

Digital Phase Lock Loops By Al Araji Saleh R Hussain Zahir M Al Qutayri Mahmoud A Springer2009 Paperback Reprint Edition

This book is intended for the graduate or advanced undergraduate engineer. The primary motivation for writing the text was to present a complete tutorial of phase-locked loops with a consistent notation. As such, it can serve as a textbook in formal classroom instruction, or as a self-study guide for the practicing engineer. A former colleague, Kevin Kreitzer, had suggested that I write a text, with an emphasis on digital phase-locked loops. As modern designers, we were continually receiving requests from other engineers asking for a definitive reference on digital phase-locked loops. There are several good papers in the literature, but there was not a good textbook for either classroom or self-paced study. From my own experience in designing low phase noise synthesizers, I also knew that third-order analog loop design was omitted from most texts. With those requirements, the material in the text seemed to flow naturally. Chapter 1 is the early history of phase-locked loops. I believe that historical knowledge can provide insight to the development and progress of a field, and phase-locked loops are no exception. As discussed in Chapter 1, consumer electronics (color television) prompted a rapid growth in phase-locked loop theory and applications, much like the

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wireless communications growth today. xiv Preface Although all-analog phase-locked loops are becoming rare, the continuous time nature of analog loops allows a good introduction to phase-locked loop theory.

With growing consumer demand for portability and miniaturization in electronics, design engineers must concentrate on many additional aspects in their core design. The plethora of components that must be considered requires that engineers have a concise understanding of each aspect of the design process in order to prevent bug-laden prototypes. Electronic Circuit Design allows engineers to understand the total design process and develop prototypes which require little to no debugging before release. It provides step-by-step instruction featuring modern components, such as analog and mixed signal blocks, in each chapter. The book details every aspect of the design process from conceptualization and specification to final implementation and release. The text also demonstrates how to utilize device data sheet information and associated application notes to design an electronic system. The hybrid nature of electronic system design poses a great challenge to engineers. This book equips electronics designers with the practical knowledge and tools needed to develop problem free prototypes that are ready for release.

A greatly revised and expanded account of phaselocktechnology The Third Edition of this landmark book presents new developmentsin the field of phaselock loops, some of which have never beenpublished until now. Established concepts are reviewed

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critically and recommendations are offered for improved formulations. The work reflects the author's own research and many years of hands-on experience with phase lock loops. Reflecting the myriad of phase lock loops that are now found in electronic devices such as televisions, computers, radios, and cellphones, the book offers readers much new material, including:

- * Revised and expanded coverage of transfer functions
- * Two chapters on phase noise
- * Two chapters examining digital phase lock loops
- * A chapter on charge-pump phase lock loops
- * Expanded discussion of phase detectors and of oscillators
- * A chapter on anomalous phase locking
- * A chapter on graphical aids, including Bode plots, root locus plots, and Nichols charts

As in the previous editions, the focus of the book is on underlying principles, which remain valid despite technological advances. Extensive references guide readers to additional information to help them explore particular topics in greater depth. Phase Lock Techniques, Third Edition is intended for practicing engineers, researchers, and graduate students. This critically acclaimed book has been thoroughly updated with new information and expanded for greater depth.

A controller for an all digital phase locked loop which operates by pulse addition and removal is investigated. Being a first order system, the digital phase locked loop is more limited in regard to parameter controls than its second order analog counterpart. A loop with a fast lock time generally has poor phase/frequency accuracy, while a loop programmed for high accuracy will have slow lock time. Given that the digital phase

locked loop is digitally programmable, a set of parameters may be selected which will minimize the lock time of the loop. Once the loop is locked, the parameters may be changed to alter the loop bandwidth and increase the loop accuracy. A controller circuit has been designed to adjust loop parameters in such a manner thereby optimizing loop performance. The exclusive-OR phase detector which is commonly used with the pulse addition/removal type digital phase locked loop has a phase lock range of plus or minus a quarter of a cycle. This work investigates the loop response to an incoming signal which is outside of the phase lock range of phase detector and inside the frequency lock range of the loop. A sub-circuit is proposed to improve the lock time of the loop when it encounters an incoming signal with these characteristics. The proposed circuits were designed using integrated circuit layout tools and submitted to a semiconductor manufacturer for fabrication. The controller concept and results of simulations and prototype experiments are presented.

