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This newly revised and
expanded edition of the
2003 Artech House

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classic, Radio Frequency Integrated Circuit Design, serves as an up-to-date, practical reference for complete RFIC know-how. The second edition includes

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numerous updates,
including greater
coverage of CMOS PA
design, RFIC design with
on-chip components, and
more worked examples
with simulation results.

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By emphasizing working designs, this book practically transports you into the authors' own RFIC lab so you can fully understand the function of each design

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detailed in this book.
Among the RFIC designs
examined are RF
integrated LC-based
filters, VCO automatic
amplitude control loops,
and fully integrated

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transformer-based circuits, as well as image reject mixers and power amplifiers. If you are new to RFIC design, you can benefit from the introduction to basic

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theory so you can quickly come up to speed on how RFICs perform and work together in a communications device. A thorough examination of RFIC technology guides

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you in knowing when RFICs are the right choice for designing a communication device. This leading-edge resource is packed with over 1,000 equations and

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more than 435

illustrations that
support key topics."

This book describes the
design of
microelectronic circuits
for energy harvesting,

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broadband energy conversion, new methods and technologies for energy conversion. The author also discusses the design of power management circuits and

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the implementation of voltage regulators. Coverage includes advanced methods in low and high power electronics, as well as principles of micro-

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scale design based on piezoelectric, electromagnetic and thermoelectric technologies with control and conditioning circuit design.

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The only book on
integrated circuits for
optical communications
that fully covers High-
Speed IOs, PLLs, CDRs,
and transceiver design
including optical

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communication The increasing demand for high-speed transport of data has revitalized optical communications, leading to extensive work on high-speed

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device and circuit design. With the proliferation of the Internet and the rise in the speed of microprocessors and memories, the transport

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of data continues to be the bottleneck, motivating work on faster communication channels. Design of Integrated Circuits for Optical Communications,

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Second Edition deals with the design of high-speed integrated circuits for optical communication transceivers. Building upon a detailed

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understanding of optical devices, the book describes the analysis and design of critical building blocks, such as transimpedance and limiting amplifiers,

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laser drivers, phase-locked loops, oscillators, clock and data recovery circuits, and multiplexers. The Second Edition of this bestselling textbook has

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been fully updated with:
A tutorial treatment of
broadband circuits for
both students and
engineers New and unique
information dealing with
clock and data recovery

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circuits and
multiplexers A chapter
dedicated to burst-mode
optical communications A
detailed study of new
circuit developments for
optical transceivers An

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examination of recent implementations in CMOS technology This text is ideal for senior graduate students and engineers involved in high-speed circuit

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design for optical communications, as well as the more general field of wireline communications.

A transistor-level, design-intensive

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overview of high speed
and high frequency
monolithic integrated
circuits for wireless
and broadband systems
from 2 GHz to 200 GHz,
this comprehensive text

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covers high-speed, RF, mm-wave, and optical fibre circuits using nanoscale CMOS, SiGe BiCMOS, and III-V technologies. Step-by-step design

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methodologies, end-of chapter problems, and practical simulation and design projects are provided, making this an ideal resource for senior undergraduate and

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graduate courses in
circuit design. With an
emphasis on device-
circuit topology
interaction and
optimization, it gives
circuit designers and

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students alike an in-depth understanding of device structures and process limitations affecting circuit performance.

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Integrated Circuits and
Systems
RF and Microwave
Circuits, Measurements,
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Integrated Frequency
Synthesis for Convergent
Wireless Solutions

The Art of Analog Layout

***This book presents a
collection of peer-
reviewed articles from the***

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***7th International
Conference on
Microelectronics,
Circuits, and Systems -
Micro 2020. The volume
covers the latest
development and***

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***emerging research topics
of material sciences,
devices, microelectronics,
circuits, nanotechnology,
system design and
testing, simulation,
sensors, photovoltaics,***

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***optoelectronics, and its
different applications.
This book also deals with
several tools and
techniques to match the
theme of the conference.
It will be a valuable***

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***resource for researchers,
professionals, Ph.D.
scholars, undergraduate
and postgraduate
students working in
Electronics,
Microelectronics,***

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Electrical, and Computer Engineering.

