

# HANDBOOK OF SENSORS AND ACTUATORS

Volume 2

Edited by J. R. Hayes

Co-Editor

## Solid State Magnetic Sensors

# Solid State Magnetic Sensors

**Huangqi Zhang**



## **Solid State Magnetic Sensors:**

**Solid State Magnetic Sensors** C.S. Roumenin, 1994-09-26 I am profoundly convinced that notwithstanding the great progress made in solid state magnetic sensors they are as yet in their cloudless infancy whereas there is still so much lying ahead in a world unlimited in time and space Good Heavens They are a whole Universe into themselves So expounds the author in his preface to this second volume in the exciting new series Handbook of Sensors and Actuators The publication presents a balanced view of the overall progress made in the field whilst summing up scientific achievements as the groundwork for further development Readers will find for the first time collected in one book detailed information regarding the physical mechanisms of the origin of magnetosensitivity the geometry and design of devices operating modes basic parameters and methods for their determination the incorporation of transducers in circuits and smart solutions many varied applications and other problems relevant to all the current Hall sensors magnetodiodes magnetotransistors carrier domain magnetometers SQUID s Superconducting Quantum Interference Devices and similar transducers of magnetic energy Particular attention is devoted to semiconductor magnetosensitive sensors and their microelectronic versions since development rates in this area signify a dominant research trend for the future Undoubtedly this book will become a vital reference tool for the ever widening circle of researchers and engineers interested in solid state magnetosensors It also makes a fundamental contribution to the handbook series as a whole

**Development of CMOS Solid State Magnetic Sensors** John G. Doyle, 2004 A magnetic field sensor is a transducer that is capable of converting a magnetic field  $H$  into a useful electronic signal These are used in a wide range of applications including retrieving data in the computer industry by reading magnetic tapes or disks or reading magnetic ink on banknotes cashcards or credit cards for identification purposes contactless switching linear and angular displacement detection e g in automotive systems and potential free current detection A majority of solid state magnetic field sensors made to date have been built on bipolar processes However it would be beneficial to obtain similar levels of capability in magnetic sensors in CMOS because this would allow magnetic sensors to be integrated into the present mainstream semiconductor technology This thesis describes a research effort to improve the sensing capability of silicon magnetic field detectors through circuit innovation such that it is possible to develop a high performance low power magnetic sensing capability in standard CMOS without extra exotic process steps or the requirement to have flux concentrators or other external devices in order to boost the sensing capability of the CMOS device There are three circuits described in this work The first a magnetic sensitive amplifier achieved the highest figure of merit  $16\text{kV AT}$  reported at the time of its publication The second device was the lowest power magnetic sensor at the time of its publication and could sense  $1\text{mT}$  while running on  $100\text{nA}$  The third used a novel noise reduction scheme to sense lower levels of magnetic field  $0.18\text{mT}$  than had been reported for a CMOS device to date and provides a path to improved performance in future The work in this thesis demonstrates that it is possible through circuit design innovation to deliver highly sensitive low

power magnetic sensors in standard CMOS      Sensors, Magnetic Sensors Wolfgang Göpel, Joachim Hesse, J. N. Zemel, 2008-11-20 Sensors is the first self contained series to deal with the whole area of sensors It describes general aspects technical and physical fundamentals construction function applications and developments of the various types of sensors This volume presents for the first time a comprehensive description of magnetic sensors with special emphasis placed upon technical and scientific fundamentals It provides important definitions and a unique overview of concepts and the nature and principles of magnetic fields General questions concerning all types of magnetic sensors such as those pertaining to material noise etc are treated Each chapter contains physical and mathematical fundamentals and applied technical concepts In addition each chapter presents an outline of the most important applications measurement ranges and accuracy of sensing etc This volume is an indispensable reference work and text book for both specialists and newcomers researcher and developers

