BSIM: Industry Standard Compact MOSFET Models

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SPICE Transistor Modeling

- **Simulation Time**
  - \( \sim 10\mu s \) per DC data point
  - No complex numerical method allowed

- **Accuracy requirements**
  - \( \sim 1\% \) RMS Error after fitting

- **Excellent Convergence**

- **Example: BSIM-CMG**
  - 5,000 lines of VA code
  - 50+ parameters
  - Open-source software implemented in major EDA tools
Compact MOSFET Modeling Approaches

- Threshold Voltage based Models (e.g. BSIM3, BSIM4)
  - Fully Analytical solution (easy to implement) – Fast
  - Currents expressed as functions of Voltages
    \[ I_{ds} = \frac{W}{L} \mu C_{ox} \left[ (V_{gs} - V_{th})V_{ds} - \frac{1}{2}V_{ds}^2 \right] \]
  - Different equations for
    - Sub-threshold and above-threshold
    - Linear/saturation regions
    - Use interpolation function to get smooth current

\[ \log(I_{ds}) \]
\[ V_{gs} \]
Compact MOSFET Modeling Approaches

- **Surface Potential based Models (e.g. PSP, HiSim, BSIM-CMG, BSIM-IMG)**

  $$V_G - V_{FB} - \Psi_S = -\frac{Q_{si}}{C_{ox}}, \quad Q_{si} = -\text{sign}(\Psi_S) \Gamma C_{ox} \sqrt{V_t \left( e^{\frac{\Psi_S}{V_t}} - 1 \right)} + V_t e^{\frac{-2 \Phi_F + V_{CH}}{V_t}} \left( e^{\frac{\Psi_S}{V_t}} - 1 \right) + \Psi_S$$

  - Implicit equation is solved either iteratively or analytically
  - Might be slower than threshold voltage based models

- **Charge based Models (e.g. BSIM5, BSIM6, EKV)**

  - Solve for charge instead of surface potential
  - No iterations
  - Faster than Surface Potential based approach with similar accuracy in charge/current
Outline

- History of BSIM Models
- BSIM6 Model
- BSIM-CMG Model
- BSIM-IMG Model
History of BSIM Models

- **BSIM1 Model**
  - Defined as an engineering model (vs a purely physical model)
  - Focus on the implementation in circuit simulator
  - Only a fast demonstration for DC simulation (no attention on derivatives)

- **BSIM2 Model**
  - A semi-physical (semi-empirical) model
  - Improvement over BSIM1 to include better fitting to output resistance and other first order derivatives
  - Huge attention placed on parameter extraction methodology
  - Still being used in many companies as internal model due to its fitting ability and simple parameter extraction
History of BSIM Models

BSIM3 Model
- Starts as a simple physical model with very few parameters
- First time – Continuous $I-V$ and derivatives for fast convergence
- The 3rd version (BSIM3v3) becomes industry standard
- Need to fit many technologies from different foundries – many new parameters added
  - Example – Need to have fitting parameters
  - Due to difficult to describe structural detail

![-diagram showing a MOSFET and the relationship between log($I_D$), $V_G$, and $V_{off}$]
History of BSIM Models

- BSIM4 model
  - Started as model for statistical simulation
  - Priority on physical effects (gate current, mobility models etc.)
  - Added gate and body resistance networks to emphasize accuracy on RF simulation
  - Industry standard in 2000 and most widely used model by semiconductor industry
  - Provides better fitting with more number of parameters

- BSIM-SOI
  - Parallel work went on SOI modeling – PD/FD/DD
  - Real device effects same as BSIM3/BSIM4
  - Industry standard in 2002
BSIM Family of Compact Device Models


BSIM1,2  BSIM3  BSIM4  BSIM5  BSIM6

Bulk MOSFET
Silicon on Insulator MOSFET
Multi-Gate MOSFET

BSIM: Berkeley Short-channel IGFET Model
BSIM6: Charge based MOSFET model

- BSIM6 – Next BSIM Bulk MOSFET model
  - Charge based core derived from Poisson’s solution
  - Real device effects (SCE, CLM etc.) from BSIM4
  - Parameter names matched to BSIM4

- Physical Capacitance model
  - Short channel CV–Velocity saturation & CLM

- Symmetry
  - Currents & derivatives are symmetric @ VDS=0
  - Capacitances & derivatives are symmetric @ VDS=0
  - Provide accurate results in Harmonic Distortion simulation

