Design of CMOS Phase-Locked Loops

Using a modern, pedagogical approach, this textbook gives students and engineers a comprehensive and rigorous knowledge of CMOS PLL design for a wide range of applications. It features intuitive presentation of theoretical concepts, built up gradually from their simplest form to more practical systems; broad coverage of key topics, including oscillators, phase noise, analog PLLs, digital PLLs, RF synthesizers, delay-locked loops, clock and data recovery circuits, and frequency dividers; tutorial chapters on high-performance oscillator design, covering fundamentals to advanced topologies; and extensive use of circuit simulations to teach design mentality, highlight design flaws, and connect theory with practice. Offering over 200 thought-provoking examples that demonstrate best practices and common pitfalls, 250 end-of-chapter homework problems to test and enhance the readers’ understanding, and solutions and lecture slides for instructors, this is the perfect text for senior undergraduate and graduate-level students and professional engineers who want an in-depth understanding of PLL design.

Behzad Razavi is Professor of Electrical Engineering at The University of California, Los Angeles. He has received numerous teaching and education awards, and is a member of the US National Academy of Engineering and a Fellow of the IEEE. His previous textbooks include Fundamentals of Microelectronics, RF Microelectronics and Design of Analog CMOS Integrated Circuits.
Design of CMOS Phase-Locked Loops
From Circuit Level to Architecture Level

BEHZAD RAZAVI
University of California, Los Angeles
To my brother Hossein,  
who has always been there for me
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Preface

A quick search on Google brings up nearly two dozen books on PLLs. So why another one? This book addresses the need for a text that methodically teaches modern CMOS PLLs for a wide range of applications. The objective is to teach the reader how to approach PLLs from transistor-level design to architecture development.

Based on 25 years of teaching courses on the subject and the latest trends in industry, this book deals with oscillators, phase noise, analog phase-locked loops, digital phase-locked loops, RF synthesizers, delay-locked loops, clock and data recovery circuits, and frequency dividers. The objective is to reach a broad spectrum of readers while maintaining a cohesive flow.

As with my past writings, I have implemented a multitude of pedagogical tools to help the reader learn efficiently—and experience the pleasure of learning. One principle that I uphold in writing is to start with the simplest possible arrangement, teach how it works and what shortcomings it has, and then add components to it to improve its performance. This approach allows the reader to see how a basic architecture evolves to a complex system. After laying the theoretical foundation for each topic, I present a step-by-step design flow and proceed to design the circuit.

And not all design efforts are successful. The reader can clearly see how certain decisions lead to a dead end and how we revise these decisions to reach a new, more practical solution. This exploratory mentality not only makes the process of learning more exciting but also helps the reader see why each component is necessary, what criteria govern its choice, and what not to do.

A unique aspect of this book is its extensive use of simulations to teach design and investigate agreement between theory and practice. For each design, I use the theoretical basis to choose certain parameters and predict the performance, and then I simulate the circuit. If the simulation results do not agree with the predictions, I delve into the details and determine why. Another unique aspect of this book is that it leverages concepts from one field (e.g., wireless technology) to another (e.g., wireline communications) by bringing the vast knowledge in these fields under one roof.

A website for the book provides additional resources for readers and instructors, including Powerpoint slides and a solutions manual.

Behzad Razavi
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My wife, Angelina, typed the entire book. I am very grateful to her.

Behzad Razavi
About the Author

Behzad Razavi received the BSEE degree from Sharif University of Technology in 1985 and the MSEE and PhDEE degrees from Stanford University in 1988 and 1992, respectively. He was with AT&T Bell Laboratories and Hewlett-Packard Laboratories until 1996. Since 1996, he has been Associate Professor and subsequently Professor of electrical engineering at University of California, Los Angeles. His current research includes wireless and wireline transceivers and data converters.


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