Buffers for Advanced SPICE to IBIS Testing

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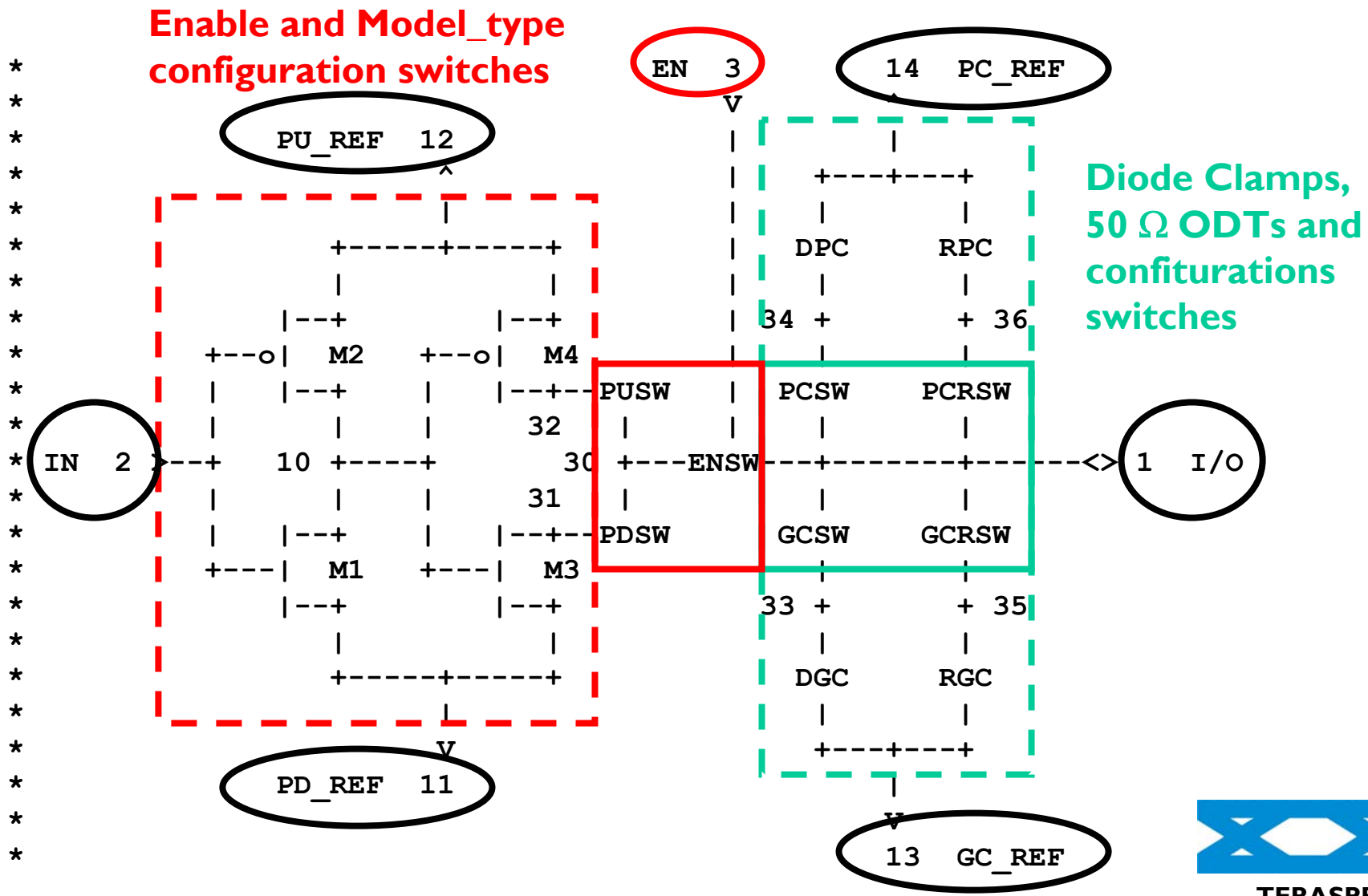
Configurable CMOS & ECL Buffers