- Continuous in all regions of operations

- Better Statistical Modeling using physical parameters
Physics of BSIM6 Model

- Gauss’ Law
  \[ V_G - V_{FB} - \Psi_S = -\frac{Q_{si}}{C_{ox}} = -\frac{Q_i + Q_b}{C_{ox}} \]

- Poisson’s solution for long channel MOSFET
  \[
  \frac{Q_{si}}{\Gamma C_{ox} \sqrt{V_t}} = \mp \sqrt{e^{-\frac{\Psi_S}{V_t}} + \frac{\Psi_S}{V_t} - 1} + e^{-\frac{2\Phi_F + V_{ch}}{V_t}} \left( e^{\frac{\Psi_S}{V_t} - \frac{\Psi_S}{V_t} - 1} \right)
  \]

- Bulk charge density is given by
  \[
  \frac{Q_b}{\Gamma C_{ox} \sqrt{V_t}} = \mp \sqrt{e^{-\frac{\Psi_S}{V_t}} + \frac{\Psi_S}{V_t} - 1}
  \]

- Combining these, we have
  \[
  V_G - V_{FB} - \Psi_S = -\frac{Q_i}{C_{ox}} \pm \Gamma \sqrt{V_t \left( e^{-\frac{\Psi_S}{V_t}} + \frac{\Psi_S}{V_t} - 1 \right)}
  \]
Defining Pinch-off potential $\Psi_P = \Psi_S$, when $Q_i = 0$

$$V_G - V_{FB} - \Psi_P = \text{sign}(\Psi_P)\Gamma\sqrt{V_t \left( e^{-\frac{\Psi_P}{V_t}} + \Psi_P - 1 \right)}$$

For $\Psi_S > \text{few } V_t$, we have

$$-\frac{Q_i}{\Gamma C_{ox} \sqrt{V_t}} = \sqrt{\frac{\Psi_S}{V_t}} + e^{-\frac{\Psi_S - 2\Phi_F - V_{ch}}{V_t}} - \sqrt{\frac{\Psi_S}{V_t}}$$

Inversion Charge linearization

$n_q$ is the slope factor

Physics of BSIM6 Model

- Using linearization approach and normalization
- No approximation to solve the charge equation compared to other models.
- Solved the charge equation analytically

\[
\ln(q_i) + \ln\left(\frac{2n_q}{\gamma} q_i + 2\sqrt{-2q_i + \psi_p}\right) + 2q_i = \psi_p - 2\phi_f - v_{ch}
\]

ACM/EKV/BSIM5 ignored the circled term
Drain current with velocity saturation

- **Drain current**
  
  
  \[ I_D = I_{\text{drift}} + I_{\text{diff}} = \mu W \left( -Q_i \frac{d\Psi_S}{dx} + V_T \frac{dQ_i}{dx} \right) \]

- **Mobility model (ensures symmetry)**
  
  \[ I_D = \frac{\mu_v W}{\sqrt{1 + \left( \frac{\mu_v}{v_{sat}} \frac{d\Psi_S}{dx} \right)^2}} \left( -Q_i \frac{d\Psi_S}{dx} + V_T \frac{dQ_i}{dx} \right) \]

- **Using charge linearization & normalization**
  
  \[ i_d = \frac{q_s^2 + q_s - (q_d^2 + q_d)}{2 \left( 1 + \sqrt{1 + \left[ \lambda_c (q_s - q_d) \right]^2} \right)} \]
Normalized $Q_i - V_G$ & derivatives

- $q_i$ vs $V_G$
- 1st derivative
- 2nd derivative
- 3rd derivative

Red – Numerical Surf. Pot. model
Blue – BSIM6 model
Normalized $I_{DS}-V_{GS}$ & derivatives

$I_{DS}$ vs $V_{G}$

1st derivative

2nd derivative

Red – Numerical Surf. Pot. model

Blue – BSIM6 model

3rd derivative
Mobility Model

- Mobility model has been adopted from BSIM4

\[
\mu_{\text{eff}} = \frac{U_0 \cdot f(L_{\text{eff}})}{1 + (UA + UC \cdot V_{bsx})} \cdot \left[ \frac{V_{gs}-\Phi_s}{\text{TOX}} \right]^{BE} + UD \left( \frac{V_{th} \cdot \text{TOX}}{V_{pddr} + 2V_{th} + 0.0001} \right)
\]

where

\[
\eta = \begin{cases} 
\frac{1}{2} \cdot ETAMOB & \text{for NMOS} \\
\frac{1}{3} \cdot ETAMOB & \text{for PMOS}
\end{cases}
\]

\[
E_{\text{effs}} = 10^{-8} \cdot \left( \frac{q_{bs} + \eta \cdot q_{is}}{\varepsilon_{\text{ratio}} \cdot \text{TOX}} \right)
\]