The recent shift in focus from defense and government work to commercial wireless efforts has caused the job

of the typical microwave engineer to change dramatically. The modern microwave and RF engineer is expected to know customer expectations, market

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trends, manufacturing technologies, and factory models to a degree that is unprecedented in the This advanced text and reference covers the design and

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***implementation of
integrated circuits for
analog-to-digital and
digital-to-analog
conversion. It begins with
basic concepts and
systematically leads the***

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reader to advanced topics, describing design issues and techniques at both circuit and system level. Gain a system-level perspective of data conversion units and

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their trade-offs with this state-of-the art book.

***Topics covered include:
sampling circuits and
architectures, D/A and
A/D architectures;
comparator and op amp***

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***design; calibration
techniques; testing and
characterization; and
more!***

***With the exponential
growth of the number of
Internet nodes, the***

volume of the data transported on the backbone has increased with the same trend. The load of the global Internet backbone will soon increase to tens of

terabits per second. This indicates that the backbone bandwidth requirements will increase by a factor of 50 to 100 every seven years. Transportation of such

high volumes of data requires suitable media with low loss and high bandwidth. Among the available transmission media, optical fibers achieve the best

performance in terms of loss and bandwidth. High-speed data can be transported over hundreds of kilometers of single-mode fiber without significant loss in signal

integrity. These fibers progressively benefit from reduction of cost and improvement of performance. Meanwhile, the electronic interfaces used in an optical network are

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not capable of exploiting the ultimate bandwidth of the fiber, limiting the throughput of the network. Different solutions at both the system and the circuit

levels have been proposed to increase the data rate of the backbone. System-level solutions are based on the utilization of wave-division multiplexing (WDM), using different

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colors of light to transmit several sequences simultaneously. In parallel with that, a great deal of effort has been put into increasing the operating rate of the

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***electronic transceivers
using highly-developed
fabrication processes and
novel c- cuit techniques.
Design of Analog CMOS
Integrated Circuits
Unified Design of Steel***

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Structures

***Design of Integrated
Circuits for Optical
Communications***

***Modeling of Carbon
Nanotubes, Graphene and
their Composites***

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***High-Speed CMOS
Circuits for Optical
Receivers***

*By helping students develop
an intuitive understanding
of the subject,
Microelectronics teaches*

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them to think like engineers. The second edition of Razavi's Microelectronics retains its hallmark emphasis on analysis by inspection and building students' design intuition, and it

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incorporates a host of new pedagogical features that make it easier to teach and learn from, including: application sidebars, self-check problems with answers, simulation problems with SPICE and MULTISIM, and an

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expanded problem set that is organized by degree of difficulty and more clearly associated with specific chapter sections.

This modern, pedagogic textbook from leading author Behzad Razavi provides a

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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

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*perfect text for senior
undergraduate and graduate
students.*

*Composed of contributions
from top experts,
Microelectronics to
Nanoelectronics: Materials,
Devices and*

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Manufacturability offers a detailed overview of important recent scientific and technological developments in the rapidly evolving nanoelectronics arena. Under the editorial guidance and technical

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expertise of noted materials scientist Anupama B. Kaul of California Institute of Technology's Jet Propulsion Lab, this book captures the ascent of microelectronics into the nanoscale realm. It addresses a wide variety of

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important scientific and technological issues in nanoelectronics research and development. The book also showcases some key application areas of micro-electro-mechanical-systems (MEMS) that have reached the

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commercial realm.

Capitalizing on Dr. Kaul's considerable technical experience with micro- and nanotechnologies and her extensive research in prestigious academic and industrial labs, the book

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offers a fresh perspective on application-driven research in micro- and nanoelectronics, including MEMS. Chapters explore how rapid developments in this area are transitioning from the lab to the market, where

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new and exciting materials, devices, and manufacturing technologies are revolutionizing the electronics industry.

Although many micro- and nanotechnologies still face major scientific and

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technological challenges and remain within the realm of academic research labs, rapid advances in this area have led to the recent emergence of new applications and markets. This handbook encapsulates

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that exciting recent progress by providing high-quality content contributed by international experts from academia, leading industrial institutions—such as Hewlett-Packard—and government laboratories

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*including the U.S.
Department of Energy's
Sandia National Laboratory.
Offering something for
everyone, from students to
scientists to entrepreneurs,
this book showcases the
broad spectrum of cutting-*

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edge technologies that show significant promise for electronics and related applications in which nanotechnology plays a key role.