- Two buffers for all Model_types, voltages, clamps and on-die terminators (ODTs)
- Berkeley SPICE to support all SPICEs
  - Level 2 CMOS, standard bipolar ECL & simple diodes
  - Numerical nodes
  - Syntax-neutral multiplier switched conductance
    - GPDSW 30 31 POLY(2) (30,31) (21,0) 0 0 0 0 1000
    - RPDSW 30 31 1G
      - Open: R = 1 GΩ
      - Closed: G = 1000 S (0.001 Ω)
  - Externally set 0 and 1 voltage assignments
    - Could be parameterized
- Multiple cases through s2ibis and scripts

CMOS Buffer



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CMOS Configuration Controls
.SUBCKT CMOSTEST

```
*********************************************************************************
*  ON-OFF CONFIGURATION SWITCHES
*     (1 OR ABOVE = ON, 0 = OFF)
*
*  VPD      1      PULLDOWN
*  VPU      1      PULLUP
*  VGC      1      GND CLAMP
*  VPC      1      POWER CLAMP
*  VGCR     0      INTERNAL GND CLAMP RESISTOR (50 ohm)
*  VPCR     0      INTERNAL POWER CLAMP RESISTOR (50 ohm)
*
*   VPD   VPU    VEN = 1       VEN = 1,0          VEN = 0
