Preface

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INCE its inception in the mid-1970s, the field of analog metal-oxide-semiconductor (MOS) integrated circuit de-sign has continued to become of increasing importance in a steadily expanding array of applications. This growth has been fueled by the continued scaling of MOS very large scale integration (VLSI) technology, which has made the digital, rather than analog, processing of signals increasingly attrac-tive. As digital VLSI circuits become pervasive in systems that were traditionally analog in nature, the primary role of analog circuits is becoming that of providing the interfaces between the analog environment of the physical world and a digital environment wherein information is represented in a form that is quantized into discrete intervals of both time and amplitude. Specific functions required in such interfaces include amplifi-cation, filtering, and both analog-to-digital and digital-to-analog conversion. Realization of these functions in turn requires building block circuits such as amplifiers, integrators, comparators, and reference networks.
The benefits of integrating the analog interface electronics in the same technology used to implement the digital signal and data processing functions stem from both economic and performance considerations. Traditional analog circuit design using bipolar technology requires that interface circuits be realized in a technology that differs greatly from that in which most of the system itself is implemented, i.e., complementary MOS (CMOS). As a consequence, although the interface circuits may represent a steadily decreasing proportion of an entire system, they have often come to represent an increas-ingly burdensome share of the system cost. It is also true that the performance of digital systems is typically limited by the capabilities of the interface circuits. Realization of the interface and data processing circuits in separate technologies implies the existence of an additional electronic and packaging interface that may significantly degrade the overall interface performance.
The above considerations have provided a strong motivation to implement analog interface functions in MOS technology, and the contributions represented in this reprint volume are a result of that motivation. For high-performance analog circuit design, the inherent limitations of MOS devices present a

difficult challenge. Compared with bipolar devices, the disadvantages of MOS transistors include low transconduc-tance, large device mismatch, and high noise levels. However, MOS technology also offers some considerable advantages for analog circuit design, namely, the availability of capacitive charge storage and fast, zero-offset analog switches. These advantages allow for the use of techniques such as offset storage and cancellation, dynamic biasing, analog pipelining, chopper stabilization, and double-correlated sampling to over-come the device limitations. Although specifically developed analog technologies have traditionally been regarded as essential to achieving the highest possible levels of perfor-mance, accomplishments of the past decade suggest that in on-chip interface applications the performance achievable with MOS circuits can often rival, and may even surpass, that obtainable with separate chips integrated in a dedicated analog bipolar technology.
Analog MOS Integrated Circuits edited by P. R. Gray,
D. A. Hodges, and R. W. Brodersen, a volume in the IEEE PRESS Selected Reprint Series, appeared in 1980. Since that time, dramatic progress has been made both in the develop-ment of new techniques to allow MOS technology to realize high-performance analog interface functions, and in the use of the technology to address applications of economic impor-tance. The present volume is intended to supplement the 1980 volume, and compiles work that has, for the most part, been published since that time.
This volume is divided into two major parts. The first is devoted to advances in circuit techniques for filtering, amplification, A/D conversion, and so forth. The second is devoted to representative applications in the areas of data acquisition, telecommunications, and data communications. Due to limited space, many important and innovative contribu-tions in these areas could not be included, but we believe that those included here are representative of progress in the area since 1980.

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