

Preface

Data conversion provides the link between the analog world and digital systems and is performed by means of sampling circuits, analog-to-digital (A/D) converters, and digital-to-analog (D/A) converters. With the increasing use of digital computing and signal processing in applications such as medical imaging, instrumentation, consumer electronics, and communications, the field of data conversion systems has rapidly expanded over the past twenty years. Monolithic integration, new architectures, and advances in integrated circuit (IC) technology have dramatically changed the design style of these systems and created new areas for research and development. As a result, the body of knowledge related to this field, primarily in the form of conference proceedings and journal papers, has grown to such extent that students and practicing engineers typically spend more than a year on the learning curve after they have completed other IC design courses. The lack of a systematic, comprehensive treatment of the subject has made the task of learning difficult and inefficient.

This book has been written as a unified text dealing with the analysis and design of data converters. Intended for classroom adoption as well as industrial practice, it methodically leads the reader from basic concepts to advanced topics while explaining design issues at both circuit and system level. In addition, to broaden the reader's view of technology-dependent design style, the text provides examples of CMOS, bipolar, and BiCMOS implementations for various circuits and discusses the trade-offs in each case.

The reader is assumed to have a solid understanding of analog IC design, preferably at the level of *Analysis and Design of Analog Integrated Circuits* by P. R. Gray and R. G. Meyer, and *Analog MOS Integrated Circuits for Signal Processing* by R. Gregorian and G. C. Temes. Some knowledge of digital circuits and the theory of signals and systems is also assumed.

The book consists of nine chapters. Chapter 1 serves as an introductory overview, familiarizing the reader with the role of data conversion in larger systems and providing the “big picture.” Chapter 2 deals with basic sampling circuits and analyzes the behavior of MOS and bipolar switches with emphasis on their speed-precision trade-offs. Circuit techniques that relax such trade-offs are also described. Chapter 3 extends these techniques to the architecture level by introducing various sample-and-hold topologies.

Chapter 4 studies basic digital-to-analog conversion, viewing this function as reference multiplication or division. Topologies in which the reference is a voltage, current, or charge are analyzed and the switching functions required in such circuits are described. These concepts are applied to system-level design in Chapter 5, where digital-to-analog converter architectures are presented.

Chapter 6 deals with analog-to-digital converter architectures. Flash, two-step, interpolating, folding, pipelined, successive approximation, and interleaved architectures are studied and their design issues and sources of error are examined. Chapter 7 describes the design of building blocks of data conversion systems. Open-loop amplifiers, operational amplifiers, and comparators are discussed and means of improving their performance are introduced.

Chapter 8 focuses on precision techniques applicable to high-resolution data conversion. Comparator and op amp offset cancellation, D/A and A/D calibration, and overlap and digital correction are covered in this chapter.

Chapter 9 is concerned with the important topic of testing and characterization. Various approaches to evaluating the static and dynamic performance of sampling circuits and D/A and A/D converters are described in detail.

Each chapter is accompanied with an extensive set of references, allowing the reader to access the original work related to each topic, understand the intricate details in more depth, and learn techniques not described in the text.

Publishing a book is an elaborate, sometimes overwhelming task that can be carried out only with the support of a great many people. During the two years I worked on this book, the stimulating environment at AT&T Bell Labs and the guidance of my supervisor, Robert Swartz, enabled me to efficiently interleave research and writing. When the first draft was finished, a number of experts from both industry and academia reviewed various

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Behzad Razavi