*    1     1     Output        3-state, I/O       Input, Terminator
*    1     0     Open_drain    I/O_open_drain     Input, Terminator
*    0     1     Open_source   I/O_open_source    Input, Terminator
*    X     X                                      Input, Terminator
*
*********************************************************************************
*
*                          Control      Voltage        Configuration
*                  I/O     Inputs       References     Switches (1 = ON)
*                  ---   ----------   -----------   ------------------
.SUBCKT CMOSTEST   1       2   3      11 12 13 14   21 22 23 24  25  26
*                  I/O     IN  EN     PD PU GC PC   PD PU GC PC GCR PCR
*
*********************************************************************************
```

Model_type plus Enable Control

Diode Clamps and 50 Ω ODTs

Enable with Model_type

I/O, Input and Enable

Voltage Refs

Model_type, Clamps and ODT Config.

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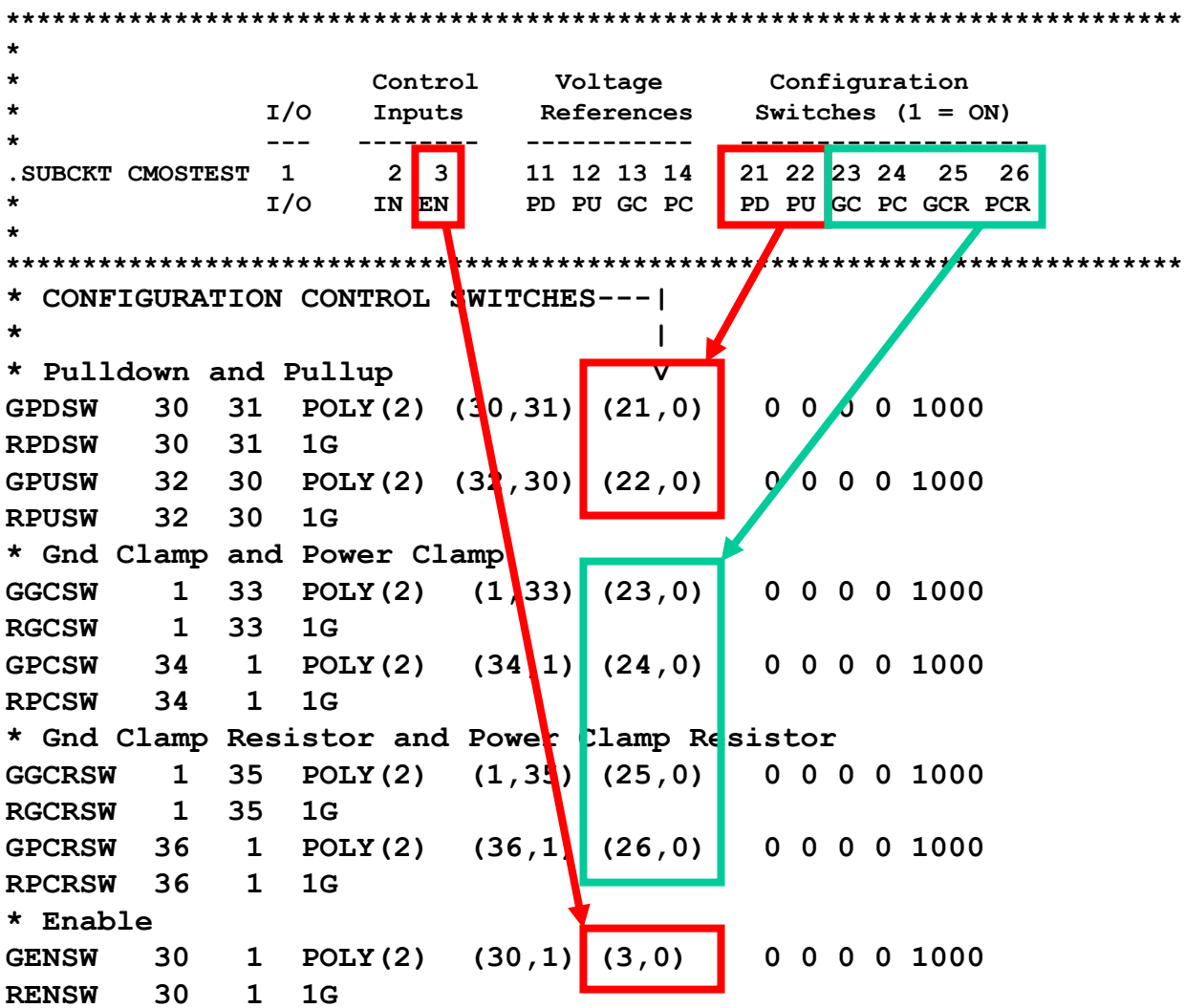
Switches (Berkeley SPICE)



