

Phase Locked Loop (PLL) Design

by Akin Akturk and Zeynep Dilli

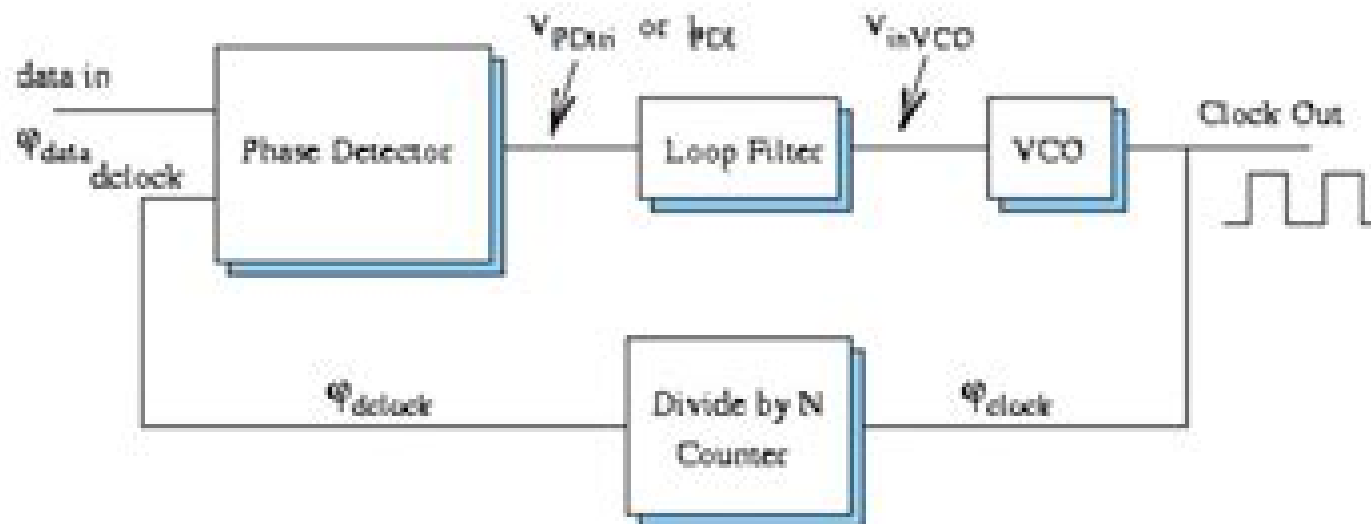


Figure 1: Basic PLL building blocks

➤ Phase detector: K_{PD}

➤ Loop filter: $K_F = \frac{K_{LFF}}{1 + \frac{s}{p}}$

➤ VCO: $\frac{K_{VCO}}{s}$

$$H(s) = \frac{\Phi_{clock}}{\Phi_{data}} = \frac{K_{PD} K_{VCO} K_F}{s + \frac{1}{N} K_{PD} K_{VCO} K_F}$$

Phase Locked Loop Circuit Design

Roland E. Best



Phase Locked Loop Circuit Design:

Phase-locked Loops Roland E. Best, 1984 *Phase-Locked Loops* Woogeun Rhee, Zhiping Yu, 2023-12-19 Phase Locked Loops Discover the essential materials for phase locked loop circuit design from fundamentals to practical design aspects A phase locked loop PLL is a type of circuit with a range of important applications in telecommunications and computing It generates an output signal with a controlled relationship to an input signal such as an oscillator which matches the phases of input and output signals This is a critical function in coherent communication systems with the result that the theory and design of these circuits are essential to electronic communications of all kinds Phase Locked Loops System Perspectives and Circuit Design Aspects provides a concise accessible introduction to PLL design It introduces readers to the role of PLLs in modern communication systems the fundamental techniques of phase lock circuitry and the possible applications of PLLs in a wide variety of electronic communications contexts The first book of its kind to incorporate modern architectures and to balance theoretical fundamentals with detailed design insights this promises to be a must own text for students and industry professionals The book also features Coverage of PLL basics with insightful analysis and examples tailored for circuit designers Applications of PLLs for both wireless and wireline systems Practical circuit design aspects for modern frequency generation frequency modulation and clock recovery systems Phase Locked Loops is essential for graduate students and advanced undergraduates in integrated circuit design as well researchers and engineers in electrical and computing subjects

