What's in the Standard?
Establishing the CMC Policy for Verilog-A Models

Geoffrey Coram, Analog Devices
CMC Technical Advisor for Verilog-A
MOS-AK Workshop Silicon Valley
December 11, 2019
Outline

• History and Motivation
• Items for Consideration
• Current Status
History and Motivation

• Verilog-A has been accepted as the de facto standard language for compact modeling
• CMC requires new model candidates in VA
  – All recent models have been in VA: MVSG, ASM-HEMT, LUTSOI
• Significant improvement over C (or Fortran!)
History and Motivation

• But how much of the Verilog-A code is considered “standard”?
  – Everything (module name, parameters, operating-point values, noise names, warning messages, ...)
  – Only electrical quantities (currents & charges)
  – Something in between
History and Motivation

• Specific issue:
  – One simulator changed the sign of VTH as defined in the Verilog-A code for PMOS devices
  – Does this violate the standard?
Items for Consideration

1. Module name
2. File name
3. Terminal names
4. Parameters
5. Operating-point values
6. Noise source names
7. Reference temperature
8. Temperature offset
9. Gmin
10. Scaling
11. Warning and error messages
1. Module name

- **Hicum has** `module hic2_full`
- **Mextram has** `module bjt504tva, bjt504va, bjtd504tva, bjtd504va`
- **PSP has** `module PSP103VA, PSP103TVA, PSPNQS103VA`
- **HiSIM-HV has** `module hisimhv_va, hisimhv_n4_va, hisimhv_n5_va`
- **BSIM-CMG has** `module bsimcmg`
- **BSIM-IMG has** `module bsimimg`
1. Module name

• We want to have a standard convention for names
• Some simulators may not allow replacement of internal devices
• For debugging, useful to be able to instantiate VA and built-in in the same netlist
• Requirement: module name should be lower-case, and append _va to the official name of the model
4. Parameters

• Should parameters be declared UPPERCASE or lowercase?

• UPPER: PSP, MOSVAR, BSIM6, BSIMCMG, BSIMIMG, BSIMSOI, HiSIM, HiSIM-HV, HiSIM-SOI, HiSIM-SOTB, Mextram, Diode_CMC

• lower: HiCUM, R2_cmc, R3_cmc
4. Parameters

- UPPERCASE makes it easy to read the code and know which quantities are parameters.
- Lowercase is consistent with implementation in (case-sensitive) simulators.
- Verilog-AMS uses lowercase in Annex E (Spice compatibility).
- Hard to switch between VA and built-in if case is not consistent.
4. Parameters

• **Requirement:** parameters should be written in lower-case

• Model developers may want to use macro to visually mark parameters:

  `define PAR(x) x

  \[ W_{\text{eff}} = \text{`PAR}(w) + \text{`PAR}(dw); \]
5. Operating-point values

- Simulations may use op-pt values for SOA checks
- CMC’s Open Model Interface (OMI) uses op-pt values for computations (e.g., aging)
- Values must be consistent across simulators

- Requirement: Operating-point values are part of the standard
Current Status

• CMC ballot on these 11 items
  – All passed per CMC voting policy
  – However, significant disagreement on Scaling (to be discussed at CMC Q4 meeting)

• Official policy document will be posted soon

• Suggestions for additional items are welcome
Implementation Timeline

• All new candidates for standard models are expected to follow the policy
• Existing CMC standards are not required to change
• Expectation that existing standards will be updated on the next version change (e.g., version 103.3 to 104.0)