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Static Drain Current; 4.1 Drain Current Expression; 4.2 Forward and Reverse Current Components; 4.3 Modes of Operation
4.4 Model of Drain Current Based on Charge Linearization
4.4.1 Expression Valid for All Levels of Inversion; 4.4.2 Compact Model Parameters; 4.4.3 Inversion Coefficient; 4.4.4 Approximation of the Drain Current in Strong Inversion; 4.4.5 Approximation of the Drain Current in Weak Inversion; 4.4.6 Alternative Continuous Models; 4.5 Fundamental Property: Validity and Application; 4.5.1 Generalization of Drain Current Expression; 4.5.2 Domain of Validity; 4.5.3 Causes of Degradation; 4.5.4 Concept of Pseudo-Resistor; 4.6 Channel Length Modulation; 4.6.1 Effective Channel Length
4.6.2 Weak Inversion
4.6.3 Strong Inversion; 4.6.4 Geometrical Effects;
5 The Small-Signal Model; 5.1 The Static Small-Signal Model; 5.1.1 Transconductances; 5.1.2 Residual Output Conductance in Saturation; 5.1.3 Equivalent Circuit; 5.1.4 The Normalized Transconductance to Drain Current Ratio; 5.2 A General NQS Small-Signal Model; 5.3 The QS Dynamic Small-Signal Model; 5.3.1 Intrinsic Capacitances; 5.3.2 Transcapacitances; 5.3.3 Complete QS Circuit; 5.3.4 Domains of Validity of the Different Models; 6 The Noise Model; 6.1 Noise Calculation Methods; 6.1.1 General Expression
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6.2 Low-Frequency Channel Thermal Noise; 6.2.1 Drain Current Thermal Noise PSD; 6.2.2 Thermal Noise Excess Factor Definitions; 6.2.3 Circuit Examples; 6.3 Flicker Noise; 6.3.1 Carrier Number Fluctuations (Mc Wörther Model); 6.3.2 Mobility Fluctuations (Hooge Model); 6.3.3 Additional Contributions Due to the Source and Drain Access Resistances; 6.3.4 Total $1/f$ Noise at the Drain; 6.3.5 Scaling Properties; 6.4 Appendices; Appendix: The Nyquist and Bode Theorems; Appendix: General Noise Expression; 7 Temperature Effects and Matching; 7.1 Introduction
7.2 Temperature Effects

Sommario/riassunto

Modern, large-scale analog integrated circuits (ICs) are essentially composed of metal-oxide semiconductor (MOS) transistors and their interconnections. As technology scales down to deep sub-micron dimensions and supply voltage decreases to reduce power consumption, these complex analog circuits are even more dependent on the exact behavior of each transistor. High-performance analog circuit design requires a very detailed model of the transistor, describing accurately its static and dynamic behaviors, its noise and matching limitations and its temperature variations. The charge-based EKV (Enz