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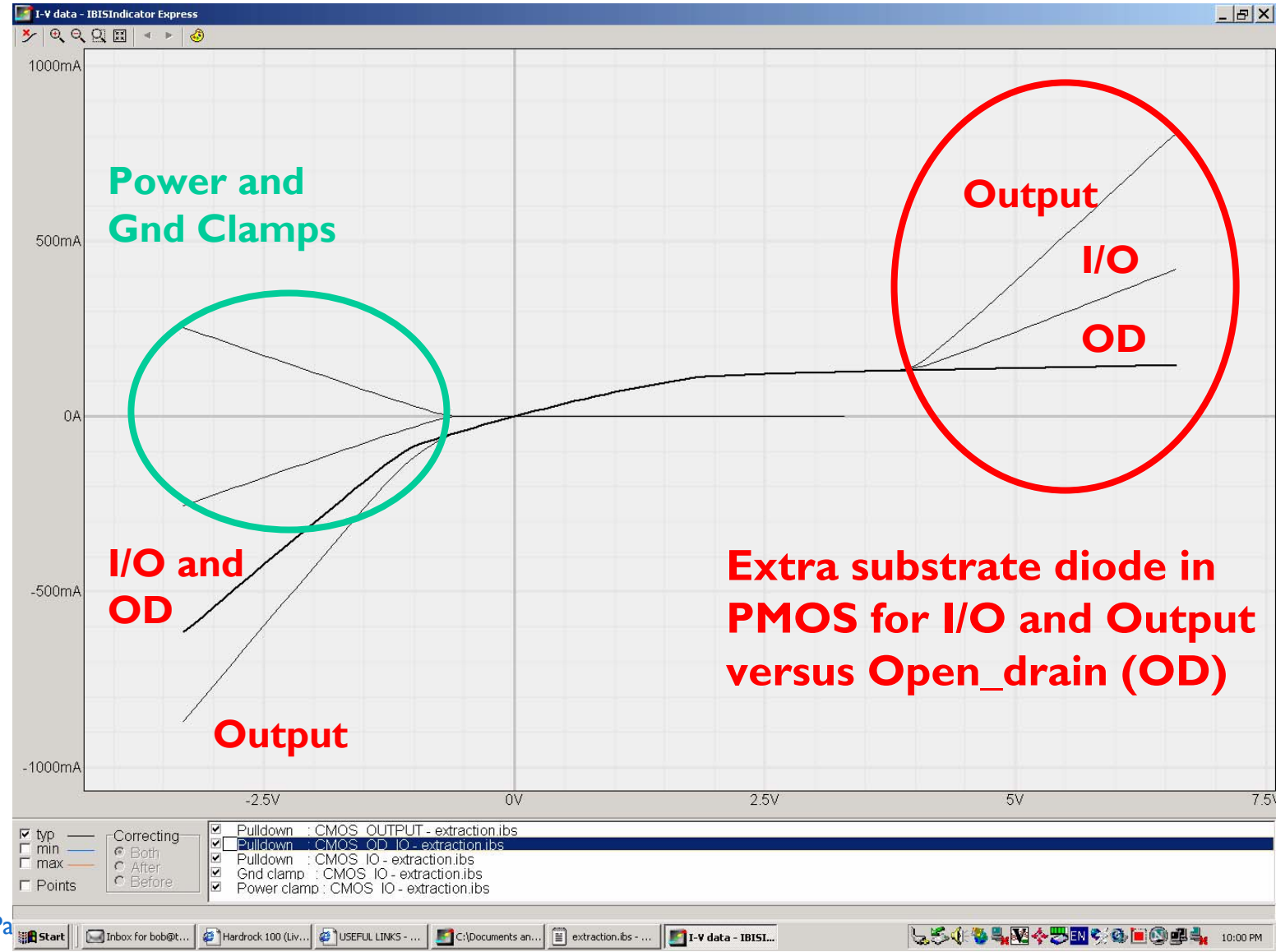
[Pulldown]s for Several Model_types