Phase Locked Loops 6/e Roland E. Best, 2007-08-13 The Definitive Introduction to Phase Locked Loops Complete with Software for Designing Wireless Circuits The Sixth Edition of Roland Best's classic Phase Locked Loops has been updated to equip you with today's definitive introduction to PLL design complete with powerful PLL design and simulation software written by the author Filled with all the latest PLL advances this celebrated sourcebook now includes new chapters on frequency synthesis CAD for PLLs mixed signal PLLs all digital PLLs and software PLLs plus a new collection of sample communications applications An essential tool for achieving cutting edge PLL design the Sixth Edition of Phase Locked Loops features A wealth of easy to use methods for designing phase locked loops Over 200 detailed illustrations New to this edition new chapters on frequency synthesis including fractional N PLL frequency synthesizers using sigma delta modulators CAD for PLLs mixed signal PLLs all digital PLLs and software PLLs new PLL communications applications including an overview on digital modulation techniques Inside this Updated PLL Design Guide Introduction to PLLs Mixed Signal PLL Components Mixed Signal PLL Analysis PLL Performance in the Presence of Noise Design Procedure for Mixed Signal PLLs Mixed Signal PLL Applications Higher Order Loops CAD and Simulation of Mixed Signal PLLs All Digital PLLs ADPLLs CAD and Simulation of ADPLLs The Software PLL SPLL The PLL in Communications State of the Art Commercial PLL Integrated Circuits Appendices The Pull In Process The Laplace Transform Digital Filter Basics Measuring PLL Parameters *Design of Phase-locked Loop Circuits with Experiments* Howard M. Berlin, 1978 *Phase-locked Loop Circuit Design* Dan H.

Wolaver,1991 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 Phaselock

Tecniques,second Edition Floyd M. Gardner,1979-05-10 This second edition of Phaselock Techniques is as was the first the standard reference on the subject Greatly expanded and largely rewritten to reflect a better understanding of the subject the book presents much new material some published here for the first time Explanation of fundamentals is improved and expanded and description of applications is greatly increased The first portion of the book is a well organized review of the fundamentals of phaselock as well as a discussion of the underlying problems faced by designers Most of this material has been rewritten from the first edition The material that follows deals with practical aspects of component circuits and with rational procedures for deciding upon phaselock loop parameters The remaining chapters provide engineering descriptions and analyses of applications of phaselock Most of this material is unique Included are discussions of phaselocked modulators and demodulators synthesizers receivers transponders oscillator stabilizers and data synchronizers **Phase Locked Loops**

J. Encinas,2012-09-24 This book is devoted to a detailed and comprehensive study of phase locked loops aimed at preparing the reader to design them and to understand their applications It is written at a level corresponding to a final year electronics undergraduate or a postgraduate student Linear and semidigital phase locked loops are studied in nine chapters Most of this book is concerned with analogue PLLs but there are chapters on semidigital PLLs and on applications The mathematical tools and background required are described at the end of the book Important symbols A Amplifier gain Mixer gain V_1 A Filter bandwidth Hz B_i Low pass filter bandwidth Hz B_L Unilateral equivalent noise bandwidth Hz B_n D s Polynomial of variable s Peak amplitude of signal voltage V E_e Peak amplitude of reference signal voltage V E_r Carrier frequency Hz f_e Intermediate frequency Hz f_i Intermediate frequency Hz f_{IF} Local oscillator frequency Hz f_{it} Reference frequency Hz f_r F s Transfer function of loop filter G Amplifier voltage gain k FM modulator sensitivity $\text{rad s}^{-1} \text{V}^{-1}$ m K Motor coefficient rad s^{-1} Back electromotive force coefficient V s rad^{-1} K_1 Reverse back electromotive force coefficient rad V^{-1} S 1 K_e PC conversion gain V rad s^{-1} K_d Motor torque coefficient N m A^{-1} K_M 1 1 VCO conversion gain rads V^{-1} K_o Conversion gain of PLL S 2 K_v m Modulation factor m Integer n Integer n Loop order N N Integers representing division 1 2 1

Phase-Locked Loops for Wireless Communications Donald R. Stephens,2002 A tutorial of phase locked loops from analogue implementations to digital and optical designs This text establishes a foundation of continuous time analysis techniques and maintains a consistent notation as discrete time and non uniform sampling are presented It examines charge

pumps and the complementary sequential phase detector Frequency synthesizers and digital divider analysis techniques are also included in this edition Starting with a historical overview presenting analogue digital and optical PLLs discussing phase noise analysis and including circuits algorithms for data synchronization this volume illustrates the techniques being used in this field The subjects covered include development of phase locked loops from analogue to digital and optical with 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 a section on automatic frequency control to provide frequency locking of the lasers instead of phase locking and a presentation of charge pumps counters and delay locked loops This volume includes the topics that should be of interest to wireless optics and the traditional phase locked loop specialist to design circuits and software algorithms