**Magnetic Sensors and Magnetometers, Second Edition** Pavel Ripka, 2021-07-31 This completely updated second edition of an Artech House classic covers industrial applications and space and biomedical applications of magnetic sensors and magnetometers With the advancement of smart grids renewable energy resources and electric vehicles the importance of electric current sensors increased and the book has been updated to reflect these changes Integrated fluxgate single chip magnetometers are presented GMR sensors in the automotive market especially for end of shaft angular sensors are included as well as Linear TMR sensors Vertical Hall sensors and sensors with integrated ferromagnetic concentrators are two competing technologies which both brought 3 axial single chip Hall ICs are considered Digital fluxgate magnetometers for both satellite and ground based applications are discussed All optical resonant magnetometers based on the Coherent Population Trapping effect has reached approval in space and is covered in this new edition of the book Whether you re an expert or new to the field this unique resource offers you a thorough overview of the principles and design of magnetic sensors and magnetometers as well as guidance in applying specific devices in the real world The book covers both multi channel and gradiometric magnetometer systems special problems such as cross talk and crossfield sensitivity and comparisons between different sensors and magnetometers with respect to various application areas Miniaturization and the use of new materials in magnetic sensors are also discussed A comprehensive list of references to journal articles books proceedings and webpages helps you find additional information quickly

**Nanosensors** Vinod Kumar Khanna, 2021-02-25 Nanosensors are innovative devices that exploit the unique properties exhibited by matter at the nanoscale A growing and exciting field nanosensors have recently spurred considerable research endeavors across the globe driving a need for the development of new device concepts and engineering nanostructured materials with controlled properties Nanosensors Physical Chemical and Biological Second Edition offers a panoramic view of the field and related nanotechnologies with extraordinary clarity and depth Presenting an interdisciplinary approach blending physics chemistry and biology this new edition is broad in scope and organised into six parts beginning with the fundamentals before moving onto nanomaterials and

nanofabrication technologies in the second part The third and fourth parts provide a critical appraisal of physical nanosensors and explore the chemical and biological categories of nanosensors The fifth part sheds light on the emerging applications of nanosensors in the sectors of society industry and defense and details the cutting edge applications of state of the art nanosensors in environmental science food technology medical diagnostics and biotechnology The final part addresses self powering and networking issues of nanosensors and provides glimpses of future trends This is an ideal reference for researchers and industry professionals engaged in the frontier areas of material science and semiconductor fabrication as well as graduate students in physics and engineering pursuing electrical engineering and electronics courses with a focus on nanoscience and nanotechnology Key features Provides an updated all encompassing exploration of contemporary nanosensors and highlights the exclusive nanoscale properties on which nanosensors are designed Presents an accessible approach with a question and answer format to allow an easy grasp of the intricacies involved in the complex working mechanisms of devices Contains clear illustrative diagrams enabling the visualization of nanosensor operations along with worked examples end of chapter questions and exhaustive up to date bibliographies appended to each chapter

**Introduction to Sensors** John Vetelino, Aravind Reghu, 2017-12-19 The need for new types of sensors is more critical than ever This is due to the emergence of increasingly complex technologies health and security concerns of a burgeoning world population and the emergence of terrorist activities among other factors Depending on their application the design fabrication testing and use of sensors all require various kinds of both technical and nontechnical expertise With this in mind Introduction to Sensors examines the theoretical foundations and practical applications of electrochemical piezoelectric fiber optic thermal and magnetic sensors and their use in the modern era Incorporating information from sensor based industries to review current developments in the field this book Presents a complete sensor system that includes the preparation phase the sensing element and platform and appropriate electronics resulting in a digital readout Discusses solid state electronic sensors such as the metal oxide semiconductor MOS capacitor the micromachined capacitive polymer and the Schottky diode sensors Uses the two dimensional hexagonal lattice as an example to detail the basic theory associated with piezoelectricity Explores the fundamental relationship between stress strain electric field and electric displacement The magnetic sensors presented are used to determine measurands such as the magnetic field and semiconductor properties including carrier concentration and mobility Offering the human body and the automobile as examples of entities that rely on a multiplicity of sensors the authors address the application of various types of sensors as well as the theory and background information associated with their development and the materials used in their design The coverage in this book reveals the underlying rationale for the application of different sensors while also defining the properties and characteristics of each Magnetic Sensors and Devices Laurent A. Francis, Kirill Poletkin, 2017-10-18 This book presents in depth coverage of magnetic sensors in industrial applications It is divided into three sections devices and technology for magnetic sensing industrial applications

automotive navigation and emerging applications Topics include transmission speed sensor ICs dynamic differential Hall ICs chopped Hall switches programmable linear output Hall sensors low power Hall ICs self calibrating differential Hall ICs for wheel speed sensing dynamic differential Hall ICs uni and bipolar Hall IC switches chopped mono cell Hall ICs and electromagnetic levitation