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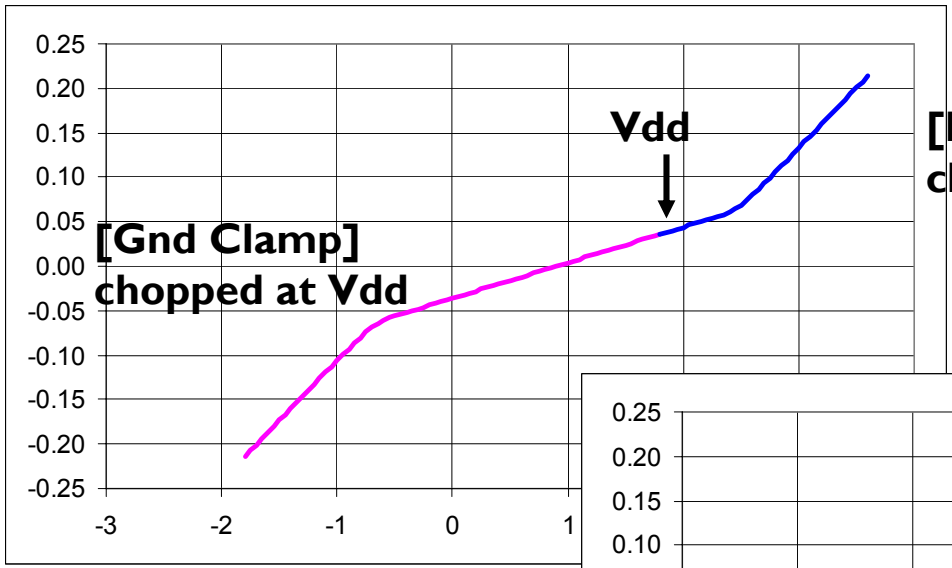
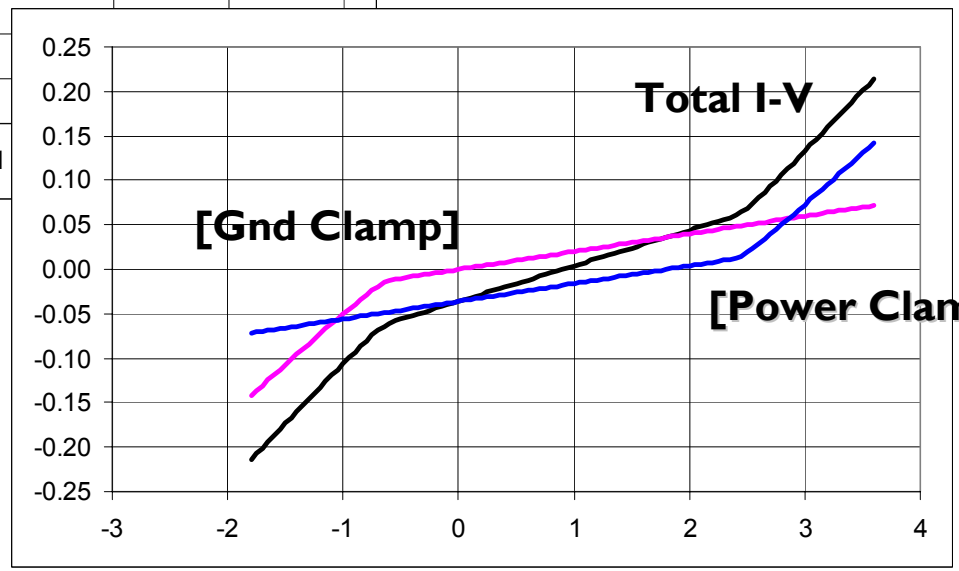
Diode and ODT – Test I-V Processing and SPICE to IBIS Methods