*The Acclaimed RF
Microelectronics Best-*

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*Seller, Expanded and Updated
for the Newest
Architectures, Circuits, and
Devices Wireless
communication has become
almost as ubiquitous as
electricity, but RF design
continues to challenge*

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*engineers and researchers.
In the 15 years since the
first edition of this
classic text, the demand for
higher performance has led
to an explosive growth of RF
design techniques. In RF
Microelectronics, Second*

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Edition, Behzad Razavi systematically teaches the fundamentals as well as the state-of-the-art developments in the analysis and design of RF circuits and transceivers. Razavi has written the second edition

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to reflect today's RF microelectronics, covering key topics in far greater detail. At nearly three times the length of the first edition, the second edition is an indispensable tome for both students and

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practicing engineers. With his lucid prose, Razavi now Offers a stronger tutorial focus along with hundreds of examples and problems Teaches design as well as analysis with the aid of step-by-step design

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*procedures and a chapter
dedicated to the design of a
dual-band WiFi transceiver
Describes new design
paradigms and analysis
techniques for circuits such
as low-noise amplifiers,
mixers, oscillators, and*

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frequency dividers This edition's extensive coverage includes brand new chapters on mixers, passive devices, integer-N synthesizers, and fractional-N synthesizers. Razavi's teachings culminate in a new chapter that begins

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with WiFi's radio specifications and, step by step, designs the transceiver at the transistor level. Coverage includes Core RF principles, including noise and nonlinearity, with ties to

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analog design, microwave theory, and communication systems An intuitive treatment of modulation theory and wireless standards from the standpoint of the RF IC designer Transceiver

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architectures such as heterodyne, sliding-IF, directconversion, image-reject, and low-IF topologies. Low-noise amplifiers, including cascode common-gate and commonsource topologies,

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*noise-cancelling schemes,
and reactance-cancelling
configurations Passive and
active mixers, including
their gain and noise
analysis and new mixer
topologies Voltage-
controlled oscillators,*

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phase noise mechanisms, and various VCO topologies dealing with noise-power-tuning trade-offs All-new coverage of passive devices, such as integrated inductors, MOS varactors, and transformers A chapter

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on the analysis and design of phase-locked loops with emphasis on low phase noise and low spur levels Two chapters on integer-N and fractional-N synthesizers, including the design of frequency dividers Power

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*amplifier principles and
circuit topologies along
with transmitter
architectures, such as polar
modulation and outphasing
Introduction to
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*In Conventional and
Miniature Systems*

*RF Circuit Design
With Robotics and
Bioengineering Applications*

**"One salient feature of this
book is its synthesis- or design-**

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oriented approach. Rather than pulling a circuit out of a bag and trying to analyze it, I set the stage by stating a problem that we face in real life (e.g., how to design a cellphone charger). I then

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attempt to arrive at a solution using basic principles, thus presenting both failures and successes in the process. When we do arrive at the final solution, the student has seen the exact role of each device as

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well as the logical thought sequence behind synthesizing the circuit. Another essential component of this book is "analysis by inspection." This "mentality" is created in two steps. First, the behavior of

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*elementary building blocks is formulated using a "verbal" description of each analytical result (e.g., "looking into the emitter, we see $1/g_m$ ").
Second, larger circuits are decomposed and "mapped" to*

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***the elementary blocks to avoid the need for writing KVLs and KCLs. This approach both imparts a great deal of intuition and simplifies the analysis of large circuits"--
For Electrical Engineering***

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courses in analog layout or professional layout designers. This text covers the issues involved in successfully laying out analog integrated circuits. Hastings provides clear guidance and does not stress

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theoretical physics or mathematical analysis of layouts. He emphasizes cross-sections of devices and carrier-based models of device operation as compared to the more common geometric and

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schematic representation of devices.