A new and innovative paradigm for RF frequency synthesis and wireless transmitter design Learn the techniques for designing and implementing an all-digital RF frequency synthesizer. In contrast to traditional RF techniques, this innovative book sets forth digitally intensive design techniques that lead the way to the development of low-cost, low-power, and highly integrated circuits for RF functions in deep submicron CMOS processes. Furthermore, the authors demonstrate how the architecture enables readers to integrate an RF front-end with the digital back-end onto a single silicon die using

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standard ASIC design flow. Taking a bottom-up approach that progressively builds skills and knowledge, the book begins with an introduction to basic concepts of frequency synthesis and then guides the reader through an all-digital RF frequency synthesizer design: Chapter 2 presents a digitally controlled oscillator (DCO), which is the foundation of a novel architecture, and introduces a time-domain model used for analysis and VHDL simulation Chapter 3 adds a hierarchical layer of arithmetic abstraction to the DCO that makes it easier to operate algorithmically Chapter 4 builds a phase correction mechanism around the DCO such that the system's frequency drift or wander performance matches that of the stable external frequency reference Chapter 5 presents an application of the all-digital RF synthesizer Chapter 6 describes the behavioral modeling and simulation methodology used in design The final chapter presents the implementation of a full transmitter and experimental results. The novel ideas presented here have been implemented and proven in two high-volume, commercial single-chip radios developed at Texas Instruments: Bluetooth and GSM. While the focus of the book is on RF frequency synthesizer design, the techniques can be applied to the design of other digitally assisted analog circuits as well. This book is a must-read for students and engineers who want to learn a new paradigm for RF frequency synthesis and wireless transmitter design using digitally intensive design techniques.

Featuring an extensive 40 page tutorial introduction, this carefully compiled anthology

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of 65 of the most important papers on phase-locked loops and clock recovery circuits brings you comprehensive coverage of the field—all in one self-contained volume. You'll gain an understanding of the analysis, design, simulation, and implementation of phase-locked loops and clock recovery circuits in CMOS and bipolar technologies along with valuable insights into the issues and trade-offs associated with phase locked systems for high speed, low power, and low noise.

How to acquire the input frequency from an unlocked state A phase locked loop (PLL) by itself cannot become useful until it has acquired the applied signal's frequency. Often, a PLL will never reach frequency acquisition (capture) without explicit assistive circuits. Curiously, few books on PLLs treat the topic of frequency acquisition in any depth or detail. Frequency Acquisition Techniques for Phase Locked Loops offers a no-nonsense treatment that is equally useful for engineers, technicians, and managers. Since mathematical rigor for its own sake can degenerate into intellectual "rigor mortis," the author introduces readers to the basics and delivers useful information with clear language and minimal mathematics. With most of the approaches having been developed through years of experience, this completely practical guide explores methods for achieving the locked state in a variety of conditions as it examines: Performance limitations of phase/frequency detector-based phase locked loops The quadrature correlator method for both continuous and sampled modes Sawtooth ramp-and-sample phase detector and how its waveform contains frequency error information that

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can be extracted The benefits of a self-sweeping, self-extinguishing topology Sweep methods using quadrature mixer-based lock detection The use of digital implementations versus analog Frequency Acquisition Techniques for Phase Locked Loops is an important resource for RF/microwave engineers, in particular, circuit designers; practicing electronics engineers involved in frequency synthesis, phase locked loops, carrier or clock recovery loops, radio-frequency integrated circuit design, and aerospace electronics; and managers wanting to understand the technology of phase locked loops and frequency acquisition assistance techniques or jitter attenuating loops. Errata can be found by visiting the Book Support Site at: <http://booksupport.wiley.com/>

This modern, pedagogic textbook from leading author Behzad Razavi provides a comprehensive and rigorous introduction to CMOS PLL design, featuring intuitive presentation of theoretical concepts, extensive circuit simulations, over 200 worked examples, and 250 end-of-chapter problems. The perfect text for senior undergraduate and graduate students.