One method based on chopping the I-V tables

Better tables based on "DEC" (Deviate, Extrapolate, Calculate)

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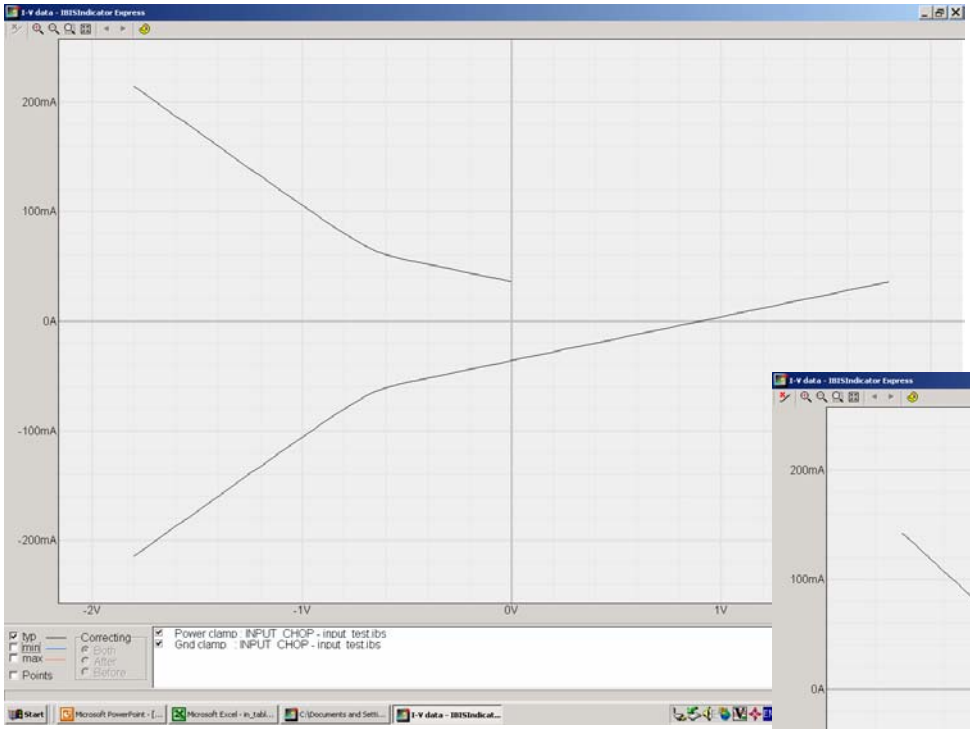
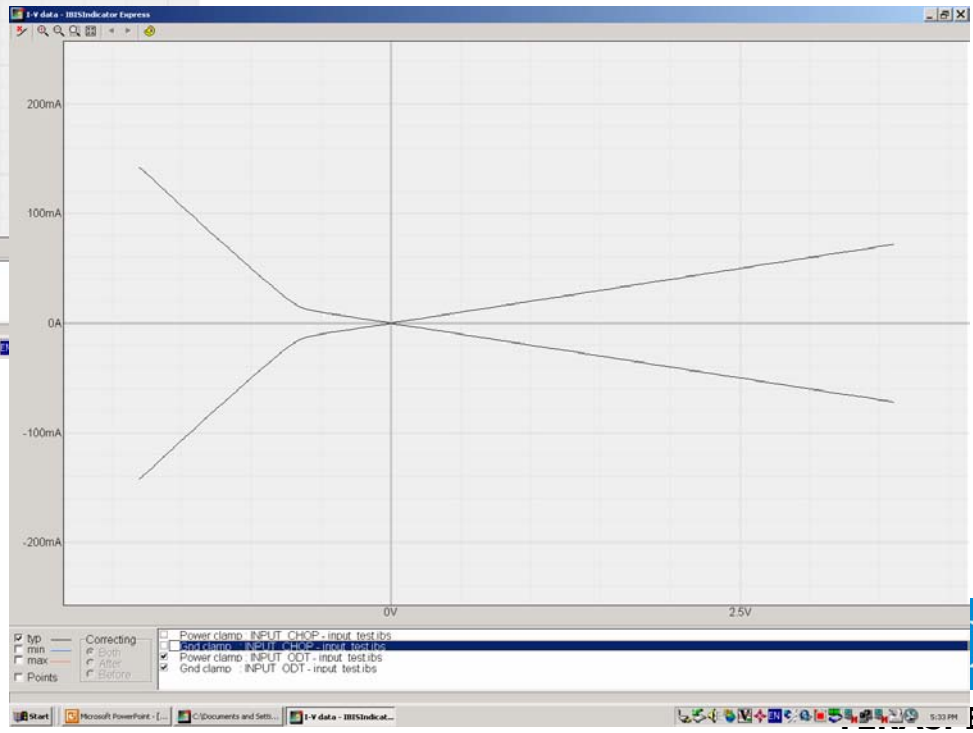
Diode and ODT – Corresponding IBIS Model Plots