This is the only comprehensive book in the market for engineers that covers the design of CMOS and bipolar analog integrated circuits. The

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fifth edition retains its completeness and updates the coverage of bipolar and CMOS circuits. A thorough analysis of a new low-voltage bipolar operational amplifier has been added to Chapters 6, 7, 9, and

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11. Chapter 12 has been updated to include a fully differential folded cascode operational amplifier example. With its streamlined and up-to-date coverage, more engineers will turn to this resource to

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a mass and energy balance approach. ABET required topics of emerging importance, such as sustainable and global engineering are also covered. Problems, similar to those on the FE and PE exams, are

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integrated at the end of each chapter. Aligned with the National Academy of Engineering's focus on managing carbon and nitrogen, the 2nd edition now includes a section on advanced

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technologies to more effectively reclaim nitrogen and phosphorous. Additionally, readers have immediate access to web modules, which address a specific topic, such as water and wastewater treatment.

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These modules include media rich content such as animations, audio, video and interactive problem solving, as well as links to explorations. Civil engineers will gain a global perspective, developing

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*into innovative leaders in
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Integrated Circuits, 5th*

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and design of more types of propulsion systems Provides in-depth, quantitative treatments of the components of jet propulsion engines, including the tools for evaluation and component matching for optimal system performance Contains additional

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challenging end-of- chapter exercises
that provide practice for analysis,
preliminary design, and systems
integration
Focussing on micro- and
nanoelectronics design and technology,

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this book provides thorough analysis and demonstration, starting from semiconductor devices to VLSI fabrication, designing (analog and digital), on-chip interconnect modeling culminating with emerging non-silicon/nano devices. It gives detailed

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description of both theoretical as well as industry standard HSPICE, Verilog, Cadence simulation based real-time modeling approach with focus on fabrication of bulk and nano-devices. Each chapter of this proposed title starts with a brief introduction of the

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devices, circuit analysis, design methodology, and real-time simulation based on industry standard HSPICE tool. Explores emerging devices such as FinFETs, Tunnel FETs (TFETs) and CNTFETs including their circuit co-designing. Covers real time illustration

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using industry standard Verilog,
Cadence and Synopsys simulations.
A comprehensive introduction to
CMOS and bipolar analog IC design.
The book presumes no prior knowledge
of linear design, making it
comprehensible to engineers with a non-

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analog back-ground. The emphasis is on practical design, covering the entire field with hundreds of examples to explain the choices. Concepts are presented following the history of their discovery. Content: 1. Devices Semiconductors, The Bipolar

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Transistor, The Integrated Circuit,
Integrated NPN Transistors, The Case
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Transistors, The Substrate PNP
Transistor, Diodes, Zener Diodes,
Resistors, Capacitors, CMOS vs.
Bipolar; 2. Simulation, DC Analysis,

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AC Analysis, Transient Analysis, Variations, Models, Diode Model, Bipolar Transistor Model, Model for the Lateral PNP Transistor, MOS Transistor Models, Resistor Models, Models for Capacitors; 3. Current Mirrors; 4. Differential Pairs; 5.

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Current Sources; 6. Time Out: Analog Measures, dB, RMS, Noise, Fourier Analysis, Distortion, Frequency Compensation; 7. Bandgap References; 8. Op Amps; 9. Comparators; 10. Transimpedance Amplifiers; 11. Timers and Oscillators; 12. Phase-

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Multipliers, Peak Detectors, Rectifiers and Averaging Circuits, Thermometers, Zero-Crossing Detectors; 17. Layout. This book provides the most comprehensive and in-depth coverage of the latest circuit design developments in RF CMOS

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technology. It is a practical and cutting-edge guide, packed with proven circuit techniques and innovative design methodologies for solving challenging problems associated with RF integrated circuits and systems. This invaluable resource features a collection of the

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finest design practices that may soon drive the system-on-chip revolution. Using this book's state-of-the-art design techniques, one can apply existing technologies in novel ways and to create new circuit designs for the future.

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Design of CMOS Phase-Locked Loops
Circuits

Fundamentals, Sustainability, Design
Radio Frequency Integrated Circuit
Design

From Fundamentals to Applied Design
The focus of Thermodynamics:

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Concepts and Applications is on traditional thermodynamics topics, but structurally the book introduces the thermal-fluid sciences. Chapter 2 includes essentially all material related to thermodynamic properties clearly showing the hierarchy of thermodynamic state relationships.

