Book REVIEWS

ANALOG INTEGRATED CIRCUIT DESIGN

By David A. Johns and Ken Martin. John Wiley, 1997, 706 pages (ISBN 0471144487).

Analog design forms a major thrust area in today's semiconductor industry. Its growth is being led by the increasing demand for wireless applications for voice and data communications. This book forms an excellent graduate-level textbook for analog design and a valuable reference for the practicing engineer. It is quite current in its approach, dealing with many of the circuit techniques developed in recent years. It also contains numerous solved examples along with a problem set at the end of each chapter to enhance understanding. Many designs are discussed in depth with SPICE simulations. Journal citations and references are provided to stimulate further reading.

Chapter 1 starts with the basic physical behavior and modeling of diodes, MOSFETs, and bipolar transistors. Many of the equations are derived from basic physics and provide useful insight into the working of these devices. Layout and manufacturing issues of an integrated circuit are discussed in Chapter 2, with emphasis on CMOS fabrication. In addition, this chapter also explains the matching and noise considerations, which are gaining importance in the present-day mixed-signal designs.

Current mirrors and single-stage amplifiers are the fundamental blocks of analog design. These are explained thoroughly in Chapter 3. Both small-signal and large-signal characteristics are discussed along with SPICE simulations. In addition, it compares and contrasts various amplifier configurations such as common source, common drain, common gate, and cascode. Careful attention is also paid to the voltage headroom issues, which are becoming increasingly critical with the decreasing power supply voltages.

Chapter 4 builds the framework for noise analysis. No prior knowledge of random signal analysis is assumed. The noise model for different circuit elements is explained extensively. Several practical examples are then given to show how to calculate the noise impact of more complex analog circuits such as the operational amplifiers (opamps).

Opamps are perhaps the most widely used electronic components, and their architectures and compensation schemes are described in chapters 5 and 6. While Chapter 5 covers the classic two-stage CMOS opamp, Chapter 6 covers more advanced architectures such as folded cascode, current-mirror, and current-feedback approaches. Fully differential techniques are described along with the common-mode feedback circuits in considerable detail. SPICE examples are provided in both chapters.

Chapter 7 is devoted to comparators, which are used in abundance in analog-to-digital (A/D) converters and data transmission circuits. This chapter gives a very good insight into comparator design and its practical limitations. A number of recent CMOS and bipolar designs are presented in detail.

Other analog building blocks such as sample/hold, bandgap voltage references, translinear gain, and multiplier circuits are presented in Chapter 8. These circuits, along with those in the previous chapters, describe all the main analog building blocks. The rest of the book deals with more system-level analog blocks.

Fundamentals of discrete-time signals are described in Chapter 9. A good understanding of discrete-time analysis is essential for understanding sampled data systems such as switched capacitor circuits and oversampled converters. This chapter explains the relationship between the Z-transform and the Laplace transform and allows a reader to use the experience of continuous-time concepts in sampled data systems.

Switched capacitor techniques are widely used in integrated circuits due to their high degree of accuracy and linearity. Chapter 10 gives an excellent introduction to switched capacitor circuits such as filters, gain stages, modulators, and voltage-controlled oscillators. Advanced techniques such as correlated double sampling are also introduced.

The next four chapters are dedicated to data converters. Such wide coverage is necessary because data converters provide the interface between the real analog world and today's largely digital circuits. Chapter 11 presents the fundamental concepts and performance metrics of data converters. Design of digital-to-analog (D/A) converters is presented in Chapter 12, and a number of different D/A architectures are discussed in detail. Chapter 13 gives a thorough introduction to the various A/D architectures in popular use such as flash, folding, interpolating, and pipelined. Oversampled data converters are described in Chapter 14. These converters trade off digital complexity to achieve higher resolution, and they form an area of growing importance due to low supply voltages and poor transistor output impedance.

Chapter 15 presents an overview of continuous-time filters with emphasis on Gm-C filters. Bipolar, CMOS, and BiCMOS approaches are described along with the techniques to tune the filters. Important measurement concepts such as spurious-free dynamic range, third-order intercept point, and harmonic distortions are also explained.