MV/cm

BSIM4

\[
U_0 
\]

BSIM6

\[
\mu_{\text{eff}} = \frac{U_0}{1 + (UA + UC \cdot V_{bsx}) \cdot E_{\text{eff}}^{EU} + \left[ \frac{1}{2} \left( 1 + \frac{q_{is}}{q_{bs}} \right) \right]^{UCS}}
\]

\[
V_{dsx} = \sqrt{V_{ds}^2 + 0.01} - 0.1
\]

\[
V_{bsx} = - \left[ V_s + \frac{1}{2} (V_{ds} - V_{dsx}) \right]
\]
Saturation Voltage $V_{dsat}$

- $V_{ds}$ to $V_{dsat}$ – BSIM4 formulation causes asymmetry

$$V_{BSIM4}(V_{ds}, V_{dsat}, \delta_0) = V_{dsat} - \frac{1}{2} \left[ (V_{dsat} - V_{ds} - \delta_0) + \sqrt{(V_{dsat} - V_{ds} - \delta_0)^2 + 4\delta_0 V_{dsat}} \right]$$

- New $V_{dsat}$ evaluation:

$$\lambda_c = \frac{2 \mu_{eff} V_t}{V_{SAT} \cdot L_{eff}}$$

$$q_{dsat} = \frac{1}{2} \frac{K_{SATIV} \cdot \lambda_c \cdot \frac{q_s^2 + q_s}{1 + \frac{1}{2} \lambda_c (1 + q_s)}}{\gamma}$$

$$V_{dsat} = \frac{V_{dsat}}{V_t} = \psi_p - 2\varphi_f - 2q_{dsat} - \ln \left[ \frac{2q_{dsat} \cdot n_q}{\gamma} \left( \frac{2q_{dsat} \cdot n_q}{\gamma} + \frac{\gamma}{n_q - 1} \right) \right]$$

$$V_{dseff} = \frac{V_{ds}}{\left[ 1 + \left( \frac{V_{ds}}{V_{dsat} - V_s} \right)^{1/Delta} \right]^{DELTAn}}$$

![Graph showing the relationship between $V_{ds}$ and $V_{dsat}$](image)
CV Model

- Physical Capacitance Model
- Poly-depletion & Quantum Mechanical Effect
- Channel Length Modulation
- Velocity Saturation Effect

- Charge conservation
Junction capacitance model

- BSIM4 junction capacitance model gave asymmetry
- Updated diode junction capacitance model for AC symmetry

\[ Q_{j\text{old}}(V_j) = \begin{cases} 
C_j \cdot P_{BS} \cdot \frac{1 - \left(1 - \frac{V_j}{P_{BS}}\right)^{1-MJS}}{1 - MJS} & \text{if } V_j < 0 \\
0 & \text{if } V_j = 0 \\
V_j \cdot C_j + V_j^2 \cdot \frac{MJS \cdot C_j}{2 \cdot P_{BS}} & \text{if } V_j > 0 
\end{cases} \]

Transition point is at \( V_j = 0 \)

\[ Q_{j\text{new}}(V_j) = \begin{cases} 
x_0 \leftarrow 0.9 \\
C_j \cdot P_{BS} \cdot \frac{1 - \left(1 - \frac{V_j}{P_{BS}}\right)^{1-MJS}}{1 - MJS} & \text{if } \frac{V_j}{P_{BS}} < x_0 \\
C_j \cdot P_{BS} \cdot \frac{1}{(1 - x_0)} \cdot \left(1 - \frac{V_j}{P_{BS}}\right) \left[\frac{1}{2} \cdot MJS, \frac{1}{(1 - x_0)} \cdot \left(1 - \frac{V_j}{P_{BS}}\right) - (1 + MJS) \right] + C_j \cdot \frac{P_{BS}}{1 - MJS} \left[1 - \frac{MJS}{2} \cdot (1 + MJS) \cdot (1 - x_0)^{1-MJS}\right] & \text{otherwise} 
\end{cases} \]

