Simple ODT Extraction

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ODT = On-Die Termination

• Earlier presentation for combined Thevenin equivalent “pullup” and “pulldown” ODT
  – DEC September, 2005
  http://www.eda.org/ibis/summits/sep05/ross2.pdf

• Simplified process
  – Tuned for calculating Typ/Min/Max clamps at the same time
  – Defaults to proportional allocation of currents

• Example of DDR2 [Submodel] extraction
Default DEC Algorithm (2005)
Proportional Allocation of Currents

Calculate

Extrapolate

delta*lp/(lp+lg)

Gnd Clamp

Total I-V

Calculate

Extrapolate

delta

Ip

0 ma

delta*lg/(lp+lg)

Power Clamp

Vg

Vp

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Simple Transformation Process
(One Clamp at a Time)

• [Gnd Clamp] extraction
  – Extract total I-V curves just beyond 0 to Vdd(max) range
    • E.g., -0.2 to Vdd(max)+0.1
  – Transform curves to the range I(V(0) and I(Vdd(typ/min/max))
  – Extrapolate at both ends

• [Power Clamp] extraction
  – Same process, but use the Vdd referenced data from about -0.2 to Vdd(max)+0.1
Real Example for 75 Ω ODT DDR2 [Submodel]

- **Vdd Typ/Min/Max = 1.8/1.7/1.9 V**
- **Modified gc* and pc* ranges:**
  - -0.2 V to 2.0 V from s2ibis2/3 setup
- **Spread sheet processing (but direct equation implementation possible)**
- **(Here, ESD clamps at Gnd and Power extracted separately by turning off ODT and modeled at top-level)**
Total I-V and [Gnd Clamp]
Typ/Min/Max by Mapping

Calculated ODT [Gnd Clamp]

0 V referenced Total I-V gc*
Map Typ/Min/Max

0 V to 1.8/1.7/1.9 V Ranges

Typ at 1.8V

Min at 1.7 V

Max at 1.9 V

After mapping, extrapolate both tables (not shown)
Total I-V to [Power Clamp]
Typ/Min/Max Mapping – Same Process

Vdd referenced Total I-V pc*
Calculated ODT [Power Clamp]
[Gnd Clamp] and [Power Clamp] with Extrapolations for [Submodel]
Summary of Simplified Process
(One Clamp at a Time)

• Use Total I-V just beyond 0 to Vdd(max) range
  – 0 V based for [Gnd Clamp] (gc*)
  – Vdd based for [Power Clamp] (pc*)

• Map Total I-V curves to (0, 0) value and I(Vdd(typ,min,max)) values

• Extrapolate to full −Vdd to 2*Vdd range

• (Easy subtractions for including ESD clamps possible, but not covered here)