Phase Locked Loop frequency synthesis is a key component of all wireless systems. This is a complete toolkit for PLL synthesizer design, with MathCAD, SIMatrix files included on CD, allowing readers to perform sophisticated calculation and simulation exercises. Describes how to calculate PLL performance by using standard mathematical or circuit analysis programs

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Phased-locked loops (PLLs) are control systems that have become indispensable in today's electronic circuitry. This highly accessible handbook is a practical resource that electronics engineers and circuit designers will find invaluable when developing these systems. PLLs are highly complex to design and are just as difficult to test. To speed development and ensure effective testing, engineers can turn to this collection of practical solutions, SPICE listings, simulation techniques, and testing set-ups. The book offers in-depth coverage of monolithic phase-locked loops and the latest generation of PLLs, showing how to meet the demand for high-powered, low-cost electronics.

Moreover, this cutting-edge volume examines the complexities and new technologies for integrating monolithic PLLs on a single chip.

This volume introduces phase-locked loop applications and circuit design. Drawing theory and practice together, the book emphasizes electronics design tools and circuits, using specific design examples, addresses the practical details that lead to a working design. Wolaver assumes no specialized knowledge in the area covered, reviewing basics as necessary; makes heavy use of figures to support the understanding of phase-locked loop theory and circuit operation; extensively discusses frequency acquisition means, an intensely nonlinear phenomenon; treats injection locking, a practical and often confounding problem; and takes a unique approach to characterizing the phase-locked loop parameters.

Unique book/disk set that makes PLL circuit design easier than ever. Table of Contents:

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PLL Fundamentals; Classification of PLL Types; The Linear PLL (LPLL); The Classical Digital PLL (DPLL); The All-Digital PLL (ADPLL); The Software PLL (SPLL); State Of The Art of Commercial PLL Integrated Circuits; Appendices; Index. Includes a 5 1/4" disk. 100 illustrations.

BURSTLOCK is a digital phase-locked loop implemented using Burst Processing. It is used in a receiver perform FM demodulation of commercial broadcast signals. It is also shown that BURSTLOCK has some theoretical advantages over conventional phase-locked loops. (Author).

Phase lock loop frequency synthesis finds uses in a myriad of wireless applications - from local oscillators for receivers and transmitters to high performance RF test equipment. As the security and reliability of mobile communication transmissions have gained importance, PLL and frequency synthesizers have become increasingly topical subjects. Phase Lock Loops & Frequency Synthesis examines the various components that make up the phase lock loop design, including oscillators (crystal, voltage controlled), dividers and phase detectors. Interaction amongst the various components are also discussed. Real world problems such as power supply noise, shielding, grounding and isolation are given comprehensive coverage and solved examples with MATHCAD programs are presented throughout. * Presents a comprehensive study of phase lock loops and frequency synthesis in communication systems * Written by an internationally-recognised expert in the field * Details the problem of spurious signals in PLL frequency synthesizers, a topic neglected by available competing titles * Provides detailed theoretical background coupled with practical examples of state-of-the-art

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device design * MATHCAD programs and simulation software to accompany the design exercises and examples This combination of thorough theoretical treatment and guidance on practical applications will appeal to mobile communication circuit designers and advanced electrical engineering students.

A systematic design procedure for a second-order digital phase-locked loop with a linear phase detector is proposed. The design procedure is based on the analogy between a type-II second-order analog PLL and a digital PLL. A new digital PLL architecture featuring a linear phase detector which eliminates the noise-bandwidth tradeoff is presented. It employs a stochastic time-to-digital converter (STDC) and a high frequency delta-sigma dithering to achieve a wide PLL bandwidth and a low jitter. The measured results obtained from the prototype chip demonstrate a significant jitter improvement with the STDC.

This book presents a novel approach to the analysis and design of all-digital phase-locked loops (ADPLLs), technology widely used in wireless communication devices. The authors provide an overview of ADPLL architectures, time-to-digital converters (TDCs) and noise shaping. Realistic examples illustrate how to analyze and simulate phase noise in the presence of sigma-delta modulation and time-to-digital conversion. Readers will gain a deep understanding of ADPLLs and the central role played by noise-shaping. A range of ADPLL and TDC architectures are presented in unified manner. Analytical and simulation tools are discussed in detail. Matlab code is included that can be reused to design, simulate and analyze the ADPLL architectures that are presented in the book.