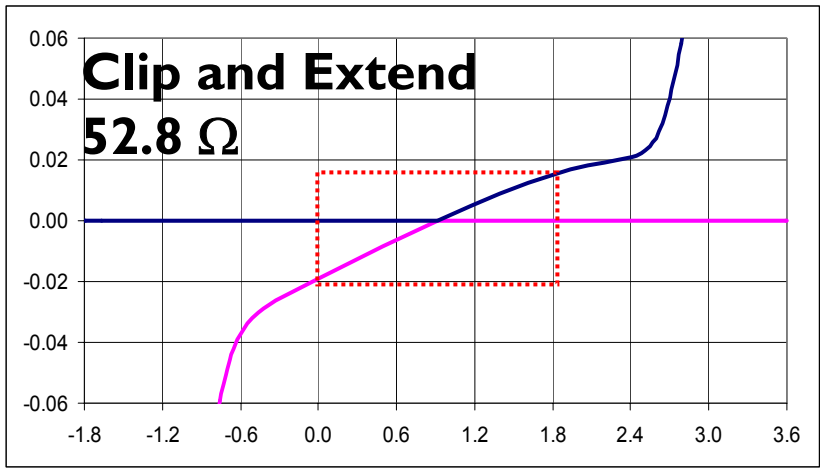


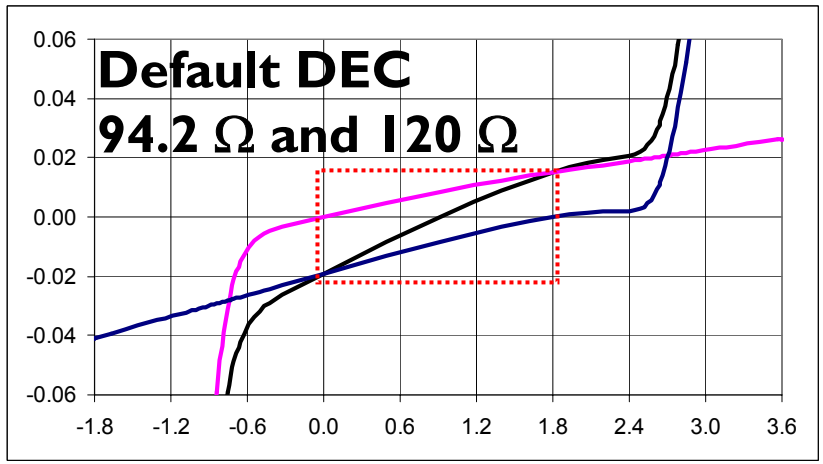
"DEC" IBIS plots show extended range

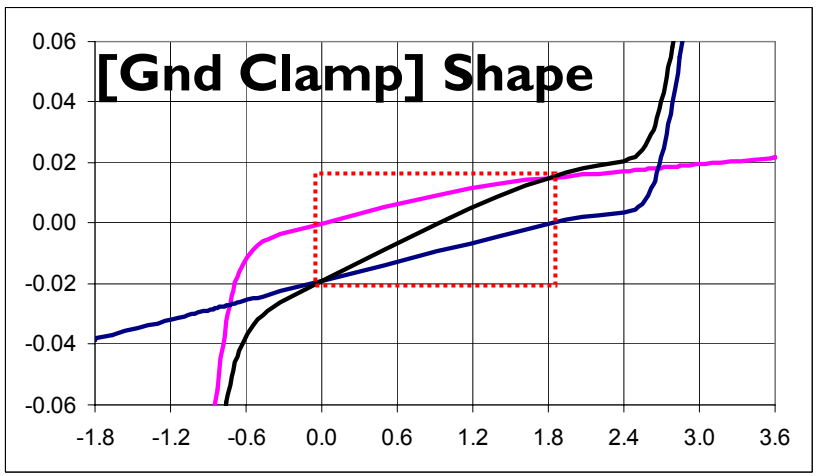


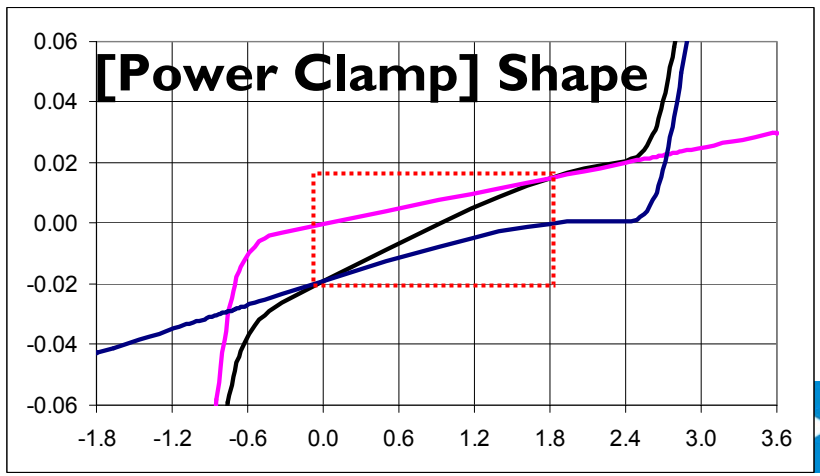
Chopped – can cause double counting of ODT currents in some EDA tools