Transition point is at \( V_j = 0.9V \) (pushed to strong forward bias)
Junction capacitance model

- Symmetry problem using old $Q_j$
- New model is infinitely differentiable @ $V_{DS} = 0$
$I_{DS}$-$V_X$ Gummel Symmetry

$I_X$ vs $V_X$ ($V_D=V_X$ & $V_S=-V_X$)

All derivatives are continuous at $V_{DS}=0$
AC Symmetry test
(C. McAndrew, IEEE TED, 2006)

Capacitance & derivatives are symmetric

Capacitances and derivatives are continuous at $V_{DS}=0$
Validation on Measured Data (Large device)

- $I_{D}V_{G}$ @ $V_{DS}=50$mV
- $I_{D}V_{G}$ in saturation
- $I_{D}V_{D}$
- $g_{ds}V_{D}$
- $I_{B}V_{G}$ for different $V_{DS}$
Validation on Measured Data (Short device)

- $I_{DVG} @ V_{DS}=50\text{mV}$
- $I_{DVG}$ in saturation
- $g_{mVG}$ in saturation
- $I_{DVG}$ for different $V_{DS}$
BSIM6 gives correct slope for all harmonics
BSIM6 model summary

- **Rapid development:** Released BSIM6.0.0-beta8 in Aug. 2012
- **Charge based physical compact model**
  - Physical effects & Parameter names matched to BSIM4
  - Smooth charge/current/capacitance & derivatives
- **Symmetric and continuous around** $V_{DS}=0$
  - Fulfills Gummel symmetry and AC symmetry
  - Shows accurate slope for harmonic balance simulation
- BSIM4’s **extraction methodology** can be easily used for BSIM6 – **fast deployment & lower cost**
- Under standardization review in CMC
Outline

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Why next generation transistors?

MOSFET becomes “resistor” at small L.

Gate cannot control the leakage current paths that are far from the gate.

One Way to Eliminate Si Far from Gate

Thin body controlled
By multiple gates.

FinFET body
is a thin Fin.

N. Lindert et al., DRC paper II.A.6, 2001
New MOSFET Structures: Demonstration

X. Huang et al. IEDM 1999 (UC Berkeley)

FinFET

Y. Choi et al. IEEE EDL 2000- (UC Berkeley)

UTBSOI

C.C. Wu et al. IEDM 2010 (TSMC)

K. Cheng et al. IEDM 2009 - (IBM / ST)
Challenges in developing a new model

- New Physics
  - Fully depleted channel
  - Quantum confinement etc.
  - When to include them?

- Support Multiple Device architectures

- Inertia with BSIM4 – Large user base
  - Familiarity with the parameters

- Convergence – Model behavior in extreme cases

- Balance Physics and Flexibility

- Balance Speed and Accuracy
Multi-Gate Compact Model: BSIM-MG

BSIM-IMG

UTBSOI

BG-ETSOI

BOX

P+ back-gate

p-sub

BSIM-CMG

FinFETs on Bulk and SOI Substrates

Vertical Fin IMG

Twin Silicon Nanowire FET

Horizontal Nanowire FET
BSIM-CMG Core Models

- Four device architectures
  - Double Gate
  - Double Gate / Trigate / FinFET
  - Quadruple Gate
  - Cylindrical Gate / Nanowire FET

- Three core models
  - Intrinsic Double Gate Core (Y. Taur et al., IEEE EDL, 2004)
  - Perturbation based DG Core for high-doping
  - Cylindrical Gate Core

- Bulk and SOI Substrate
- Solution of Poisson’s equation and Gauss’s Law.

- Poisson’s equation inside the body can be written as ($V_{ch}$ is channel potential)

\[ \frac{d^2 \psi}{dx^2} = \frac{q n_i}{\epsilon S_i} \cdot \left( \frac{q \psi}{e kT} \cdot e^{-\frac{q \phi_B}{kT}} \cdot e^{-\frac{q V_{ch}}{kT}} + \frac{q \phi_B}{e kT} \right) \]

where $\phi_B = \frac{kT}{q} \ln \left( \frac{N_A}{n_i} \right)$

- Body doping complicates the solution of the Poisson’s equation.

- Perturbation approach is used to solve this problem.