Phase-Locked Loops (PLLs) are electronic systems that can be used as a synchronized oscillator, a driver or multiplier of frequency, a modulator or demodulator and as an amplifier of

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phase modulated signals. This book updates the methods used in the analysis of PLLs by drawing on the results obtained in the last 40 years. Many are published for the first time in book form. Nonlinear and deterministic mathematical models of continuous-time and discrete-time PLLs are considered and their basic properties are given in the form of theorems with rigorous proofs. The book exhibits very beautiful dynamics, and shows various physical phenomena observed in synchronized oscillators described by complete (not averaged) equations of PLLs. Specially selected mathematical tools are used: the theory of differential equations on a torus, the phase-plane portraits on a cylinder, a perturbation theory (Melnikov's theorem on heteroclinic trajectories), integral manifolds, iterations of one-dimensional maps of a circle and two-dimensional maps of a cylinder. Using these tools, the properties of PLLs, in particular the regions of synchronization are described. Emphasis is on bifurcations of various types of periodic and chaotic oscillations. Strange attractors in the dynamics of PLLs are considered, such as those discovered by Rössler, Henon, Lorenz, May, Chua and others.

Filling the gap in the market dedicated to PLL structures for power systems Internationally recognized expert Dr. Masoud Karimi-Ghartemani brings over twenty years of experience working with PLL structures to Enhanced Phase-Locked Loop Structures for Power and Energy Applications, the only book on the market specifically dedicated to PLL architectures as they apply to power engineering. As technology has grown and spread to new devices, PLL has increased in significance for power systems and the devices that connect with the power grid. This book discusses the PLL structures that are directly applicable to power systems using simple language, making it easily digestible for a wide audience of engineers,

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technicians, and graduate students. Enhanced phase-locked loop (EPLL) has become the most widely utilized architecture over the past decade, and many books lack explanation of the structural differences between PLL and EPLL. This book discusses those differences and also provides detailed instructions on using EPLL for both single-phase applications and three-phase applications. The book's major topics include: A basic look at PLL and its standard structure A full explanation of EPLL EPLL extensions and modifications Digital implementation of EPLL Extensions of EPLL to three-phase structures Dr. Karimi-Ghartemani provides basic analysis that helps readers understand each of the structures presented without requiring complicated mathematical proofs. His book is filled with illustrated examples and simulations that connect theory to the real world, making Enhanced Phase-Locked Loop Structures for Power and Energy Applications an ideal reference for anyone working with inverters, rectifiers, and related technologies.

Phase Locked Loops (PLLs) are electronic circuits used for frequency control. Anything using radio waves, from simple radios and cell phones to sophisticated military communications gear uses PLLs. The communications industry's big move into wireless in the past two years has made this mature topic red hot again. The fifth edition of this classic circuit reference comes complete with extremely valuable PLL design software written by Dr. Best. The software alone is worth many times the price of the book. The new edition also includes new chapters on frequency synthesis, CAD for PLLs, mixed-signal PLLs, and a completely new collection of sample communications applications.

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This book is a concise guide to the theory and design of phase-locked loop circuits. It is written from an engineering viewpoint, with many illustrations, block diagrams, example circuits and experimental results - many based on the author's personal experience - and use of engineering analytical methods, such as signal flow graphs and Laplace transforms. The author shows how the potential pit-falls in PLL design may be avoided by adopting a rigorous theoretical approach, with almost all results derived from first principles, although mathematics is used for practical relevance rather than academic interest. An important consequence is that the text is substantially self-contained.

Phase-Locked Loops for Wireless Communications: Digital, Analog and Optical Implementations, Second Edition presents a complete tutorial of phase-locked loops from analog implementations to digital and optical designs. The text establishes a thorough foundation of continuous-time analysis techniques and maintains a consistent notation as discrete-time and non-uniform sampling are presented. New to this edition is a complete treatment of charge pumps and the complementary sequential phase detector. Another important change is the increased use of MATLAB®, implemented to provide more familiar graphics and reader-derived phase-locked loop simulation.

Frequency synthesizers and digital divider analysis/techniques have been added to this second edition. Perhaps most distinctive is the chapter on optical phase-locked loops that begins with sections discussing components such as lasers and photodetectors and finishing with homodyne and heterodyne loops. Starting with a historical overview,

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presenting analog, digital, and optical PLLs, discussing phase noise analysis, and including circuits/algorithms for data synchronization, this volume contains new techniques being used in this field. Highlights of the Second Edition: Development of phase-locked loops from analog to digital and optical, with consistent notation throughout; Expanded coverage of the loop filters used to design second and third order PLLs; Design examples on delay-locked loops used to synchronize circuits on CPUs and ASICs; New material on digital dividers that dominate a frequency synthesizer's noise floor. Techniques to analytically estimate the phase noise of a divider; Presentation of optical phase-locked loops with primers on the optical components and fundamentals of optical mixing; Section on automatic frequency control to provide frequency-locking of the lasers instead of phase-locking; Presentation of charge pumps, counters, and delay-locked loops. The Second Edition includes the essential topics needed by wireless, optics, and the traditional phase-locked loop specialists to design circuits and software algorithms. All of the material has been updated throughout the book.

