

# Table of Contents

## Chapter 1: Effective Oxide Thickness, Channel Length and Channel Width 1-1

- 1.1 Gate Dielectric Model 1-1
- 1.2 Poly-Silicon Gate Depletion 1-2
- 1.3 Effective Channel Length and Width 1-5

## Chapter 2: Threshold Voltage Model 2-1

- 2.1 Long-Channel Model With Uniform Doping 2-1
- 2.2 Non-Uniform Vertical Doping 2-2
- 2.3 Non-Uniform Lateral Doping: Pocket (Halo) Implant 2-5
- 2.4 Short-Channel and DIBL Effects 2-6
- 2.5 Narrow-Width Effect 2-9

## Chapter 3: Channel Charge and Subthreshold Swing Models 3-1

- 3.1 Channel Charge Model 3-1
- 3.2 Subthreshold Swing  $n$  3-5

## Chapter 4: Gate Direct Tunneling Current Model 4-1

- 4.1 Model selectors 4-2
- 4.2 Voltage Across Oxide  $V_{ox}$  4-2
- 4.3 Equations for Tunneling Currents 4-3

## Chapter 5: Drain Current Model 5-1

- 5.1 Bulk Charge Effect 5-1
- 5.2 Unified Mobility Model 5-2
- 5.3 Asymmetric and Bias-Dependent Source/Drain Resistance Model 5-4
- 5.4 Drain Current for Triode Region 5-5
- 5.5 Velocity Saturation 5-7
- 5.6 Saturation Voltage  $V_{dsat}$  5-8
- 5.7 Saturation-Region Output Conductance Model 5-10
- 5.8 Single-Equation Channel Current Model 5-16

## Chapter 6: Body Current Models 6-1

6.1 *Iii* Model 6-1

6.2 *IGIDL* & *IGISL* Model 6-2

## Chapter 7: Capacitance Model 7-1

7.1 General Description 7-1

7.2 Methodology for Intrinsic Capacitance Modeling 7-3

7.3 Charge-Thickness Capacitance Model (CTM) 7-9

7.4 Intrinsic Capacitance Model Equations 7-13

7.5 Fringing/Overlap Capacitance Models 7-19

## Chapter 8: High-Speed/RF Models 8-1

8.1 Charge-Deficit Non-Quasi-Static (NQS) Model 8-1

8.2 Gate Electrode Electrode and Intrinsic-Input Resistance (IIR) Model 8-6

8.3 Substrate Resistance Network 8-8

## Chapter 9: Noise Modeling 9-1

9.1 Flicker Noise Models 9-1

9.2 Channel Thermal Noise 9-4

9.3 Other Noise Sources Modeled 9-7

## Chapter 10: Asymmetric MOS Junction Diode Models 10-1

10.1 Junction Diode IV Model 10-1

10.2 Junction Diode CV Model 10-6

## Chapter 11: Layout-Dependent Parasitics Model 11-1

11.1 Geometry Definition 11-1

11.2 Model Formulation and Options 11-3

## Chapter 12: Temperature Dependence Model 12-1

12.1 Temperature Dependence of Threshold Voltage 12-1

12.2 Temperature Dependence of Mobility 12-1

12.3 Temperature Dependence of Saturation Velocity 12-2

12.4 Temperature Dependence of LDD Resistance 12-2

12.5 Temperature Dependence of Junction Diode IV 12-3

12.6 Temperature Dependence of Junction Diode CV 12-5

12.7 Temperature Dependences of  $E_g$  and  $n_i$  12-8

## Chapter 13: Parameter Extraction Methodology 13-1

13.1 Optimization strategy	13-1
13.2 Extraction Strategy	13-2
13.3 Extraction Procedure	13-3

## Appendix A: Complete Parameter List A-1

A.1BSIM4.0.0 Model Selectors/Controllers	A-1
A.2 Process Parameters	A-3
A.3Basic Model Parameters	A-5
A.4Parameters for Asymmetric and Bias-Dependent $R_{ds}$ Model	A-10
A.5Impact Ionization Current Model Parameters	A-11
A.6Gate-Induced Drain Leakage Model Parameters	A-11
A.7Gate Dielectric Tunneling Current Model Parameters	A-12
A.8Charge and Capacitance Model Parameters	A-15
A.9High-Speed/RF Model Parameters	A-17
A.10Flicker and Thermal Noise Model Parameters	A-18
A.11Layout-Dependent Parasitics Model Parameters	A-19
A.12Asymmetric Source/Drain Junction Diode Model Parameters	A-20
A.13Temperature Dependence Parameters	A-23
A.14 $dW$ and $dL$ Parameters	A-25
A.15Range Parameters for Model Application	A-26
A.16 Notes 1-8	A-26

## Appendix B: References B-1