

Preface

Modern analog circuits and systems of mixed-signal very large scale integrated (VLSI) chips for multimedia, perception, control, instrumentation, and telecommunications operate with much smaller supply voltages than the discrete circuits and integrated circuits of the last decade. This new environment and needs have forced designers to develop new design approaches more amenable to low-voltage and low-power integrated circuits. In this book, we are the first to attempt to bring together these new design methodologies together with a number of applications in an understandable manner. Furthermore, since the design of analog and mixed-signal circuits with low voltage requires suitable system architectures, we discuss proper circuit models, optimization, and innovative circuit design. In the past, a circuit designer required little or no knowledge of the overall system and where the circuit was going to be used; these days a complete notion of the system, applications, requirements, and limitations is essential for a circuit designer to optimize a sound circuit design.

This book deals with analog and digital circuit design. When combined, these circuits are known as *mixed-signal circuits*. A particular emphasis of this book is on low-power supply voltages and low-power consumption. The revival of analog circuits in the last few years has been significant. The optimal use of analog circuits versus digital circuits has been a controversial issue, which is application dependent. There is a trend to combine analog and digital circuits in an optimal way. In current applications, high-speed analog front ends impose high speed and power consumption requirements. This book has developed from the need to fill a vacuum of information about low-power and low-voltage integrated circuits. We cover fundamental aspects of metal-oxide-semiconductor (MOS) device modeling, analog and

digital building blocks, analog filters, DC-to-DC conversion, as well as analog, digital, and mixed-signal systems, including several important applications.

Several unique features of this book are (1) the introduction of an all-region transistor model that allows optimization of the circuit design; (2) device performance limitations under low-voltage operation; (3) discussion of both continuous-time and switched-capacitor filters including high-frequency design techniques; (4) a key issue regarding the optimal design of DC-to-DC conversion for portable operation; (5) digital circuit design and new directions in low-power digital VLSI design; (6) a complete discussion of data conversion for low-voltage conditions; (7) a host of applications, from very low frequency (a few hertz) to telecom circuits, including a digital approach to solve a YUV-to-RGB converter. The advantages and drawbacks of digital and analog circuits are also discussed at different hierarchical levels. A quick overview of the book is given in Chapter 1. We have tried to present this book as a combination of a bottom-up and a top-down approach. Systems are covered as well as basic device transistor physics, models, and limitations to understand devices. Systems that can operate with less than 2 V are already demanded in industry; thus, it is a must for designers to quickly become acquainted with current low-voltage circuit design techniques. Even though the applications presented in this book are a reflection of present trends, we also cover a set of underlying concepts required to understand low-voltage circuit design.

This book is intended as a key reference for upper level courses as well as for graduate courses. It is also a resource for practicing professional engineers employed in circuit and system design involving both digital and analog circuits.

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