DEC and Some Other Choices from Ross, 9/2005 ODT Presentation









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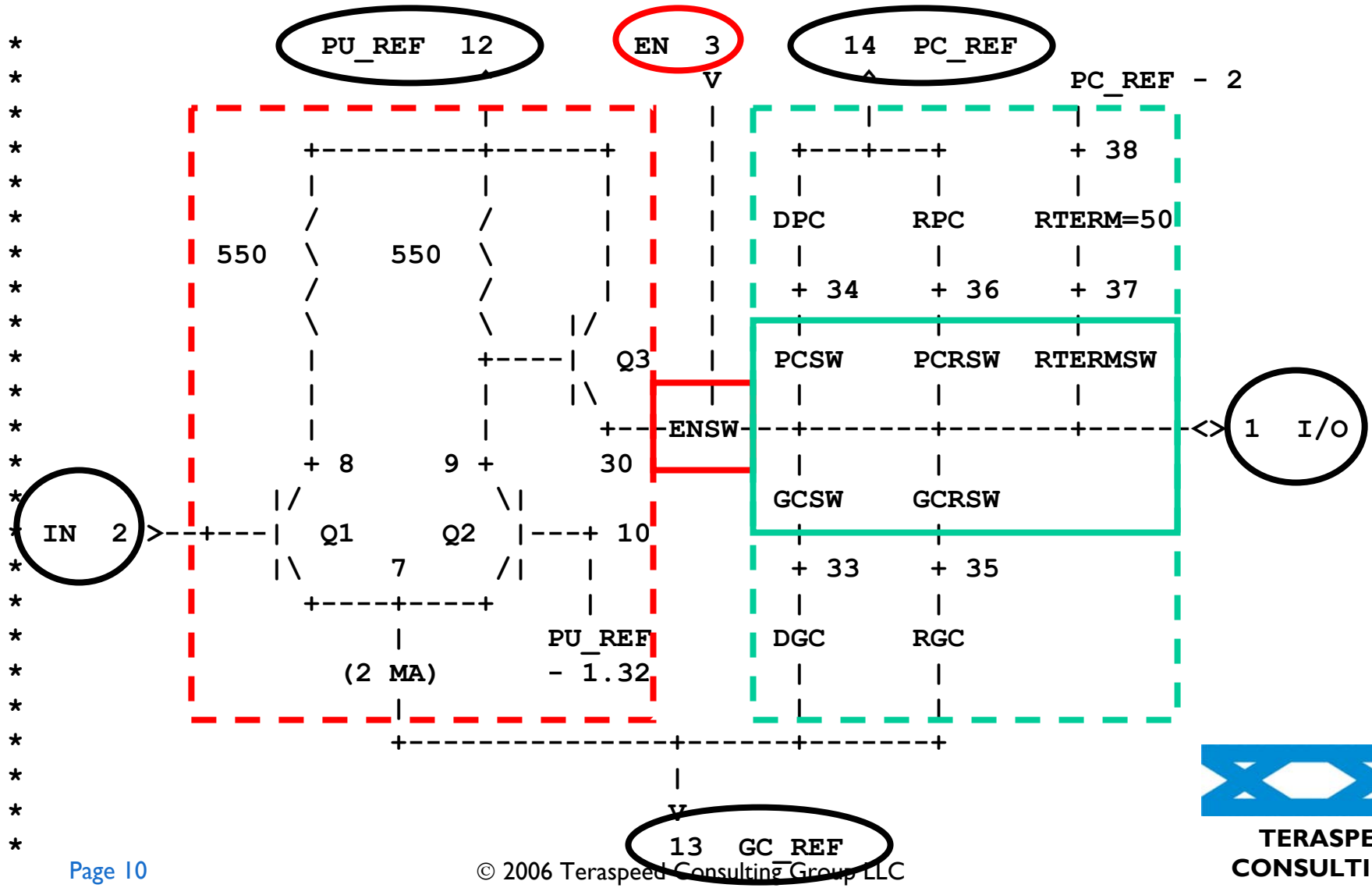
ECL (PECL) Buffer



ECL (PECL) Configuration Control .SUBCKT ECLTEST

```
*********************************************************************
*  ON-OFF CONFIGURATION SWITCHES
*    (1 OR ABOVE = ON, 0 = OFF)
*
*  VGC      1      GND CLAMP
*  VPC      1      POWER CLAMP
*  VGCR     0      INTERNAL GND CLAMP RESISTOR (3K ohm)
*  VPCR     0      INTERNAL POWER CLAMP RESISTOR (2K ohm)
*  VTERM    0      INTERNAL 50 OHM TERMINATOR TO VCC - 2
*
*  VEN = 1       VEN = 1,0        VEN = 0
*  Output_ECL    I/O_ECL,         Input_ECL
*                3-state_ECL
*
*********************************************************************
*
*                        Control   Voltage      Configuration
*                I/O     Inputs    References   Switches (1 = ON)
*                ---   ----------  ----------  --------------------
.SUBCKT ECLTEST  1       2   3     12 13 14    23 24  25  26  27
*                I/O     IN  EN    PU GC PC    GC PC GCR PCR  R50
*                                                   3K  2K  50_2V
*
*********************************************************************
```

Diode Clamps, 2 kΩ and 3 kΩ ODTs, and 50 Ω Internal Terminator

Enable (ECL/PECL voltage levels require EN voltage shifts so that "0" is off)

I/O, Input and Enable

Voltage Refs

Clamps and ODT Configuration

Extraction Tests

- CMOSTEST and ECLTEST for advanced extraction testing
  - All Model_type configurations
  - Voltage reference settings
  - Clamps and internal ODT
    - Double counting
    - Truncation of tables
  - Differential models though subcircuit calls
  - Typ-Min-Max alignment
- Does any s2ibis tool consider all these cases??
  - Otherwise need several passes and hand calculations
- Not covered
  - Submodel modes (for example: DDR2 ODT)
  - Pre-emphasis - [Driver Schedule] partitioning