M. Dunga et al., IEEE TED, Vol. 53, No. 9, 2006
M. Dunga et al., VLSI 2007
Core Drain Current Model

- No charge sheet approximation

\[ I_d = \mu \frac{W_{eff}}{L} \left[ \frac{Q_i^2}{2C_{ox}} + 2V_t Q_i - V_t \cdot (5C_{Si} V_t + Q_B) \ln (5V_t C_{Si} + Q_B + Q_i) \right] \]

Graphs showing drain current vs. drain voltage and gate voltage for different gate voltages and drain voltages.

- Drain Current (A)
  - Na = 3e18 cm⁻³
  - Vg = 0.9V
  - Vg = 1.2V
  - Vg = 1.5V

- Drain Voltage (V)
  - 0.0 0.5 1.0 1.5
  - 500µm 1m

- Gate Voltage (V)
  - Vd = 0.1
  - Vd = 0.2
  - Vd = 0.4
  - Vd = 0.6

Na = 3e18 cm⁻³
Core Capacitance Model

- Model inherently exhibits symmetry
  - $C_{ij} = C_{ji} @ V_{ds} = 0 \text{ V}$
- Model matches TCAD data (No parameter used)
- Accurate short channel behavior
Short Channel (2D) Effects

- **Quasi-2D analysis**

  **Characteristic Length**

  \[ H_{\text{eff}} = \sqrt{\frac{H_{\text{FIN}}}{8}} \cdot (H_{\text{FIN}} + 2 \cdot \varepsilon_{\text{ratio}} \cdot EOT) \]

  \[ \lambda = \begin{cases} \sqrt{\frac{\varepsilon_{\text{ratio}}}{2} \left(1 + \frac{T_{\text{FIN}}}{4\varepsilon_{\text{ratio}}EOT}\right) T_{\text{FIN}} \cdot EOT} & \text{if GEOMOD} = 0 \\ \sqrt{\frac{1}{2\varepsilon_{\text{ratio}}(1+\frac{T_{\text{FIN}}}{4\varepsilon_{\text{ratio}}EOT})T_{\text{FIN}}EOT + \frac{1}{4H_{\text{eff}}^2}}} & \text{if GEOMOD} = 1 \\ \frac{1}{2} & \text{if GEOMOD} = 2 \\ \sqrt{\frac{\varepsilon_{\text{ratio}}}{2} \left(1 + \frac{R}{2\varepsilon_{\text{ratio}}EOT}\right) R \cdot EOT} & \text{if GEOMOD} = 3 \end{cases} \]

- **Analytical expressions model**

  Auth and Plummer, IEEE EDL, 2007
Quantum Mechanical Effects

- Predictive model for confinement induced Vth shift due to band splitting present in the model
- Effective Width model that accounts for reduction in width for a triple/ quadruple/ surround gate structure

![Diagram showing normalized charge centroid vs. inversion charge with different radii and the effective width perimeter marked with dashed lines.](image)
FinFET $C_{fr}$ Modeling – TCAD Verification

- $C_{fg}$: fin $\rightarrow$ gate
- $C_{cg} = C_{cg1} + C_{cg2} + C_{cg3}$: contact $\rightarrow$ gate

Both $C_{fg}$ and $C_{cg}$ agree well with 2D numerical simulations.
Real Device Effects

- Channel Length Modulation and DIBL
- Velocity Saturation
- GIDL Current
- Impact Ionization current
- Direct tunneling gate current
- Mobility Degradation
- Short Channel Effects
- Quantum Effects
- Temperature Effects
- Fringe Capacitances
- Overlap capacitances
- S/D Resistance/Parasitic Resistance
- Noise models
Bulk FinFET Fitting

- Bulk FinFETs are fabricated by TSMC
- $T_{FIN} = 25\text{nm}$, $H_{FIN} = 27.5\text{nm}$, $EOT = 2.42\text{nm}$

Symbols: Data
Lines: Model
Asymmetric Vertical Nanowire fitting

- $L_g=120\text{nm}$, $D=80\text{nm}$, $Tox=3\text{nm}$

Symbols: Data
Lines: Model
Symmetry / Continuity Tests

- Model passes both DC and AC Symmetry Tests

\[ C_{C.McAndrew}, IEEE TED, Vol. 53, No. 9, 2006 \]

Drain Current

Capacitances (\( C_{gg} \) and \( C_{sd} \))
BSIM-CMG Summary

- BSIM-CMG 106.0.0 is industry standard production level model – standardized in March 2012
  - Available in major EDA tools
- Released BSIM-CMG 106.1.0 in Sept. 2012
- Physical, Scalable Core Models for multiple device architectures
  - Supports both SOI and Bulk Substrates
  - Many Real Device Effects captured
- Validated on Hardware Data from different technologies
Outline

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Device Structure & BSIM-IMG

- Asymmetric structure
  - Different Gate Work-functions
  - Allows dissimilar Gate Potentials
  - Different Oxide thickness and Material!

