fF