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Element conservation is considered in Chapter 3 as a way of expressing conservation of mass. Constant-pressure and volume combustion are considered in Chapter 5 - Energy Conservation. Chemical and phase equilibria are treated as a consequence of the 2nd law in

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Chapter 6. 2nd law topics are introduced hierarchically in one chapter, important structure for a beginner. The book is designed for the instructor to select topics and combine them with material from other chapters seamlessly. Pedagogical devices include: learning objectives, chapter

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overviews and summaries, historical perspectives, and numerous examples, questions and problems and lavish illustrations. Students are encouraged to use the National Institute of Science and Technology (NIST) online properties database. The operational amplifier ("op amp") is

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the most versatile and widely used type of analog IC, used in audio and voltage amplifiers, signal conditioners, signal converters, oscillators, and analog computing systems. Almost every electronic device uses at least one op amp. This book is Texas Instruments' complete professional-

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level tutorial and reference to operational amplifier theory and applications. Among the topics covered are basic op amp physics (including reviews of current and voltage division, Thevenin's theorem, and transistor models), idealized op amp operation and configuration,

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feedback theory and methods, single and dual supply operation, understanding op amp parameters, minimizing noise in op amp circuits, and practical applications such as instrumentation amplifiers, signal conditioning, oscillators, active filters, load and level conversions, and

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analog computing. There is also extensive coverage of circuit construction techniques, including circuit board design, grounding, input and output isolation, using decoupling capacitors, and frequency characteristics of passive components. The material in this book is applicable

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to all op amp ICs from all manufacturers, not just TI. Unlike textbook treatments of op amp theory that tend to focus on idealized op amp models and configuration, this title uses idealized models only when necessary to explain op amp theory. The bulk of this book is on real-world

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op amps and their applications; considerations such as thermal effects, circuit noise, circuit buffering, selection of appropriate op amps for a given application, and unexpected effects in passive components are all discussed in detail. *Published in conjunction with Texas Instruments *A

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single volume, professional-level guide to op amp theory and applications

*Covers circuit board layout techniques for manufacturing op amp circuits.

This textbook deals with the analysis and design of analog CMOS integrated circuits, emphasizing recent

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technological developments and design paradigms that students and practicing engineers need to master to succeed in today's industry. Based on the author's teaching and research experience in the past ten years, the text follows three general principles:

- (1) Motivate the reader by describing

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the significance and application of each idea with real-world problems; (2) Force the reader to look at concepts from an intuitive point of view, preparing him/her for more complex problems; (3) Complement the intuition by rigorous analysis, confirming the results obtained by the intuitive, yet

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rough approach.

Highlighting the challenges RF and microwave circuit designers face in their day-to-day tasks, RF and Microwave Circuits, Measurements, and Modeling explores RF and microwave circuit designs in terms of performance and critical design

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specifications. The book discusses transmitters and receivers first in terms of functional circuit block and then examines each block individually. Separate articles consider fundamental amplifier issues, low noise amplifiers, power amplifiers for handset applications and high power,

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power amplifiers. Additional chapters cover other circuit functions including oscillators, mixers, modulators, phase locked loops, filters and multiplexers. New chapters discuss high-power PAs, bit error rate testing, and nonlinear modeling of heterojunction bipolar transistors, while other

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chapters feature new and updated material that reflects recent progress in such areas as high-volume testing, transmitters and receivers, and CAD tools. The unique behavior and requirements associated with RF and microwave systems establishes a need for unique and complex models

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and simulation tools. The required toolset for a microwave circuit designer includes unique device models, both 2D and 3D electromagnetic simulators, as well as frequency domain based small signal and large signal circuit and system simulators. This unique suite of tools

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requires a design procedure that is also distinctive. This book examines not only the distinct design tools of the microwave circuit designer, but also the design procedures that must be followed to use them effectively.

Design of CMOS RF Integrated Circuits and Systems

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Design and Technology

Op Amps for Everyone

Principles of Data Conversion System
Design

High-Frequency Integrated Circuits

This book describes the design
and implementation of an
electronic subsystem called the

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frequency synthesizer, which is a very important building block for any wireless transceiver. The discussion includes several new techniques for the design of such a subsystem which include the usage modes of the wireless device, including its support for

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several leading-edge wireless standards. This new perspective for designing such a demanding subsystem is based on the fact that optimizing the performance of a complete system is not always achieved by optimizing the performance of its building

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blocks separately. This book provides "hands-on" examples of this sort of co-design of optimized subsystems, which can make the vision of an always-best-connected scenario a reality.

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