Phase-Locked Loops Woogeun Rhee,Zhiping Yu,2024-01-18 Phase Locked Loops Discover the essential materials for phase locked loop circuit design from fundamentals to practical design aspects A phase locked loop PLL is a type of circuit with a range of important applications in telecommunications and computing It generates an output signal with a controlled relationship to an input signal such as an oscillator which matches the phases of input and output signals This is a critical function in coherent communication systems with the result that the theory and design of these circuits are essential to electronic communications of all kinds Phase Locked Loops System Perspectives and Circuit Design Aspects provides a concise accessible introduction to PLL design It introduces readers to the role of PLLs in modern communication systems the fundamental techniques of phase lock circuitry and the possible applications of PLLs in a wide variety of electronic communications contexts The first book of its kind to incorporate modern architectures and to balance theoretical fundamentals with detailed design insights this promises to be a must own text for students and industry professionals The book also features Coverage of PLL basics with insightful analysis and examples tailored for circuit designers Applications of PLLs for both wireless and wireline systems Practical circuit design aspects for modern frequency generation frequency modulation and clock recovery systems Phase Locked Loops is essential for graduate students and advanced undergraduates in integrated circuit design as well researchers and engineers in electrical and computing subjects

Phase-Locked Loops Roland Best,2003-07-11 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 **Phase-locked Loops** Paul V. Brennan,1996 Written from an engineering viewpoint this book is a concise guide to the theory and design of phase locked loop circuits It includes novel techniques and analytical treatments as well as worked examples Design of CMOS Phase-Locked Loops Behzad Razavi,2020-01-30 Using a modern pedagogical approach this textbook gives students and engineers a comprehensive and rigorous knowledge of CMOS phase locked loop 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 Including over 200 thought provoking examples highlighting 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

Monolithic Phase-Locked Loops and Clock Recovery Circuits Behzad Razavi,1996-04-18 Featuring an extensive 40 page tutorial introduction this carefully compiled anthology 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 *Design of Phase-locked Loop Circuits, with Experiments* H. M. Berlin,1985 The basic phase locked loop principle Performing the experiments The phase detector The voltage controled oscillator The loop filter and loop response Digital frequency synthesizers Monolithic integrated circuits and applications Derivations Datasheets Breadboarding aids Symbols used **Phase-locked Loops** Roland E. Best,1997 ide includes new Windows software for creating interactive PLL simulations a feature that presents a new dimension in PLL design as well as an entirely new directory of commercially available PLLs Readers learn how to perform a PLL design from start to finish then use the simulation program to check and optimize performance *Theory of the Non-linear Analog Phase Locked Loop* Nikolaos I. Margaris,2004-05-18 This book develops for the first time a complete and connected nonlinear theory for the analog Phase Locked Loop PLL which clarifies the obscure points of its complex non linear behaviour The book suggests new non linear models for the PLL components and applies the averaging method to analyse PLL The book presents the physical interpretation of the PLL operation locates the difficulties presented by its operation and suggests solutions to overcome these problems Finally it provides closed form expressions for all the important measures of the PLL and proposes new design criteria **Design Methodology for RF CMOS Phase Locked Loops** Guillermo Bistué,Carlos Quemada,Iñigo

Adin,2009 After a review of PLL essentials this uniquely comprehensive workbench guide takes you step by step through operation principles design procedures phase noise analysis layout considerations and CMOS realizations for each PLL building block You get full details on LC tank oscillators including modeling and optimization techniques followed by design options for CMOS frequency dividers covering flip flop implementation the divider by 2 component and other key factors The book includes design alternatives for phase detectors that feature methods to minimize jitter caused by the dead zone effect You also find a sample design of a fully integrated PLL for WLAN applications that demonstrates every step and detail right down to the circuit schematics and layout diagrams Supported by over 150 diagrams and photos this one stop toolkit helps you produce superior PLL designs faster and deliver more effective solutions for low cost integrated circuits in all RF applications

Phase-Locked Loops John L. Stensby,1997-06-19 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 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

Low-Noise Low-Power Design for Phase-Locked Loops Feng Zhao,Fa Foster Dai,2014-11-25 This book introduces low noise and low power design techniques for phase locked loops and their building blocks It summarizes the noise reduction techniques for fractional N PLL design and introduces a novel capacitive quadrature coupling technique for multi phase signal generation The capacitive coupling technique has been validated through silicon implementation and can provide low phase noise and accurate I Q phase matching with low power consumption from a super low supply voltage Readers will be enabled to pick one of the most suitable QVCO circuit structures for their own designs without additional effort to look for the optimal circuit structure and device parameters

Low Power RF Circuit Design in Standard CMOS Technology Unai Alvarado,Guillermo Bistué,Iñigo Adín,2011-10-18 Low Power Consumption is one of the critical issues in the performance of small battery powered handheld devices Mobile terminals feature an ever increasing number of wireless communication alternatives including GPS Bluetooth GSM 3G WiFi or DVB H Considering that the total power available for each terminal is limited by the relatively slow increase in battery performance expected in the near future the need for efficient circuits is now critical This book presents the basic techniques available to design low power RF CMOS analogue circuits It gives circuit designers a complete guide of alternatives to

optimize power consumption and explains the application of these rules in the most common RF building blocks LNA mixers and PLLs It is set out using practical examples and offers a unique perspective as it targets designers working within the standard CMOS process and all the limitations inherent in these technologies

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