The book reports two approaches of implementation of the essential components of a Digital Phase Locked Loop based system for dealing with wireless channels showing Nakagami-m fading. It is mostly observed in mobile communication. In the first approach, the structure of a Digital phase locked loop (DPLL) based on Zero Crossing (ZC) algorithm is proposed. In a modified form, the structure of a DPLL based systems

for dealing with Nakagami-m fading based on Least Square Polynomial Fitting Filter is proposed, which operates at moderate sampling frequencies. A sixth order Least Square Polynomial Fitting (LSPF) block and Roots Approximator (RA) for better phase-frequency detection has been implemented as a replacement of Phase Frequency Detector (PFD) and Loop Filter (LF) of a traditional DPLL, which has helped to attain optimum performance of DPLL. The results of simulation of the proposed DPLL with Nakagami-m fading and QPSK modulation is discussed in detail which shows that the proposed method provides better performance than existing systems of similar type. The digital loop filter for an all-digital phase-locked loop was designed to meet a given set of specifications, and the performance of the filter was verified using MATLAB simulations. The number of bits used to represent each coefficients was selected so that the filter met specifications for magnitude while managing the are and power of the filter.

This book describes the digitally intensive time-domain architectures and techniques applied to millimeter-wave frequency synthesis, with the objective of improving performance and reducing the cost of implementation. Coverage includes system architecture, system level modeling, critical building block design, and digital calibration techniques, making it highly suitable for those who want to learn about mm-wave frequency generation for communication and radar applications, integrated circuit implementation, and time-domain circuit and system techniques. Highlights the

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challenges of frequency synthesis at mm-wave band using CMOS technology
Compares the various approaches for mm-wave frequency generation (pros and cons)
Introduces the digitally intensive synthesizer approach and its advantages
Discusses the proper partitioning of the digitally intensive mm-wave frequency synthesizer into mm-wave, RF, analog, digital and software components
Provides detailed design techniques from system level to circuit level
Addresses system modeling, simulation techniques, design-for-test, and layout issues
Demonstrates the use of time-domain techniques for high-performance mm-wave frequency synthesis

This exciting new book covers various types of digital phase lock loops. It presents a comprehensive coverage of a new class of digital phase lock loops called the time delay tanlock loop (TDTL). It also details a number of architectures that improve the performance of the TDTL through adaptive techniques that overcome the conflicting requirements of the locking range and speed of acquisition.

Applications of phase-locked loops play an increasingly important role in modern electronic systems, and the last 25 years have seen new developments in the underlying theories as well. Phase-Locked Loops presents the latest information on the basic theory and applications of PLLs. Organized in a logical format, it first introduces the subject in a qualitative manner and discusses key applications. Next, it develops basic models for components of a PLL, and these are used to develop a basic PLL model. The text then discusses both linear and nonlinear methods that are used to

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analyze the basic PLL model. This book includes extensive coverage of the nonlinear behavior of phase-locked loops, an important area of this field and one where exciting new research is being performed. No other book available covers this critical area in such careful detail. Improvements brought about by the advent of the personal computer, especially in the use of numerical results, are integrated into the text. This book also focuses on PLL component technologies used in system implementation. Do you need to know how to develop more efficient digital communication systems? Based on the author's experience of over thirty years in industrial design, this practical guide provides detailed coverage of synchronization subsystems and their relationship with other system components. Readers will gain a comprehensive understanding of the techniques needed for the design, performance analysis and implementation of synchronization functions for a range of different modern communication technologies. Specific topics covered include frequency-looked loops in wireless receivers, optimal OFDM timing phase determination and implementation, and interpolation filter design and analysis in digital resamplers. Numerous implementation examples help readers to develop the necessary practical skills, and slides summarizing key concepts accompany the book online. This is an invaluable guide and essential reference for both practicing engineers and graduate students working in digital communications.

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