

# Status

- **All emphasis has been on 2-terminal model, not 3-terminal model**
- **Agere Systems provided non-linear formulation**
  - has effective first and second order voltage coefficients
  - well-behaved numerically c.f. polynomials
  - fitted to data by ADI and Freescale
- **Broadcom provided tanh model**
  - in use by Broadcom and Intersil
  - not directly compared to Agere Systems model

# Formulations

- **Agere Systems**

- $r(V)/r_0 = (1 - p_2 - p_3) + p_2 * (1 + (q_2 * E)^2)^{(1/2)} + p_3 * (1 + (q_3 * |E|)^3)^{(1/3)}, E = V/L$

- **Broadcom**

- $r(V)/r_0 = 1 + A * (\tanh(B * |V| + C) - \tanh(C))$
  - A, B, C have constant, 1/L, 1/W, 1/LW components

# Verilog-A

- **Agere Systems model implemented**
  - field calculation selectable from drawn or effective length
  - should a separate XL be available for E calculation?
    - easy to add so default is  $L_{eff} (=L+XL+dXL_e)$
- **Handling of specifications of L,W or R,W or R,L implemented**
- **(Mostly) mapped to new Verilog-A definition**

# Verilog-A (cont'd)

- **Mismatch included (really need to include global stat. parameters as well)**
  - spatial separation needed?
- **1/f noise scaling needs to be updated to be physical, must be  $I^A/(LW^{A-1})$ , present form does not enforce this (no SPICE model does!)**
- **p2 and p3 constraints can be declared in parameter definitions**
  - p2 range is [0,1)
  - p3 range is [0,1-p2)

# Open Issues/Actions

- **Paul and Colin will compare Agere Systems, Broadcom, and new ADI formulations on the same data sets**
- **Field or voltage formulation?**
  - E formulation is preferable
  - but has nonlinearity go to zero as  $L \rightarrow \infty$
  - Broadcom  $B=b_0+b_1/L$  does not have this issue
- **Explicit ET model with temperature rise node that is optionally external is preferred**
  - intrinsic model then requires no NDR
  - has frequency dependence, implicit model doesn't
- **Efficiency: will look at relative operation times**
  - non-linear code should be bypassed if parameters are 0