- Captures important features
  - $V_{th}$ tuning through Back-Gate
  - Multi-$V_{th}$ technology
Computationally Efficient Core

- Efficient Non-iterative Surface Potential calculation

- Surface potential needs to solved at least twice - Source and Drain side
  - Obtain $\psi_s / Q_{is}$ and $\psi_d / Q_{id}$

Results: Surface-Potential

Comparison with Numerical Solution

 Absolute Error (<nV)
Volume Inversion

- Preserves Important Property like Volume Inversion

- In sub-threshold (Low field), the charge density $Q_i$ is proportional to the body thickness $T_{si}$

$$T_{oxb} = 10\mu m$$
Drain Current Model

\[
I_{ds} = \mu \frac{W}{L} \left[ \frac{Q_{inv,s} + Q_{inv,d}}{2} \left( \psi_{s1,d} - \psi_{s1,s} \right) + \eta \frac{kT}{q} \left( Q_{inv,s} - Q_{inv,d} \right) \right]
\]

\[
\eta = 2 - \frac{2\varepsilon_{si}E_{s2}}{Q_{inv} + 2\varepsilon_{si}E_{s2}}
\]

- **Drift**
- **Diffusion**

Q_{inv}: inversion carrier density
E_{s2}: back-side electric field
\psi_{s1}: front-side surface potential

No Charge-sheet Approximation

Very high accuracy

![Graph showing Drain Current vs Drain Voltage](image1)

![Graph showing Error Relative to TCAD (%)](image2)
Length Dependent $\gamma$ Model

- **Capacitive coupling ratio**

$$\gamma = -\frac{dV_{TH}}{dV_{bg}}$$

**Gate Length ($\mu$m)**

- $T_{si}=8\text{nm}$
- $T_{box}=4\text{nm}$

$\gamma$ degraded at short channel

Captures $V_{bg}$ effect in I-V
QM Effect: Inv. Charge Centroid Model

\[ V_{dd} = 0.9 \text{ V} \; ; \; V_{fb} = 28 \text{ mV} \]
\[ T_{BOX} = 140 \text{ nm} \; ; \; T_{si} = 6 \text{ nm} \; ; \; N_{sub} = 1e16 \text{ cm}^{-3} \]

\[ EOT_{phys} = 0.65 \text{ nm} \]
\[ T_{inv} = 1.13 \text{ nm} \]
\[ EOT_{eff} = 0.95 \text{ nm} \]
Self Heating Model

- **Thermal Node: Rth/Cth methodology**

\[ R_{th} = \frac{R_{TH0}}{W_{TH0} + W_{eff}} \]

\[ C_{th} = C_{TH0} \cdot (W_{TH0} + W_{eff}) \]

- Relies on Accurate physical modeling of Temperature Effects in the model

Global Extraction: $I_d - V_{gs}$ at different $V_{bg}$

- $V_{bg}=0, -0.2, -0.5, -0.8, -1.1$ V; $V_{ds}=50$ mV
- $L=11$ um, 1.1 um, 270nm, 60 nm, 40 nm, 30 nm

$TBOX=10$ nm
Gummel Symmetry Test

- **Drain Current Symmetry**

- **AC (charge) Symmetry**

Analog /RF Ready

C. C. McAndrew, TED 2006
BSIM-IMG: Current Status & Future

- **Production level UTBSOI Model**
  - Physical and Scalable for FDSOI devices
  - Plethora of Real Device Effects model

  - Available in different EDA tools
  - Already being used by SOI Consortium

- Under standardization at Compact Model Council

- Verilog-A code and Well-documented Manual

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- ST Microelectronics
- Analog Devices
- Texas Instruments
- IBM
- TSMC
- Global Foundries
- All other CMC Members
BSIM6 Publications & References


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Thank You