*Magnetic Sensors for Biomedical Applications* Hadi Heidari,Vahid Nabaei,2019-12-24 An important guide that reviews the basics of magnetic biosensor modeling and simulation *Magnetic Sensors for Biomedical Applications* offers a comprehensive review of magnetic biosensor modelling and simulation The authors noted experts on the topic explore the model s strengths and weaknesses and discuss the competencies of different modelling software including homemade and commercial for example Multi physics modelling software The section on sensor materials examines promising materials whose properties have been used for sensing action and predicts future smart materials that have the potential for sensing application Next the authors present classifications of sensors that are divided into different sub types They describe their working and highlight important applications that reveal the benefits and drawbacks of relevant designs The book also contains information on the most recent developments in the field of each sensor type This important book Provides an even treatment of the major foundations of magnetic biosensors Presents problem solution methods such as analytical and numerical Explains how solution methods complement each other and offers information on their materials design computer aided modelling and simulation optimization and device fabrication Describes modeling work challenges and solutions Written for students in electrical and electronics engineering physics chemistry biomedical engineering and biology *Magnetic Sensors for Biomedical Applications* offers a guide to the principles of biomagnetic sensors recent developments and reveals the impact of sensor modelling and simulation on magnetic sensors

*Solid-State Physics* Nikhil Lakhani,2025-02-20 *Solid State Physics Core Principles* delves into recent advancements particularly in quantum materials Edited by experts we cover both foundational concepts and cutting edge research We begin with basics like crystal structures and electronic properties of solids then explore exciting areas such as topological insulators and superconductors A key theme is discovering new quantum materials with unique properties We examine how these materials are created studied and their potential use in future technologies like quantum computing Another important aspect is the advanced techniques used to understand these materials We discuss complex experiments and computer modeling that allow scientists to manipulate materials at the atomic level Additionally we highlight how solid state physics connects to other fields like materials science and nanotechnology emphasizing interdisciplinary collaboration for future breakthroughs *Solid State Physics Core Principles* is a valuable resource for researchers and students interested in the latest developments in solid state physics We provide a comprehensive overview of the field while looking towards future directions and the potential of quantum materials to revolutionize technology

*Magnetic Sensors and Actuators in Medicine* Horia Chiriac,Nicoleta Lupu,2023-07-15 *Magnetic Sensors and Actuators in Medicine Materials Devices and Applications* provides an overview of

the various sensors and actuators their characteristics role in the development of medical applications the medical problems they solve and future directions The book brings together recent advances in the physics chemistry and engineering of magnetic materials related to sensors and actuators that improve their functions in medical applications The book describes the main applications of magnetic sensors and actuators starting from the common and emerging magnetic materials their principles of operation the medical problems that they are used to address and the latest achievements in the field Reviews a wide range of magnetic sensors and actuators employed in medical applications such as diagnosis surgery and therapy Describes magnetic material based sensors and actuators including their operation principles properties and optimization for specific applications Includes examples of recent advances such as emerging magnetic materials magnetic nanowires nanorods and or nanotubes

**Next-Generation ADCs, High-Performance Power Management, and Technology Considerations for Advanced Integrated Circuits** Andrea Baschiroto, Pieter Harpe, Kofi A. A. Makinwa, 2019-10-24 This book is based on the 18 tutorials presented during the 28th workshop on Advances in Analog Circuit Design Expert designers present readers with information about a variety of topics at the frontier of analog circuit design including next generation analog to digital converters high performance power management systems and technology considerations for advanced IC design For anyone involved in analog circuit research and development this book will be a valuable summary of the state of the art in these areas Provides a summary of the state of the art in analog circuit design written by experts from industry and academia Presents material in a tutorial based format Includes coverage of next generation analog to digital converters high performance power management systems and technology considerations for advanced IC design