Chapter 16 gives a good introduction to phase-locked loops, which are essential

for clock and data recovery in digital and data communication circuits. The basic concepts are explained in detail along with difference modeling and C programming for simulation.

To summarize, this book contains a thorough introduction to analog design. Its excellent collection of solved problems and practice exercises makes it an ideal text for graduate and undergraduate analog design courses. It is also an excellent reference for working engineers as it covers many of the latest circuit techniques and provides detailed explanations of the fundamental concepts. Overall, it is a great contribution to the field of analog design and is a book worthy enough to be in any analog designer's collection.

—Anand Dixit
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OPTICAL SEMICONDUCTOR DEVICES

By Mitsuo Fukuda. John Wiley, 1999 (ISBN 0471149594).

In recent years, optoelectronic technology has taken on increasing importance. Prominent examples include fiber-optic transmission of voice and data and the use of optical methods of data storage and retrieval in compact disks and their successors.

A variety of devices are used to mediate between the optical and solid-state worlds. This text provides a rather comprehensive description of the various semiconductor devices used for the generation, detection, and modulation of optical radiation and thus provides a useful reference on these topics.

The text begins by discussing semiconductor physics, first with a general discussion and then proceeding to a more detailed consideration of properties, which are important for optoelectronic devices. The book then moves on to discuss light-emitting diodes (LEDs) based on forward-biased p-n junctions; topics covered include efficiency, surface reflection, the power-current relationship, and small-signal modulation. Next, laser diodes are considered; the discussion includes consideration of confinement methods required to generate a population inversion, reflections in a cavity, and various methods of constraining the active region to improve the efficiency (chiefly through bandgap engineering). Moving from emitters to detectors, the text next covers photodiodes, which are also p-n junctions but which are reversed-biased; topics covered include conventional p-n junction devices, p-i-n diodes, and avalanche photodiodes, as well as a discussion of various detector noise topics.

Next, optical modulators are considered. Unlike the situation in emitters or detectors, light passes through a modulator and is altered in some way. A variety of physical effects are important, and particular attention is paid to phase modulation, frequency modulation, and intensity modulation. The discussion then moves on to consider fabrication technology aspects, such as crystal growth, specific processing steps and methods, reflective coatings, and packaging; this part of the text might have been better placed were it near the beginning of the book rather than near the end. Attention then turns to device reliability, starting with some simple basic concepts and then moving on to degradation processes (both operational and environmental), wear-out, catastrophic failure, packaging problems, and electrostatic discharge (ESD). The book concludes with an overview of various applications of optoelectronic devices, such as fiber-optics, beam optics (e.g., for CDs), CD-RW and magneto-optical methods, printers, scanners, fax machines, and various sensors.

The text provides a good overview of the varied material as well as specific details on a large variety of devices, and it includes an extensive list of references. The book is targeted mainly at those already familiar with the field of optoelectronics, but it is a good addition to the library of anyone working in this area. CD■

BOOKS AVAILABLE FOR REVIEW

IEEE Circuits & Devices Magazine has received the books listed below. If you are willing and qualified, you can review one of these books in exchange for a short (~500 word) written review, which we will edit and publish either in the magazine or on our homepage.

00-13 *Understanding Semiconductor Devices*
By Sima Dimitrijev
ISBN 0-19-513186-X
574 pages + CD ROM
Oxford University Press (NY), 2000

00-14 *Mixed Signal VLSI Wireless Design: Circuits and Systems*
By Emad N. Farag and Mohamed I. Elmasry
ISBN 0-7923-8687-6
319 pages
Kluwer Academic Publishers, 2000

00-15 *Timing Optimization Through Clock Skew Scheduling*
By Ivan S. Kourtev and Eby Friedman
ISBN 0-7923-7796-6
194 pages
Kluwer Academic Publishers, 2000

00-16 *Circuits and Systems for Wireless Communications*
By Markus Helfenstein and George S. Moschytz
ISBN 0-7923-7722-2
387 pages
Kluwer Academic Publishers, 2000

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