**Sensor Materials** P.T Moseley, J Crocker, 2020-11-25 Because artificial sensors have assumed a major role in both domestic and industrial settings the development of new technologies continues Sensor Materials is the first publication that approaches the subject of sensors from a materials standpoint and provides a global overview of the field in a single compact and accessible volume Introductory chapters present a solid introduction to the classification of sensors and the various properties of materials used in sensing The subsequent chapters deal with specific areas of sensor materials including metal semiconductor dielectric solid electrolytic magnetic fiber optics radiant and biological materials In addition there is substantial bibliographic information that provides a source of published research literature for each sensor

**Current Developments in Solid-state Fermentation** Ashok Pandey, Carlos Ricardo Soccol, Christian Larroche, 2008-09-16 Over the period of last two decades there has been significant resurgence in solid state fermentation due to the numerous benefits it offers especially in the engineering and environmental aspects SSF has shown much promise in the development of several bioprocesses and products This resurgence gained further momentum during the last 5 6 years with the developments in fundamental and applied aspects A good deal of information has been generated in published literature and patented information Several commercial ventures have come up based on SSF in different parts of the world The contents are organized into four parts

Part 1 deals with the General and Fundamentals aspects of SSF Part 2 deals with the production of bulk chemicals and products such as enzymes organic acids spores and mushrooms in SSF Part 3 is on the use of SSF for specialty chemicals such as gibberellic acid antibiotics and other pharmaceutically valuable secondary metabolites pigments and aroma compounds Part 4 deals with the use of SSF miscellaneous application such as SSF for food and feed applications agro industrial residues as substrates in SSF and the production of silage and vermicompost

**Sensors for Automotive Applications** Jiri Marek,Hans-Peter Trah,Yasutoshi Suzuki,Iwao Yokomori,2006-03-06 Taken as a whole this series covers all major fields of application for commercial sensors as well as their manufacturing techniques and major types As such the series does not treat bulk sensors but rather places strong emphasis on microsensors microsystems and integrated electronic sensor packages Each of the individual volumes is tailored to the needs and queries of readers from the relevant branch of industry An international team of experts from the leading companies in this field gives a detailed picture of existing as well as future applications They discuss in detail current technologies design and construction concepts market considerations and commercial developments Topics covered include vehicle safety fuel consumption air conditioning emergency control traffic control systems and electronic guidance using radar and video

*Fiber Optic Sensors* Ignacio R. Matias,Satoshi Ikezawa,Jesus Corres,2016-11-01 This book describes important recent developments in fiber optic sensor technology and examines established and emerging applications in a broad range of fields and markets including power engineering chemical engineering bioengineering biomedical engineering and environmental monitoring Particular attention is devoted to niche applications where fiber optic sensors are or soon will be able to compete with conventional approaches Beyond novel methods for the sensing of traditional parameters such as strain temperature and pressure a variety of new ideas and concepts are proposed and explored The significance of the advent of extended infrared sensors is discussed and individual chapters focus on sensing at THz frequencies and optical sensing based on photonic crystal structures Another important topic is the resonances generated when using thin films in conjunction with optical fibers and the enormous potential of sensors based on lossy mode resonances surface plasmon resonances and long range surface exciton polaritons Detailed attention is also paid to fiber Bragg grating sensors and multimode interference sensors Each chapter is written by an acknowledged expert in the subject under discussion

*Essderc'98* ,1998

**Spintronics** Puja Dey,Jitendra Nath Roy,2021-04-13 This book highlights the overview of Spintronics including What is Spintronics Why Do We Need Spintronics Comparative merit demerit of Spintronics and Electronics Research Efforts put on Spintronics Quantum Mechanics of Spin Dynamics of magnetic moments Landau Lifshitz Gilbert Equation Spin Dependent Band Gap in Ferromagnetic Materials Functionality of Spin in Spintronics Different Branches of Spintronics etc Some important notions on basic elements of Spintronics are discussed here such as Spin Polarization Spin Filter Effect Spin Generation and Injection Spin Accumulation Different kinds of Spin Relaxation Phenomena Spin Valve Spin Extraction Spin Hall Effect Spin Seebeck Effect Spin Current



Measurement Mechanism Magnetoresistance and its different kinds etc Concept of Giant Magnetoresistance GMR different types of GMR qualitative and quantitative explanation of GMR employing Resistor Network Theory are presented here Tunnelling Magnetoresistance TMR Magnetic Junctions Effect of various parameters on TMR Measurement of spin relaxation length and time in the spacer layer are covered here This book highlights the concept of Spin Transfer Torque STT STT in Ferromagnetic Layer Structures STT driven Magnetization Dynamics STT in Magnetic Multilayer Nanopillar etc This book also sheds light on Magnetic Domain Wall MDW Motion Ratchet Effect in MDW motion MDW motion velocity measurements Current driven MDW motion etc The book deals with the emerging field of spintronics i e Opto spintronics Special emphasis is given on ultrafast optical controlling of magnetic states of antiferromagnet Spin photon interaction Faraday Effect Inverse Faraday Effect and outline of different all optical spintronic switching One more promising branch i e Terahertz Spintronics is also covered Principle of operation of spintronic terahertz emitter choice of materials terahertz writing of an antiferromagnetic magnetic memory device is discussed Brief introduction of Semiconductor spintronics is presented that includes dilute magnetic semiconductor ferromagnetic semiconductor spin polarized semiconductor devices three terminal spintronic devices Spin transistor Spin LED and Spin Laser This book also emphasizes on several modern spintronics devices that includes GMR Read Head of Modern Hard Disk Drive MRAM Position Sensor Biosensor Magnetic Field sensor Three Terminal Magnetic Memory Devices Spin FET Race Track Memory and Quantum Computing

*Innovative Testing and Measurement Solutions for Smart Grid* Qi Huang, Shi Jing, Jianbo Yi, Wei Zhen, 2016-04-25 Focuses on sensor applications and smart meters in the newly developing interconnected smart grid Focuses on sensor applications and smart meters in the newly developing interconnected smart grid Presents the most updated technological developments in the measurement and testing of power systems within the smart grid environment Reflects the modernization of electric utility power systems with the extensive use of computer sensor and data communications technologies providing benefits to energy consumers and utility companies alike The leading author heads a group of researchers focusing on the construction of smart grid and smart substation for Sichuan Power Grid one of the largest in China's power system

**Sensors for Mobile Robots** H.R. Everett, 1995-07-15 The author compiles everything a student or experienced developmental engineer needs to know about the supporting technologies associated with the rapidly evolving field of robotics From the table of contents Design Considerations Dead Reckoning Odometry Sensors Doppler and Inertial Navigation Typical Mobility Configurations Tactile and

*Sensors and Actuators in Mechatronics* Andrzej M Pawlak, 2017-12-19 From large scale industrial systems to components in consumer applications mechatronics has woven itself into the very fabric of modern technology Among the most important elements of mechatronic systems are electromagnetic sensors and electromechanical actuators Cultivated over years of industrial and research experience *Sensors and Actuators in Mechatronics Design and Applications* builds a practical understanding of the features and functions of various electromagnetic and electromechanical devices necessary to

meet specific industrial requirements This work focuses on various components that receive less attention in the available literature such as magnetic sensors linear and latching solenoid actuators stepper motors rotary actuators and other special magnetic devices including magnetic valves and heart pumps Each chapter follows a consistent format working from theory to design applications and numerical problems and solutions Although the crux of the coverage is design and application the author also discusses optimization and testing introduces magnetic materials and shares his enlightened perspective on the social and business aspects of developing world class technologies Examples from mainly the automotive industry illustrate the wide variety of mechatronic devices presented Providing a complete picture from conception to completion Sensors and Actuators in Mechatronics Design and Applications places critical tools in the hands of any researcher or engineer seeking to develop innovative mechatronic systems

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